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ABSTRACT

This project was designed to develop a combinational strategy using microcomputers and cross-aged instruction designed to: (1) increase the achievement of low-achieving sixth-grade students; (2) increase enrollment in high school mathematics and science courses; (3) evaluate microcomputers as a unique instructional tool; and (4) develop effective applications of microcomputers. Thirty-four high school students served as tutors for 34 sixth-grade students. During an 18-week pre-tutoring period, the high school students were trained to be tutors using microcomputers. During the 18-week tutoring period, the high school students tutored the sixth-grade students. Pre- and post-treatment data were collected on the mathematics achievement and attitudes of both groups, as well as data on attendance and enrollment. The methodology used is described, and the results, conclusions and recommendations are presented. The combinational strategy had no noticeable effect on the achievement of the sixth-grade students. Their attitudes toward mathematics, computers, and science and technology were positive, but not influenced by the tutoring; the high school students' attitudes toward computers became significantly more positive. Appendices include the instruments used in the project. (MNS)

NSF #SED 79-18974
FINAL REPORT

PERSONAL COMPUTERS AND CROSS AGED INSTRUCTION

Final Report for NSF Project SED 79-18974 *

by

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The principal investigator would like to thank the following persons who were directly involved in carrying out the project; Dr. Kathy Gilbert-MacMillan, now an Assistant Professor in the College of Education, Rutgers University, who had the initial concept; Mr. Paul Canny, the teacher of project classes, who had too many tasks to accomplish and did an outstanding job of carrying them out; James Podolak (now Dr. Podolak) and William Blubaugh, the Research Assistants on the project; Mr. Randy Wallace, who was the original school system contact; Richard Turner, Dean of the School of Education, University of Colorado-Boulder, who provided a great amount of financial support and personnel time; and lastly, the sixth grade and high school student subjects (and their parents), perhaps the most delightful ingredient in this exercise.

As with with most all research endeavors many people were indirectly and indispensibly involved in completing this project; the teachers of classes from which the sixth grade subjects were drawn; the counselors at the high school; principals, clerical staff, and custodians of the three schools involved; the bus drivers who were patient and provided safe transportation; and the central office adminstrators and staff who tolerated the project interfering with the regular routine of running the school system.

Lastly to my wife and children for their love and patience with me while all this was going on.

Marc Swadener, Principal Investigator

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CHAPTER 1

Introduction

Historical Perspective

This project has its historical beginnings in the early 1970's. At that time there was an undergraduate student (Ms. Kathleen Gilbert) majoring in mathematics at the University of Colorado- Boulder. She completed her bachelor's degree along with teacher certification and accepted a teaching position in a public school in the Denver area. Her involvement in teaching was intense and she soon became involved with computers and constructed a microcomputer for her school. She left public school teaching to seek a master's degree in instructional computing at the State University of New York (SUNY) at Stoney Brook. Within that master's degree she completed a project which was done on consultation with the principal investigator of the project reported here. This master's degree project was submitted to The National Science Foundation in 1978 as a preliminary proposal and ultimately was selected for a formal proposal. The research proposed in this formal proposal was funded to begin in the fall of 1980 (NSF #SED 79-18974), and is the project reported here, and with this report is now complete. Ms. Gilbert (now Dr. Kathleen Gilbert-MacMillan) has since completed her master's degree, and a PhD degree at Stanford University and is now an assistant professor at Rutgers University. Without her initial conception this project would not have taken place. Her concern for the well being of students and seeking a better foundation for teaching are clearly reflected in this report.

Program Description

The goals of NSF project #SED 79-18974, titled "Personal Computers and Cross Aged Instruction" were to develop a combinational strategy using personal computers and cross-aged instruction in order to:

1. Increase the level of basic mathematical skill of mathematically low-achieving sixth grade students.

2. Increase the number of students enrolling in high school mathematics and science courses.

3. Evaluate microcomputers as a unique instructional tool.

4. Develop effective applications of microcomputers in education.

The plan for the attainment of these goals included the selection of about thirty able high school students and about thirty mathematically low achieving sixth graders. These groups served as the experimental groups in the project classes. Groups of nearly corresponding size were selected to serve as control groups. The experimental group high school students served as tutors for the sixth grade experimental students. Tutoring was done in mathematics. The "treatment period" of the project was divided into two parts, the pre-tutoring period and the tutoring period. During the pre-tutoring period, eighteen weeks in the Fall semester 1981, the high school students studied specific areas of mathematical weakness of the thirty sixth grade students, became familiar with the operation of microcomputers and existing software, and generated their own software for the purpose of tutoring the sixth graders. During the tutoring period of the project, eighteen weeks in the Spring semester of 1982, the high school students tutored, on a one-to-one basis, the sixth grade students using the microcomputer as a tool and continued their study of mathematics and microcomputers.

The desired results of the project included an increase in mathematical skills for the sixth grade students and increased enrollment in mathematics and science courses for the high school students.

School involvement in the project was in effect for the 1980-81 and 1981-82 school years. The fall semester 1980 was for planning, spring semester 1980-81 was the pilot period (a compressed version of the 1981-82 year) and the 1981-82 school year was the experimental period. Data collection continued through Spring 1983, data analyses and writing of this report continued through Fall 1983.

Remaining Parts of this Report

The remaining parts of this report describe in detail the methodology used in the project, give the project director's final report, give the statistical procedures used and present the results, provide discussion of statistical and non- statistical results, and give conclusions and recommendations based on what was learned in the conduct of this project.

Chapter 2

Methodology

The methodology of the project was designed to address the goals specified above. This chapter is divided into sections discussing; the selection of the school district, the equipment used, target populations, samples, selection criteria, data utilized, instrumentaion, the community, the pilot pre-tutoring period, experimental pre-tutoring period, pilot tutoring period, experimental tutoring period.

Selection of the School District

The process of selecting a school district in which to conduct the project had several stages. In the preliminary grant request one school district had expressed interest in cooperating and had given preliminary approval for conducting the project in that school district. Subsequent to this and prior to submission of the formal proposal to the NSF there was a change in direction within that district and the administration within that district decided to not pursue implementation. The principal investigator then contacted several school districts and chose the St. Vrain School District, Longmont, Colorado, for continuing association with the project. There were several reasons for choosing the St. Vrain Schools:

1. Of the several school systems contacted, the St. Vrain system had just completed an internal study concerning the direction that was to be taken with respect to instructional computing. The report was supportive of the innovative use of microcomputers in instruction. Two other school systems that were

contacted were in the process of completing similar studies and it was felt that to enter a confounding factor in these internal studies would not give the chance for those school systems to make decisions with minimal influence from outside sources. Each of these two school systems has since completed these studies.

2. The St. Vrain system was not so large that internal procedures of the district could unduly delay the conduct of the study.

3. The mix of ethnic groups in the St. Vrain system was reasonably representative of the mix in the Rocky Mountain West.

4. The principal investigator had a long history of active contact with the St. Vrain Schools, as he has had with many districts in the state.

5. The administration of the St. Vrain school system had expressed overwhelming commitment to carrying out the project from the time of first contact.

The last of these points is very important in instituting a project in public schools. Without this, any project would have serious difficulty. Even with this committment many problems arose that could not be foreseen.

Equipment Used

The equipment used in the project were nine APPLE II+, 48K single disk drive (DOS 3.3) microcomputers with language systems, nine color monitors, three Epson MX-80 printers, and three APPLE graphics tablets.

Target Populations

Two target populations were of interest; (1) mathematically able tenth and eleventh grade students, and (2) mathematically low achieving sixth graders.

Samples

The samples of students for this study were selected from schools in the St. Vrain Valley Public Schools, Longmont, Colorado. The sample from the population of high school students consisted of 34 students (29 in the pilot phase) from Skyline High School. A control group of equal size was selected from this same school. The high school control group was a random selection of students from three existing mathematics classes at the high school. The sample of sixth graders consisted of 34 (29 for the pilot phase) students selected from the students in Columbine and Spangler Elementary Schools. The sixth grade control group consisted of the remaining sixth graders at these schools. The distribution of subjects by sex, group and level is given in Table 1 (p. 20).

Selection Criteria

Secondary students were to be selected based on the following criteria.

1. Expressed interest.
2. Parental approval (see Appendix A for consent forms).
3. Concurrent enrollment in either Geometry or Algebra II.
4. Enrollment in grade ten or eleven.
5. Stanford Achievement Test - mathematics score at or above the fifth stanine.

An appropriate size sample (n=29) of experimental secondary students, for the pilot phase, was achieved without culling from a larger than needed supply of students satisfying the above criteria. This had both an advantage and a disadvantage. The advantage was that there was no need to reject students for the experimental group. This prevented having students diappointed at not being selected. The disadvantage was that there was no readily available control group, that is, those students who were not selected from the pool of candidates who satisfied the above criteria. This delayed the identification of control group.

Identification of the experimental and control groups for the experimental phase was not as easily accomplished. Due to unknown causes the announcement of the availability of the project classes was not included in the schedule of courses for the fall semester 1981 at Skyline High School. Because of this, when the time came for the project classes to begin there were only four students enrolled in the two project classes (these were to be the experimental group). Project staff therefore had to search for students who had some interest and some freedom in their schedules to add project classes. An additional thirty students were recruited, however the background of the resulting experimental group did not meet the desired criteria. A high school control group for the experimental phase consisted of students enrolled in three existing mathematics classes; consumer mathematics, algebra II, and geometry.

The criteria for selection for the experimental group of sixth grade students was the following:

1. Enrollment in the sixth grade.

2. A score of less than the sixtieth percentile on the district-wide criterion referenced (CRT) mathematics test.

3. Parental approval (see Appendix A for consent forms).

4. Teacher recommendation.

The last of these criteria was included since it was conceivable that some personal factors might prevent a student from benefiting from a one- on- one tutoring situation. Teachers seemed to be the best source for such information. There was no difficulty in identifying sufficient numbers of students for the sixth grade experimental group given these criteria. Working with two elementary schools and desiring about thirty students satisfying these criteria caused the project staff to resort to a control group that was a random selection of the remaining sixth graders. This in turn caused the use of statistical analyses which would statistically equate the experimental and control groups on selected covariates.

Data Utilized

Numerical data were collected on each of the subjects in the study in order to provide the basis for analyses. For each of the high school students in both the experimental and control groups, the following data were collected.

1. Ninth grade Stanford Test of Academic Skill score (Mathematics): during the experimental phase this test was administered by the project staff as a pre- and post- test.

2. Sex

3. Age

4. Grade level

5. Source mathematics class

6. Score on an attitude scale: for the pilot phase this was a short attitude toward mathematics scale, for the experimental phase this was a scale assessing attitudes toward mathematics, technology and computers as a pre- and post- test.

7. Attendance by period of the day and days per year

8. Enrollment data with respect to the classes in which participants choose to enroll.

For each of the elementary students in the experimental and control groups the following data were collected.

1. Criterion referenced mathematics test score, a school district test administered on a pre- and post- test basis.

2. School

3. Class

4. Sex

5. Attitude toward mathematics, technology and computers (post test only).

6. Computer literacy scale - experimental phase only.

7. Attendance data in days per semester and year.

Parental reaction to the project was solicited through a locally prepared mailed questionnaire.

During the pilot phase, when possible, data were collected from existing school records. For the experimental phase the project staff administered a number of instruments specifically for the project in order to assure more complete data on participants.

Anectdotal information was collected throughout the conduct of the project.

Instrumentation

Five instruments were used to gather data for the project; 1) a criterion referenced mathematics test, 2) two attitude scales, one for sixth grade students the other for the high school students, 3) the Stanford Test of Academic Skill- Mathematics, and 4) a parent questionnaire.

Criterion Referenced Mathematics Test

The criterion referenced mathematics test (Appendix C) was used to measure the mathematics achievement of the sixth graders. The test consists of 76 multiple choice mathematics items in three categories; whole numbers, fractions, and decimals. The test was developed by the St. Vrain School District and is used to test incoming sixth graders each year. This, and the fact that project staff wanted to minimize special testing was the reason that this test was used for the mathematics achievement measure. The test was scored on the basis of the percent of items the subject responded to correctly (minimum score of 0 and a maximum score of 100). The test was administered by the school district at the beginning of the year, and was used as a pre- test and for selection of subjects for the project, using the above criteria. The pre- test score was also used as a covariate for analyses purposes. In addition, the test was administered as a post- test, by the project staff, to all sixth graders in the two schools in the 1981-82 school year. The post- test score for each of the sections as well as the composite score were criterion measures for the project. The number of items and sub- scale reliabilities, computed by the Hoyt method, are given in Table 2

(p. 21).

Sixth Grade Attitude Instrument

The instrument used to measure the attitude of the sixth graders (Appendix B) was developed by the project staff specifically for this purpose. It consists of 84, five alternative Likert scale, items with alternatives ranging from "Strongly Disagree" to "Strongly Agree." The test was designed with three sub- scales, attitude toward mathematics, computers, and science and technology. Students responded on mark sense answer sheets. In scoring the completed instruments, weights of -2, -1, 0, 1 and 2 were assigned to responses "Strongly Disagree," "Disagree," "No Opinion," "Agree," and "Strongly Agree," respectively. Items with negative wording were scored in reverse. The resulting coding for all the items within a sub- scale were then summed and this sum transformed so that a scores would range on a continuum of -100 to +100, -100 being the maximum negative attitude and +100 being the maximum positive attitude. The number of items and scale reliabilities, computed by the Hoyt method, are given in Table 2 (p. 21). Items for the three sub- scales are randomly arranged within the instrument and are approximately balanced between positive and negative wording. The instrument was administered on a post- test basis only. The three scores from the test were used as criterion measures for the sixth graders. The instrument was tested for level of readability, using a program titled "Readability Analysis 2.0" published by Random House, Inc. for the APPLE II+ computer (MicroLIne, 1981). The average readability level for the instrument is grade 5.7, which is pre- sixth grade, and thus appropriate for sixth grade students. The average is computed based on the results of four readability tests conducted on the complete instrument not a portion of the instrument. The four tests are; the Dale, Fog, Flesch and Smog tests. These four tests (and others) are included within the "Readability" software..

High School Attitude Instrument

The instrument used to measure the attitude of the high school students (Appendix D) was also developed by the project staff specifically for this purpose. It consists of 90, five alternative Likert scale, items with alternatives ranging from "Strongly Disagree" to "Strongly Agree." Subjects responded on mark sense answer sheets. The test was designed with three sub-scales, attitude toward mathematics, computers, and science and technology. In scoring the completed instruments, weights of -2, -1, 0, 1 and 2 were assigned to responses "Strongly Disagree," "Disagree," "No Opinion," "Agree," and "Strongly Agree," respectively. Items with negative wording were scored in reverse. The resulting coding for all the items within a sub- scale were then summed and this sum transformed so that a scores would range on a continuum of -100 to +100, -100 being the maximum negative attitude and +100 being the maximum positive attitude. The number of items and scale reliabilities, computed by the Hoyt method, are given in Table 2 (p. 21). Items for the three sub- scales are randomly arranged within the instrument and are approximately balanced between positive and negative wording. The instrument was administered on a pre- and post- test basis. Scores on the pre- test sub- scales were used individually, along with the Stanford score (see below) as covariates. That is, for the mathematics attitude results, both the Stanford score and the score on the pre- test for mathematics attitude were used as covariates. For the computer attitude results, both the Stanford and the score on the pre- test for computer attitude were used as covariates. Lastly, for the science and technology attitude results, the Stanford and the score on the pre- test for science and technology attitude were used as covariates. Thus, scores on the high school attitude post- test were used as three of the criterion measures for the high school subjects. The instrument was tested for level of readability, using the readability software cited above. The average readability level for the instrument is grade 7.3, and thus is appropriate for high school students.

Stanford Test of Academic Skill - Mathematics

The Stanford Test of Academic Skill - Test 3- Mathematics is a 48 item multiple choice instrument published by Harcourt Brace Javanovich, Inc. Form A, copyright 1973, was used in the project. It was administered by the school district to all ninth graders and thus it was not necessary to administer it separately for project purposes. Raw scores as defined in the manual (Gardner, 1973) for the instrument, were obtained from school records for each of the subjects in the project. The Stanford score was used as one covariate in the analysis of the results for the high school subjects. The test has a reported reliability of .94 with a standard error of measurement of 2.6 (Gardner,1973).

Parent Questionnaire

The parents of subjects in the project were surveyed as to their opinions about their child's participation, using a parent questionnaire (Appendix E). This questionnaire consisted of a short letter, five objective response items and one open- ended item. The questionnaire was reproduced in both English and Spanish on opposite sides of one sheet of paper. Students took one of the questionnaires home with them for their parents to complete. It was to be returned to the school by the student.

The Community

Schools utilitzed in this project were located in Longmont, Colorado, a growing community with a population of about 40,000. Originally an agricultural center, the city is now rapidly growing and changing into a suburban community on the fringe of the Denver metropolitan area. The community is attracting several light industrial companies which are planning to build large facilities in Longmont. Thus the total community is in transition from agricultural to a more suburban-light industrial orientaion.

The ethnic mix of the school district is somewhat typical of communities of its size in the Rocky Mountain region. The school district student population was (1980-81) 88.25% white, 9.88% Hispanic and 1.87% other minority (Native American, Black, and Asian).

Spangler Elementary School had a student enrollment of 450 (1980-81) which was 9.8% Hispanic, 86.7% white and 3.6% other minorities. The mobility rate for the school was 62% as compared to the district average of 28%. 21.8% of the students in the school applied for the free lunch program and 7.1% applied for the reduced lunch program.

Columbine Elementary School had a student enrollment of 363 (1980-81) and was approximately 32% Hispanic, 65.3% white and 2.7% other minorities. The mobility rate for Columbine Elementary School was 32%. 41% of the students in the school applied for the free lunch program and 5% applied for the reduced lunch program.

Skyline High School's student enrollment was 860 (1980-81). The student body was 10.2% Hispanic, 87.2% white and 2.6% other minorities. 9.2% of the students had applied for a free lunch and 2.1% had applied for reduced lunch. Skyline has a mobility rate of 32%, which caused difficulty during the experimental phase.

Pilot Pre-Tutoring Period

Since two elementary schools were utilized, two sections of the high school project class were scheduled. One class was to be transported to one of the two elementary school during the tutoring period and the other to the second elementary school. The approximate distribution of the experimental group high school students between the two sections was twenty in one section, ten in the second.

During the pilot phase the experimental group high school students met with the project director fifty minutes each day, five days a week, for nine weeks prior to tutoring in the elementary schools. These classes met in the afternoon with one period between the two sections. The content of these forty-five hours of instruction was the following:

A. Testing and Administration (10%)

B. Tutoring preparation (50%)

1. Techniques of tutoring
2. Characteristics of sixth graders
3. Psychology of learning
4. Stages of development
5. Lesson planning
6. Discipline
7. Active vs. passive learning
8. Problem solving
9. Sixth grade mathematics curriculum scope and sequence
10. Reinforcement
11. Memory and mastery
12. Estimation
13. Questioning

C. Microcomputers (40%)

1. Orientation to hardware
2. Hardware capabilities
3. Operating procedures
4. Vocabulary
5. Elementary programming
6. Software familiarization (drill and practice, tutorials, simulations and games)
7. Computers and social issues

Experimental Pre-Tutoring Period

The arrangement of time for the project classes at the high school during the experimental phase of the project (the 1981-82 school year) was approximately the same as in the pilot phase (see above). The actual time in the classes during the experimental phase was twice (90 hours) that in the pilot phase since the treatment time was twice as long. During the experimental phase the project classes were held in the morning.

Pilot - Tutoring Period

During the pilot phase tutoring sessions took place in the two elementary schools. The high school students were transported to the elementary schools by a district school bus. The distance from the high school to each of the elementary schools was approximately one mile. The high school students tutored, on a one- on- one basis, the sixth grade experimental group students. Tutoring took place, as much as possible, during the time of regular mathematics instruction in the sixth grades.

The amount of time available for tutoring was a factor of the length of the classes at the high school. Each high school period was 50 minutes, high school students being transported to the elementary schools by district school bus, during the 50 minutes. Round trip transportation time was between 15 and 20 minutes, permitting approximately 30 minutes for each tutoring session. One section of the high school students was transported to one elementary school and the other to the second elementary school. The ratio of the number of high school students in the two sections was approximately equal to the ratio of the enrollments in the two elementary schools (2:1). High school students were transported to the elementary schools every other day (Tuesday and Thursday one week, Monday- Wednesday- Friday the next week). On other days the high school students remained at the high school planning for the tutoring sessions and continuing their familiarization with tutoring and microcomputers. Thus the total amount of time actually tutoring elementary school students over the eight weeks was about 10 hours.

During the pilot phase, distribution of equipment over the three schools was such that the high school retained four machines for continued training of the high school students, three machines were placed in one elementary school and two were placed in the other. No machines were transported between schools for tutoring. Thus, over the eight weeks of the pilot tutoring period, the total computer time available to the elementary students was 67 hours. This time had to be distributed over the 29 elementary students, therefore each elementary student was able to use a computer (under the direction of a high school student) for at most 2.3 hours over the eight weeks or an average of slightly more than one-half hour for each two weeks (during the pilot phase).

The secondary students, under the direction of the elementary student's regular teacher and Mr. Canny, the Project Director, assessed the elementary students mathematical difficulties and provided one- on- one tutoring. Over the eight week pilot tutoring period the secondary students provided each sixth grader about 8.7 hours of "off line" tutoring.

As much as possible, tutoring took place during the period of regular mathematics instruction in the elementary schools. Because of this the elementary participants in the project received one- on- one tutoring in place of up to one half of their regular mathematics instruction for the eight weeks in the pilot tutoring phase.

Experimental - Tutoring Period

The experimental tutoring period was a full semester (17 weeks) as opposed to one-half of a semester in the pilot phase. Therefore the tutoring time for the experimental phase was double that of the pilot phase. Time arrangements for the experimental tutoring period were much the same as in the pilot phase with the exception that sessions were held in the morning. During the experimental phase tutoring period two machines were placed in one elementary school, one in the other, five other machines were transported between the elementary schools and the high school by the high school students. This necessitated the use of carrying cases for the five machines. The advantage gained from transporting the machines was that each experimental group elementary student had more than ten hours of machine time during the semester of tutoring. This was more than double the amount of time available for tutoring during the pilot phase. The ten hours of machine time for each student was approximately evenly distributed over the semester

Table 1

Distribution of males and females in experimental and control groups.

	Experimental Group	Control Group	Total
Grade six			
Males	20	24	44
Females	4	20	24
Total	24	44	68
High School			
Males	17	15	32
Females	10	16	26
Total	27	31	58

Table 2

Instrument reliability, computed by the Hoyt method.

Instrument	# of items	Estimate of reliability
Grade Six		
Mathematics test:		
Whole numbers	52	.96
Fractions	15	.86
Decimals	9	.72
Composite	76	.96
Attitude:		
Mathematics	28	.91
Computers	35	.74
Science and Technology	21	.71
High School		
Attitude:		
Mathematics	34	.92
Computers	33	.85
Science and Technology	23	.81

CHAPTER 3

Results

Chapter Overview

This chapter presents the results of the research investigation described in the previous chapters. Recall that the major objectives of the research reported here were to:

1. Increase the level of basic mathematics skill of mathematically low achieving sixth grade students;
2. Increase the number of students enrolling in high school mathematics and science courses;
3. Evaluate microcomputers as a unique instructional tool; and
4. Develop effective applications of microcomputers.

The results reported in this chapter deal most directly with the first two objectives. The latter two objectives are dealt with primarily in Chapter 5, Conclusions and Recommendations.

In this chapter most of the results are based on quantitative data but some results based on non- quantitative are given as well. Results for the sixth grade groups are reported first, for the high school groups second. Within these two levels, correlations between the instruments used, pre- treatment experimental and control group differences within that level, and post- treatment differences are presented in that order. Subsequent to these sections, summaries of the reactions of the high school students and the parents are given. Tables and figures referenced in the chapter appear after the narrative of the chapter in the order referenced. The reader is directed to the Table of Contents, List of Tables, and List of Figures, at the beginning of this report, for page numbers of specific sections, tables and figures in the chapter.

Correlations Between the Sixth Grade Instruments

Two sixth grade instruments were examined in detail within the project, the criterion referenced mathematics test and the attitude instrument. Both were checked for reliability, as reported in Table 2 (p. 21). Validity was assumed based on examination of the content of each of the tests. Correlations between these tests and their sub- scales are reported in Tables 3, 4 and 5 (pp. 45-46).

The sixth grade mathematics test provided four scores used within the project, whole numbers, fractions, decimals, and a composite score. Correlations between these scores are given in Table 3 (p. 45). As expected the correlations between sub- scales of this test (whole numbers, fractions and decimals) were less than the correlations between the sub- scales and the composite score. Correlations between the sub- scales ranged between .54 and .67. Correlations between the sub- scales and the composite score ranged between .73 and .97. These figures are of interest primarily with respect to the "independence" of the scores on the sub- scales. It was expected that the sub- scales would have relatively high correlations with the composite score. The correlations between the sub- scales indicate that there is a maximum of 45% (square of .65) "overlap" between what is measured by the sub- scales. If the correlations between the sub- scales had been much greater then there would not have been sufficient independence to warrant treating them separately.

Correlations between the scales on the mathematics pre- and post- tests are presented in Table 4 (p. 45). These correlations ranged between .42 (fractions pre- test and whole number post- test) and .80 (fractions pre- and post- tests). All correlations between pre- and post- scales were non- negative.

Tabel 5 presents correlations between the scales of the mathematics pre- test and the scales on the attitude instrument. There is very little correlation between these two tests, with a maximum correlation of .37 (between decimals and mathematics attitude) and minimum of .00 (between fractions and science and technology attitude). As expected, correlations between mathematics attitude and the scales on the mathematics test were the greatest. All correlations between these tests were non-negative.

Sixth Grade Experimental/Control Group Pre- Test Differences

Sixth grade experimental subjects were selected primarily on their low achievement in mathematics. Analyses were conducted which checked the scope of the differences between the sixth grade experimental and control groups with respect to their pre-treatment mathematics achievement. These analyses were completed with a univariate analysis of variance using the MANOVA precedure of the Statistical Package for the Social Sciences (SPSS) (Hull, 1981). The results of these analyses are presented in Table 6-A (p. 47). The experimental and control groups differed significantly (p=<.05) on all the scales of the mathematics test. The control group out performed the experimental group on all four sub- scales of the pre- test in mathematics. This was an expected result and supported the selection process used.

The experimental and control groups were also compared with respect to the number of days subjects were tardy and the number of days they were absent during the Fall semester, before any treatment was provided. The purpose of these analyses was to establish any pre- treatment differences between the groups on the two variables, number of days tardy and number of days absent (Fall semester). This was of interest since the common notion is that students who are less able (in this case in mathematics) have poorer attendance habits. These analyses were conducted using univariate analysis of variance (Hull, 1981). The results of the analyses are given in Table 6-A (p. 47). While no differences (p=<.05) between the two groups were found on either of the pre- treatment attendance variables, the difference between the two groups relative to the number of days tardy in the Fall semster bordered on significance (p=.082). These results established the possibility that if there were post- treatment differences, that these differences might be the result of treatment provided by the project.

Research Questions - Sixth Grade

One of the major goals of the research in this project was to raise the mathematics achievement of low achieving sixth graders through one- on- one tutoring, using microcomputers as a tutoring aid. The treatment provided in an attempt to accomplish this was described in chapter two. To establish whether or not this goal was achieved, the sixth grade post- test scores in mathematics were subjected to a univariate analysis of covariance using the

MANOVA prodecure of SPSS (Hull, 1981), with the pre- test composite mathematics test score as the covariate. Each of the four scores on the sixth grade mathematics post- test were subjected to this analysis of covariance, using the same covariate. Results of these analyses are presented in Table 6-A (p. 47). Statistically significant differences were found between the experimental and control groups only on the whole number and composite scores of the mathematics test. These differences favored the control group in each case. The control group also out- performed the experimental group on the other two post- test mathematics scales (fractions and decimals), but there was not a significant difference between the groups on these later two scales.

Examining the two groups on mean performance on the pre- and post- tests in mathematics shows that the experimental group decreased in mean performance on whole numbers between the pre- and post- tests. This fact prompted additional analyses of the difference between individual performance on the pre- and post- mathematics tests. Gain scores were omputed for each subject. That is the pre- test score was subtracted from the post- test score for each of the mathematics scales for each subject. The resulting gain scores were subjected to analyses of variance to establish differences between the two groups. The results of these analyses are given in Table 6-B (p. 48). The results indicate that on the average, when taken as individuals, subjects in both experimental and control groups decreased in performance on both whole numbers and composite mathematics between the pre- and post- tests, but increased in performance on fractions and decimals. However; a.) the groups did not differ significantly on any of these four mathematics gain scores, and b.) none of the mean gains for either groups were significantly different from zero (no gain). The latter of these statements is justified because the maximum deviation from zero of the mean mathematics gain score was 7.28 and the minimum standard deviation was 18.43. Because of these two last two figures, none of the resulting mean gains in mathematics in Table 6-B (p. 48) is sufficiently "distant" from zero (0) to be significant.

Post- treatment attitude measures were administered to both the experimental and control groups at the end of the school year. The results of these were analyzed using univariate analysis of covariance, using the MANOVA procedure (Hull, 1981), with the pre-treatment composite mathematics score as the covariate. Results of these analyses are given in Table 6-A (p. 47). There were no statistically significant differences between the two groups for either of the three attitude scales; attitude toward mathematics, attitude toward computers, or attitude toward science and technology. However all means reflected positive attitudes and the control group had a more positive attitude than the experimental group for each of the three scales.

Data were collected concerning the number of days subjects were tardy and absent during the Spring semester. These data were subjected to the same analyses as the scores on the mathematics test and the attitude instrument, univariate analysis of covariance, with the pre- treatment composite mathematics score as the covariate. No statistically significant differences between the experimental and control groups were found for either of these two attendance variables. In order make certain that differences might exist between the two groups on the attendance variables, two additional analyses were conducted. First, an analysis of variance (without a covariate) was computed for each of the Spring semester attendance variables. Neither of these ANOVAs resulted in significance between the groups for either the number of days tardy (F(1.46)=.037, *p*=.848), nor the number of days absent during the Spring (F(1,46)=.412, *p*=.524). Secondly, "gain scores" for attendance were computed for each subject for the attendance variables. That is, for each subject the number of tardies (and number of absences) during the Fall was subtracted from the the number of tardies in the Spring, to arrive at two attendance "gain" scores. These attendance gain scores were then subjected to a univariate analysis of variance to determine differences between the groups. Resulting means and F values are presented in Table 6-B (p. 48). The groups differed significantly (*p*=<.05) in the "gain" in the number of tardies but not in "gain" in the number of days absent. The mean "tardy gain" for the experimental and control groups (-.71 and 1.00 respectively) indicate that individuals in the experimental group were, on the average, tardy nearly one day less in the Spring than they were in the Fall, and that individuals in the control group were, on the average, tardy one day more in the Spring than they were in the Fall. A mean of zero (0) on these variables would indicate that on the average there was no difference between the value of these variables between Spring and Fall, that is no mean change in attendance. It cannot be said that the resulting means for the two groups for these two attendance gain variables are significantly different from zero (no change in attendance from Fall to Spring), because of the value of their associated standard deviations (2.73 and 2.80 respectively). Lastly, it should be noted that the treatment provided in the Spring was not at the beginning of the morning or the afternoon session in the school.

It is common for statistical tests to mask patterns in data which can be more clearly seen using graphs. The graphs of the cumulative relative frequency distributions of the data generated by the sixth grade groups were constructed in various combinations of groups and scales in order to see more detailed trends which might provide greater information than statistical analyses. These graphs are presented in Figures 1 through 27 (pp. 49-62). Figures 1 through 4 (pp. 49-50) present visual evidence of the pre- treatment differences in mathematical achievement between the experimental and control groups. In each case the control group exhibits greater achievement than the experimental group, and in each case there is no intersection between the graphs for the two groups. Also, in each case the least able of the experimental group performed as well as the least able of the control group, but the most able of the experimental group did not perform as well as the most able of the control group.

Figures 5 and 6 (p. 51) are graphs for the distributions of the pre- treatment attendance variables for the experimental and control groups. Even though there is no statistical difference between the two groups on these two variables, it appears that there is a difference between them with respect to the number of days tardy in the Fall (Figure 5, p. 51). The experimental group having a consistently greater number of tardies across the distribution. There were greater similarities between the groups with respect to the number of days absent for the pre- treatment period, than there were for the number of days tardy.

In comparing Figures 5 and 14 (p. 51, 55, and Tables 6-A and B, pp. 47-48), it is seen that there was a drop in the number of tardies for the experimental group but an increase for the control group. For the number of absences (Figures 6, p. 51, Figure 15, p. 56, and Tables 6-A and B, pp. 47-48) no such patterns of change are observed.

Figures 7 through 10 (pp. 52-53) present graphs of post- test mathematics performance for the experimental and control groups. Consistent with pre- test results, the control group outperformed the experimental group on each of the four post- test mathematics scales. None of the graphs of the experimental group intersect that of the control group. In addition, as in the pre- tests, for all four post- treatment mathematics tests, the least able subject in the experimental group did as well as the least able subject in the control group, but the most able of the experimental group did not do as well as the most able in the control group.

Figures 11 through 13 (pp. 54-55) show graphs of the sixth grade attitude measures given at the end of the school year. A difference is noted in mathematics attitude in favor of the control group. That is the control group had a more positive, but non- significant, mathematics attitude than did the experimental group. About 10% of the conrol group had a negative attitude toward mathematics, while about 40% of the experimental group had a negative attitude towards mathematics. This was not the case however for attitude towards computers or science and technology.

Both groups exhibited about the same positive attitude on these scales, almost no negative portions of the graphs in both cases.

Figures 14 and 15 (pp. 55-56) present graphs of the distributions of the number of days tardy and the number of days adsent in the Spring for the sixth grade groups. The patterns of the distributions is nearly the same for both groups in both figures. However the relationship between the graphs of the number of days tardy in Spring (Figure 14, p. 55) is in contrast with that shown in the graphs for Fall (Figure 5, p. 51). The experimental group decreased in the number of days tardy, whereas the control group increased. This is consistent with the means in Tables 6-A and B (pp. 47-48).

Figures 16 through 19 (pp. 56-58) are graphs of pre- and post- mathematics tests for the experimental group. Figures 16 and 19 show that there was a slight drop (non- significant) in the whole number and composite mathematics performance for the experimental group. Performance on the mathematics fractions and decimals post- tests were greater than on the pre- test. Figure 19, the mathematics composite score for the experimental group pre- and post- tests, shows that there was a slight decrease (not significant) in composite mathematics performance. These graphs (Figures 16 through 19) reinforce results of the analyses of the mathematics gain scores reported in Tables 6-B (p. 48). Recall that during the time of the tutoring, most of the regular classroom activity in mathematics dealt with fractions and decimals, not whole numbers. This may explain these results shown in Figures 16 through 19.

Figures 20 through 23 (pp. 58-60) are graphs of pre- and post- mathematics tests for the control group. These graphs show an increase in performance in fractions and decimals for the control group, a slight increase in composite mathematics score, and a decrease in performance in whole numbers on the low end of the scale. None of these differences between the pre- and post-tests were significant however. These graphs are consistent with the results of the mathematics gain scores (Table 6-B, p. 48), except for the composite mathematics score. The small negative composite gain is most likely caused by the decrease in performance at the low end of the scale on the post- test in Figure 23.

In comparing the respective figures from Figures 5 through 12 (pp. 51-54) it is interesting to note that there were in general similar patterns of change for the two groups. Recall that the experimental group had tutoring substitute for about 40% of their regular classroom instruction in mathematics. Also note that there was a negative gain for the control group in whole numbers <u>and</u> in composite mathematics after nine months of regular instruction in the classroom. This is reflected in the means reported in Table 6-B (p. 48) also. The experimental group performance was consistent with that of the control group, a decrease in the mean whole number and composite mathematics score. This was despite the intervention efforts from the project.

Correlations Between the High School Instruments

Table 7 (p. 63) presents the correlations between the instruments used used with the high school experimental and control groups. There was a low moderate positive significant correlation between the mathematics pre-test, which was the Stanford Test of Academic Skill (STASK) and the pre-tests on attitude toward mathematics (.53) and attitude toward computers (.45). There was a low non-significant positive correlation between the STASK and the pre-test on attitude toward science and technology (.23). These results mean that there is reasonable expectation that the STASK and the attitude measures do measure different constructs. Correlations between the STASK and the post- test attitude scales differed from the correlation with the pre- test attitude scales. The correlation between the STASK and post- tests for attitude toward mathematics dropped from that of the pre- test (from .51 to .35).

The correlations between the STASK and pre- attitude toward computers, and post- attitude toward computer increased by .05 (from .45 to .50) and with post- attitude toward science and technology increased from the pre- attitude toward science and technology by .15, from a non- significant .23 to a significant .35.

Correlations between the pre- attitude scales were all significant and in the .55 range. The correlation between pre-treatment attitude toward mathematics and attitude toward science and technology (.53) was the least of the three. The correlation between pre- treatment attitude toward computer and attitude toward science and technology (.58) was the greatest.

Correlation between the post- attitude scales, all significant and in the high moderate range (.67 to .78), were greater than the correlations between the pre- attitude scales. Possible explanations of this occurrance are that one of the sets of correlations of the pre- testing or the post- testing was not a true measure of these correlations, and/or events within the nine months between these testings caused this gain in correlation. In either case, the project staff was unable to identify what might have caused this gain.

Corelations between the pre- attitude scales and the post- attitude scales were all significant ($p=<.05$) and within the moderate to high range (.49 to 77), and greater that correlations between the pre- attitude scales themselves. The greatest of the pre- to post attitude correlations was between corresponding scales, that is between the pre- and post- attitude toward mathematics, toward computers and toward science and technology (.73, .70 and .77 respectively). This is an expected result. It is interesting to note the relatively strong correlations between the pre- attitude toward mathematics scale and the post- attitude toward computers, toward and science and technology (.59 and .58 respectively); between the pre- attitude toward computers and the post- attitude toward science and technology (.65); and between the pre- attitude toward science and technology and the post- attitudes toward mathematics, and toward computers (.61 in each case).

Correlations between the STASK and the three attendance measures were generally low (all less than .26) and non significant (except for the correlation with days absent Fall).

Correlations between the three attendance measures and all other measures were nearly all negative and generally either low or low moderate. The greatest of these (maximum of -.39) was the correlation with pre- attitude toward matheamtics. There was a low moderate significant correlation (.41) between Fall and Spring days absent. The high correlations (.83 and .84) between the Fall, and Spring days absence and the total days absent for the school year is an expected result since days absent during the year is the sum of the days absent during the Fall and Spring terms.

High School Experimental/Control Group Pre- Test Differences

Table 8 (p. 64) presents pre- test scores for the high school experimental and control groups. At the beginning of the treatment period the experimental and control groups differed significantly on attitude toward mathematics and attitude toward computers. In both these cases the difference favored the experimental group by about 15 scale points. The difference in attitude toward mathematics was an unexpected difference since there was some difficulty recruiting students for the experimental group. Because the project classes were not announced as planned, it was necessary to do "last minute" recruiting to obtain students for project classes. That is, individual student contact and "combing the halls" were used to fill project classes. The difference in favor of the experimental group on attitude toward computers was to some degree expected since students recruited into the project classes knew that the project involved computers. Project staff presume that one of the reasons students agreed to participate in the project was the amount of involvement they would have with computers, an expression of interest in computers, and resultingly a predisposition to a positive attitude toward computers. There were no pre- test differences between the experimental and control groups with respect to the STASK or attitude toward science and technology. Despite these results these four variables were used in associated pairs as covariates in the analyses of the port- measures. This was done to assure fairness in any results.

It should be noted that for neither the experimental nor the control group was there a negative mean for any of the three pre-attitude scales.

Research Questions - High School

The primary research question for the high school group was whether participation in the project would cause an increase in the students enrollment in mathematics and science classes. In order to measure this, data were collected on the number of mathematics and science classes in which the experimental and control groups enrolled in each of five semesters, the semester previous to the experimental period, the two semesters of the experimental period and the two semesters following the experimental period. The objective was to use these data to compute means for both the experimental and control groups for each of these semesters, conduct a statistical test, and arrive at some conclusion, based on the research question. What the project staff did not anticipate was the transiency of the student body at the school nor the resulting incompleteness of school records. These two factors in association with the number of students involved in the project (both experimental and control) resulted in cells with insufficient cases on which to base conclusions with an acceptable degree of certainty for the high school research question which was of primary interest. Thus, the data obtained relative to this question is, for practical purposes, useless because of its incompleteness.

What is devastating to the project staff is that a one year extension of the due date for this final report was obtained in order to obtain the data for this analysis. The effort expended and delay in time time has produced absolutely no gain.

Despite the resulting frustrating, other data were obtained on the high school groups. Data on pre- treatment mathematics achievement, attitudes toward mathematics, computers and science and technology, and from post- testing relative to the three attitude scales, and the number of days absent during the year were obtained. Summary data from the analyses of these data are given in Table 8 (p. 64). Analysis of covariance was used on the post- treatment data. For the post- attitude toward mathematics results, the STASK and pre- attitude toward mathematics scores were used as covariates. For the post- attitude toward computers results, the STASK and pre- attitude toward computers scores were used as covariates. For the post- attitude toward science and technology results, the STASK and pre- attitude toward science and technology scores were used as covariates. And, for the attendance results, the STASK score was used as a single covariate.

From the four analyses of covariance only one resulted in significance. The experimental group had a significant greater positive attitude toward computers (by 37 scale points) upon completion of the project than did the control group. There were no significant differences between the groups with respect to attitude toward mathematics, attitude toward science and technology, nor days absence during the year.

Once again, statistical analyses do not give the complete picture. Figures 28 through 41 (pp. 65-71) present graphs of various configurations of the data obtained for the high school groups. The two groups did not differ significantly in total on the STASK scores but as can be seen in Figure 28 (p. 65) the experimental group was less evenly distributed across the distribution than was the control group.

Figures 29 through 34 (pp. 65-68) compare the experimental and control groups with respect to the pre- and post- attitude measures. These figures confirm the superiority of the experimental group on all attitude measures, both pre- and post. All of these figures show a dramatic difference between the groups except Figures 29 and 31 which show small to moderate differences. These differences shown are not statistically significant except for that shown in Figure 33 (p. 67).

Figure 35 (p. 68) compares the experimental and control groups with respect to the number of days absent during the year. Clearly there is little difference between the group on this variable.

Figures 36 through 41 (pp. 69-71) compare pre- and post- test attitude scores for the experimental and control groups. Figures 36 and 37 show that the experimental group performed similarly on the pre- and post mathematics and computer attitude scales. This is consistent with the means in Table 8 (p. 64). Figure 38 (p. 70) shows that there was a more dramatic increase across the distribution between the pre- and post- tests for attitude toward science and technology for the experimental group, consistent with the increase in means in Table 8 (p. 64). Figure 39 (p. 70) shows the dramatic drop in attitude toward mathematics between the pre- and post- tests for the cotrol group (drop in mean from 12.6 to -2.1). This drop was across the complete distribution. Figures 40 and 41 (p. 71) show the relative stability of the control group's attitudes toward computers, and science and technology.

High School Student Reactions

Students in the high school experimental group were asked to respond to several questions at the end of the 1981-82 school year. These questions were:

1. Please list the things you liked about the class.
2. List the things you didn't like.
3. List your reactions to tutoring now that it is over.
4. List the things you learned about yourself and others.

The students did not have to sign their name to the responses. The complete text of all the students' responses to this inquiry is contained in Appendix G.

The students in the project classes evidently experienced some frustration in their tutoring of the sixth graders. A common complaint was the lack of interest and motivation on the part of the sixth graders. Because of this many of the high school students had a feeling that they did not accomplish what as much as they expected. Teachers will find this complaint familiar. Almost all the high school students were positive about the aspect of the program which dealt with computers. Operating the machines, programming, and the equipment itself impressed the students. Students in the project classes has some freedom to pursue their own interests. This was valued by many of the students. Almost all the high school students enjoyed working with their assigned sixth grader, however in a few cases this was not the case. All enjoyed their classmates and a few commented that they learned more about themselves than they expected. The instructor, Mr. Canny, was popular with the students and received very few negative comments.

On the negative side, the students wanted more computer time for themselves. This was expected and was an unavoidable problem. A common complaint was that no follow up class was going to be available the next year. This was anticipated but beyond the control of the project staff. The assignment of grades for the project class was a concern of several of the students. Evidently some students felt that there was insufficient communication with the students about grading. Many students did not like having to do a report as part of their course, and a few felt that the amount of time needed to prepare for tutoring was not well spent.

In general, the sense of the students' reactions were very positive and supportive of the project and their involvement in the project.

An attempt was made within the project to note incidents which would give indications of student's reaction to the activities of the project. Several incidents stand out as exemplary of the positive feelings of the students toward their involvement. One case involved a high school student who did not attend school on infrequent and random days. On some of these intermittent day long vacations, this student would show up for the project class but none others during the day. It seems that this student enjoyed the project classes so much that he would go out of his way to attend them but would "ditch" other classes. Two incidents occurred on the last day of turoring. A strong bond developed between the most all the high school students and the sixth grader they tutored. One high school student wore a pendant to school daily and clearly was very attached to this. On the last day of tutoring, without attempting to disguise what was happening, gave his sixth grader the pendant as a gift. The act of giving was completely spontaneous and was almost ritualistic. It was clear that there was a genuine bond of affection betwen the two students, common among many others but with more subtle expression. Such an event would not have happened to two students at these grade levels outside the activities and atmosphere that the project provided. A second incident (more of an event than an incident) on the last day, while not as profound as the one previously mentioned, was provided more activity, involved all the students, was a nice gesture, and delighted the students. The principals of the two elementary schools provided softdrinks for each of the sixth graders and high school students in the project as a small celebration. This turned out to be a lively interchange of "thanks," affection, and for some, tears at the end of a valued experience. For many it was difficult because it was likely to be the last contact between the sixth graders and their tutors.

No systematic record was kept of such incidents but they occurred frequently enough for the persons in charge to notice. All but a few reinforced the view of the staff that on a personal level, the project was an great success.

Parent Reactions

The Parents of each of the subjects in the experimental groups were sent a questionnaire (Appendix E) near the end of the experimental period. The questionnaire was sent home with the student and parents were asked to return the completed form with the student. The questionnaire contained six items and was in both English and Spanish to account for language differences, none of the parents chose to use the Spanish language side for their response. There was a return rate of about 50% for each of the levels. The first five items were objective response items. The sixth item was an open ended item seeking information on the project that was not included in the first five items. A compilation of responses to the first five of the items is given in Table 9 (p. 72) at the end of this chapter. Of the 32 respondents, eleven wrote comments to the open ended item. The complete text of these responses is given in Appendix H. The five objective response items were:

1. What have you noticed about your son"s or daughter's interest in math since particpating in the project?
   a. Increased interest b. No change c. Less interest

2. In considering math skills, the project;
   a. improved the skills greatly,
   b. improved the skills some, or
   c. did not change the level of skills.

3. In considering the use of time in the project, the amount of computer time was;
   a. too much, b. about right, or c. not enough.

4. Would your daughter or son participate in a computer program again if given the opportunity?
   a. Yes b. No c. Uncertain

5. What was your son's or daughter's reaction to the project?
   a. Positive b. Negative c. Uncertain

A chi- square statistic was computed from the responses to each of these items. The values of the chi- square statistics were 37.50, 18.13, 20.82, 50.14 and 42.94 respectively. All were significant at $p<.05$ with two degrees of freedom (critical value of 5.99). The major difference between the responses to the five items was in item three. For this item, all the secondary parents indicated that the amount of computer time available to the students was less than "too much," that is "about right" or "too little." While half of the elementary parents felt that the amount of computer time was "too much." On other items, more than 90% of the parents of elementary subjects and nearly 70% of the parents of high school subjects indicated that their child exhibited heightened interest in mathematics because of particpation in the project and only one parent indicated a lessening of interest in mathematics on the part of their child. All of the parents indicated that their child showed "some" or "great" improvement in mathematics because of the project. Only one parent indicated that their child would not participate in a computer program again if given the opportunity. The same parent indicated that their child had a negative reaction to their particpation in the project.

The open ended item on the parent questionnaire was:

6. If you have any comments about the program, please feel free to make them below.

All responses to this item were positive and differed little by whether the child was in sixth grade or high school. From the comments to this item, exposure to computers apparently was a stimulant to many of the students, and provided motivation that some of the students had never shown prior to their involvement in the project.

Disposition of Equipment

One of the conditions of the accepting this grant was that seven of the sets of computer systems were to become the property of the St. Vrain Schools when the project was complete. On August 12, 1982 seven complete computer systems became the property of the St. Vrain Schools in accordance with this condition of the grant. A copy of the letter of transfer for this equipment, signed by both the principal investigator and a resresentative of the St. Vrain Schools is contained in Appendix I.

Miscellaneous Information

Throughout the project several articles on the project appeared in newspapers. These were due in part to staff efforts and partly due to community interest. Copies of most of these articles are contained in Appendix I. Several meetings were held throughout the project for parents of students in the project. One of the notices of such a meeting is contained in Appendix I. Additionally, the students in the project classes were issued a certificate of completion at the end of the experimental period. A copy of this certificate is in Appendix I.

All tables and figures referenced in this chapter follow.

Table 3

Interscale correlations for the sixth grade criterion referenced mathematics pre-test.

Mathematics Pre-test Scale	# of items	Correlation with								
		Fractions			Decimals			Composite		
		r	p	n	r	p	n	r	p	n
1. Whole Numbers	52	.54	.001	68	.64	.001	68	.97	.001	68
2. Fractions	15				.65	.001	68	.73	.001	68
3. Decimals	9							.76	.001	68

Table 4

Correlations between the sixth grade criterion referenced mathematics post-test scales and the attitude scales.

Mathematics Post-test Scale	Computer Attitude			Mathematics Attitude			Science and Tech. Attitude		
	r	p	n	r	p	n	r	p	n
1. Whole numbers	.27	.020	58	.30	.012	58	.15	.136	58
2. Fractions	.09	.249	58	.21	.058	58	.00	.485	58
3. Decimals	.29	.017	58	.37	.003	58	.09	.252	58
4. Composite	.26	.023	58	.30	.012	58	.12	.180	58

Table 5

Correlations between the sixth grade mathematics pre-test and post-test by scale.

Mathematics	Correlation with Post-Test Scale											
Pre-test	Whole Numbers			Fractions			Decimals			Composite		
Scale	r	p	n	r	p	n	r	p	n	r	p	n
1. Whole Numbers	.59	.001	68	.48	.001	68	.65	.001	61	.60	.001	68
2. Fractions	.42	.001	68	.80	.001	68	.58	.001	61	.54	.001	68
3. Decimals	.53	.001	68	.65	.001	68	.65	.001	61	.60	.001	68
4. Composite	.61	.001	68	.63	.001	68	.70	.001	61	.66	.001	68

Table 6-A

Pre- test and post- test results for sixth graders.

Variable	Mean Performance						F	df	p
	Experimental Group			Control Group					
Pre- tests:	Mean	S.D.	n	Mean	S.D.	n	ANOVA		
Whole Numbers	55.95	24.56	24	80.42	20.77	44	18.923	1,66	.000
Fractions	16.89	16.89	24	36.91	28.67	44	9.807	1,66	.003
Decimals	29.14	20.13	24	50.46	20.24	44	17.295	1,66	.000
Composite math	45.07	19.48	24	68.28	19.59	44	21.878	1,66	.000
Days tardy Fall 1981	4.59	7.42	17	1.87	3.16	31	3.161	1,46	.082
Days absent Fall 1981	5.82	6.12	17	4.74	5.48	31	.394	1,46	.533
Post-tests:							ANCOVA		
Whole numbers	53.11	22.81	22	85.12	17.33	39	13.867	1,58	.000
Fractions	24.79	21.58	22	49.69	30.63	39	.324	1,58	.571
Decimals	36.83	19.19	22	64.34	25.51	39	3.257	1,58	.076
Composite math	45.60	19.16	22	75.66	18.23	39	13.972	1,58	.000
Mathematics attitude	10.13	27.00	16	30.41	27.02	27	1.251	1,40	.270
Computer attitude	29.06	16.82	16	32.89	14.24	27	.104	1,40	.748
Sci/Tech attitude	27.31	19.47	16	33.74	17.24	27	.079	1,40	.786
Days tardy Spring 1982	3.75	5.39	16	3.11	4.86	27	.280	1,40	.600
Days absent Spring 1982	5.87	5.86	16	4.31	4.34	27	.157	1,40	.694

Table 6-B

Analysis of post- test minus pre- test difference scores for sixth graders.

	Mean Performance								
Variable	Experimental Group			Control Group			F	df	p
Difference score:	Mean	S.D.	n	Mean	S.D.	n	ANOVA		
Whole Numbers	-7.28	21.35	24	-4.97	29.64	44	.113	1,66	.738
Fractions	5.84	20.23	24	7.13	18.43	44	.072	1,66	.790
Decimals	4.63	23.36	24	6.57	26.27	44	.092	1,66	.763
Composite math	-3.27	18.43	24	-1.21	24.87	44	.126	1,66	.724
Days tardy	- .71	2.73	24	1.00	2.80	44	5.877	1,66	.018
Days absent	.08	4.18	24	.16	3.86	44	.006	1,66	.940

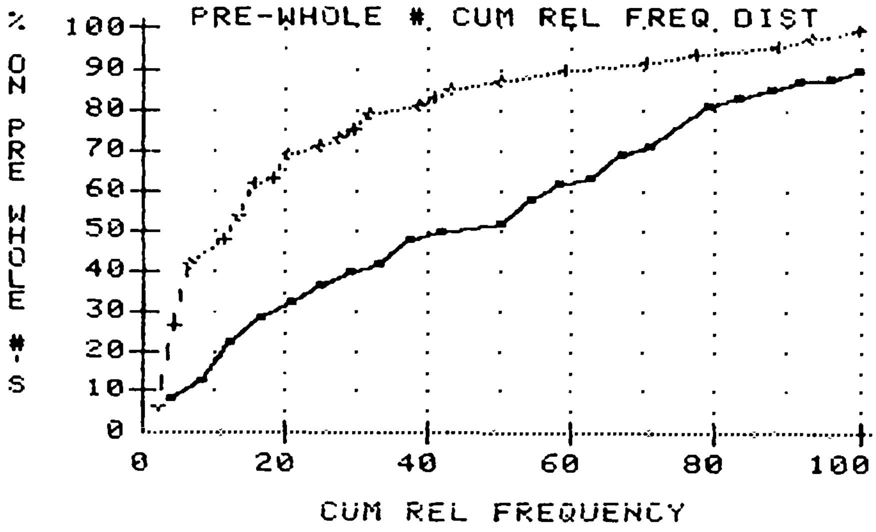

Figure 1. Graph of the cumulative relative frequency distribution of mathematics whole number pre- test for the sixth grade experimental and control groups. (Solid line = experimental group, broken line = control group.)

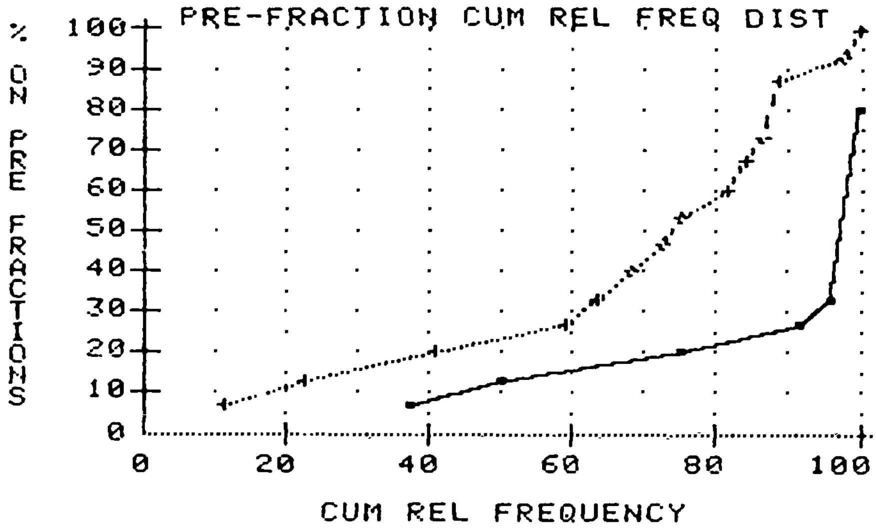

Figure 2. Graph of the cumulative relative frequency distribution of mathematics fraction pre- test for the sixth grade experimental and control groups. (Solid line = experimental group, broken line = control group.)

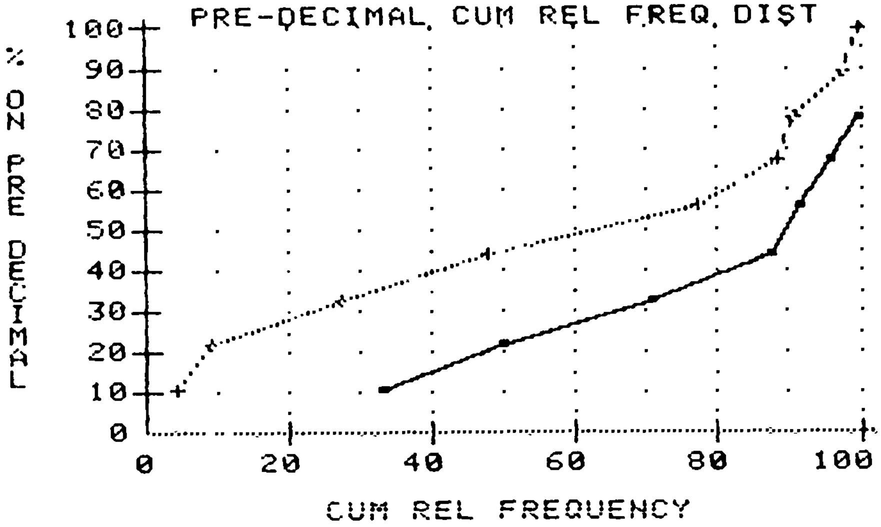

Figure 3. Graph of the cumulative relative frequency distribution of mathematics decimal pre- test for the sixth grade experimental and control groups. (Solid line = experimental group, broken line = control group.)

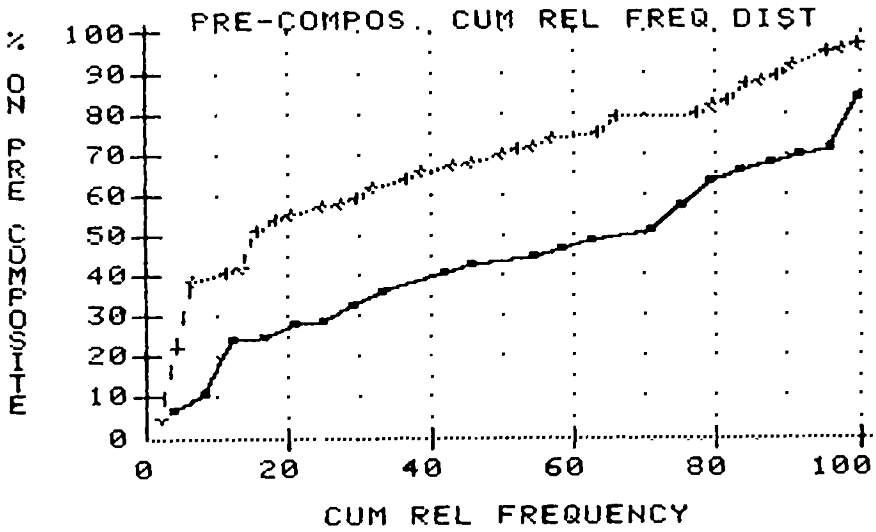

Figure 4. Graph of the cumulative relative frequency distribution of mathematics composite pre- test for the sixth grade experimental and control groups. (Solid line = experimental group, broken line = control group.)

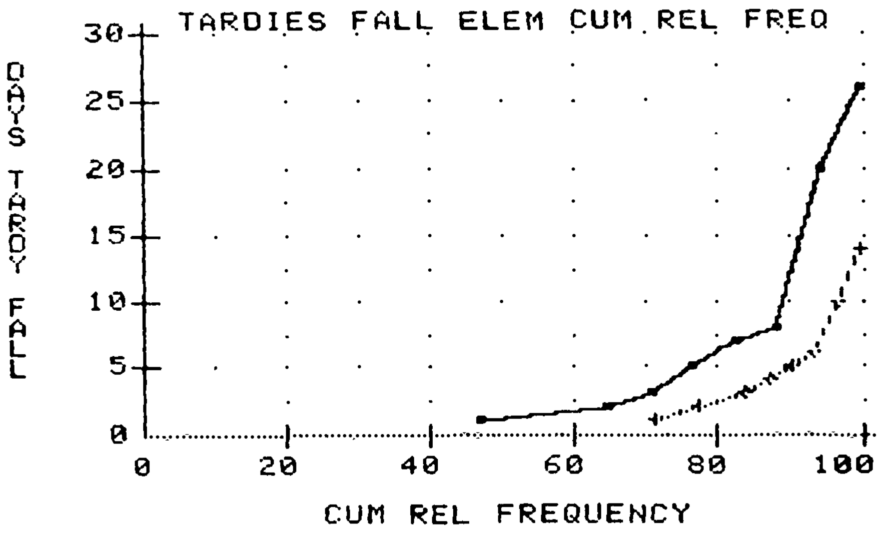

Figure 5. Graph of the cumulative relative frequency distribution of the number of days tardy, Fall semester, for sixth grade experimental and control groups (Solid line = experimental group, broken line = control group.)

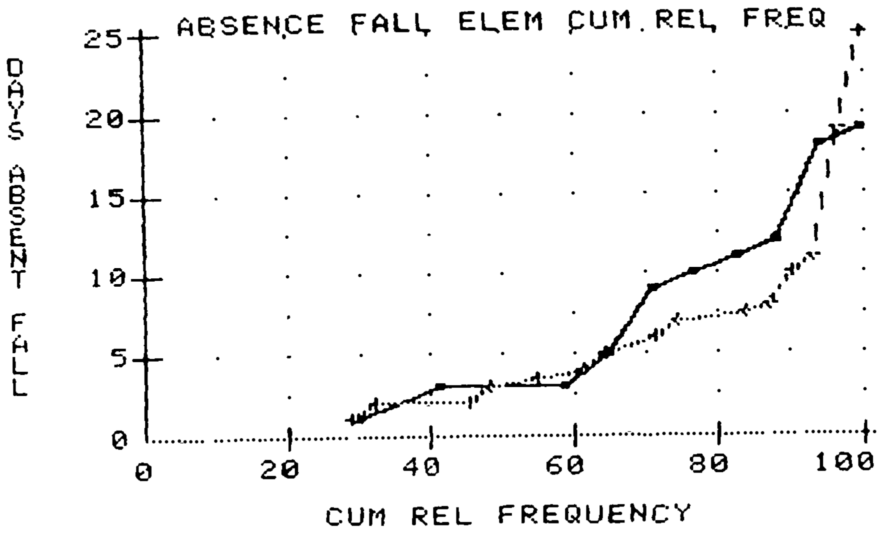

Figure 6. Graph of the cumulative relative frequency distribution of the number of days absent, Fall semester, for sixth grade experimental and control groups. (Solid line = experimental group, broken line = control group.)

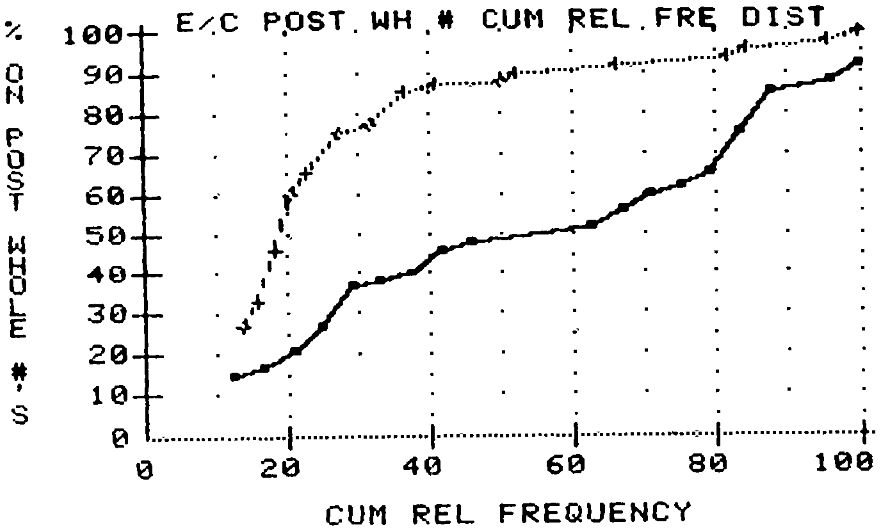

Figure 7. Graph of the cumulative relative frequency distribution of mathematics whole number post- test for the sixth grade experimental and control groups. (Solid line = experimental group, broken line = control group.)

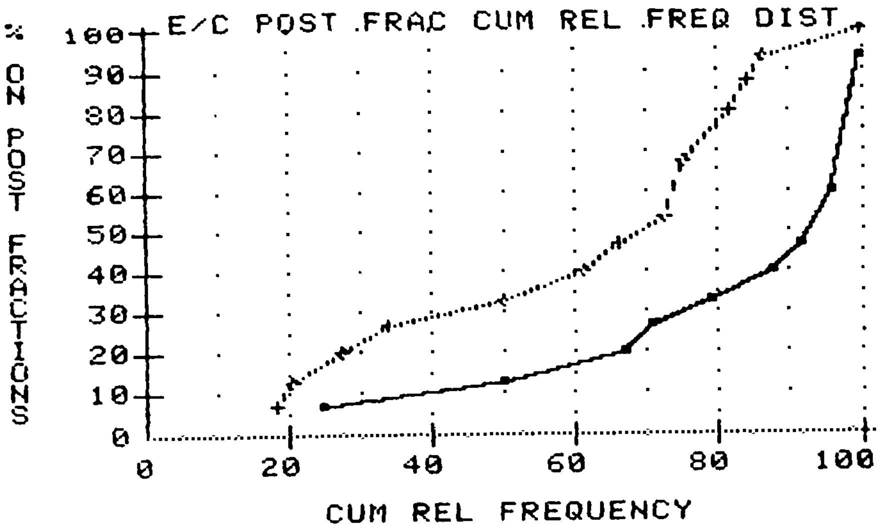

Figure 8. Graph of the cumulative relative frequency distribution of mathematics fraction post- test for the sixth grade experimental and control groups. (Solid line = experimental group, broken line = control group.)

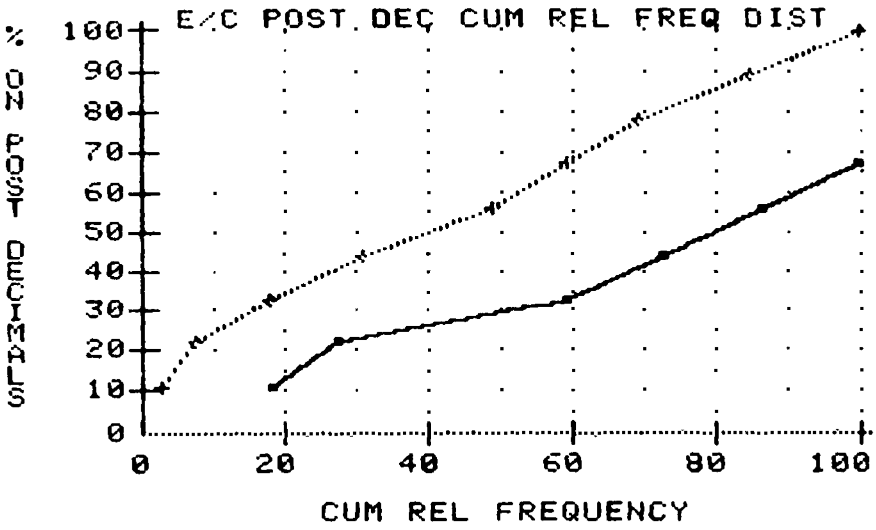

Figure 9. Graph of the cumulative relative frequency distribution of mathematics decimal post- test for the sixth grade experimental and control groups. (Solid line = experimental group, broken line = control group.)

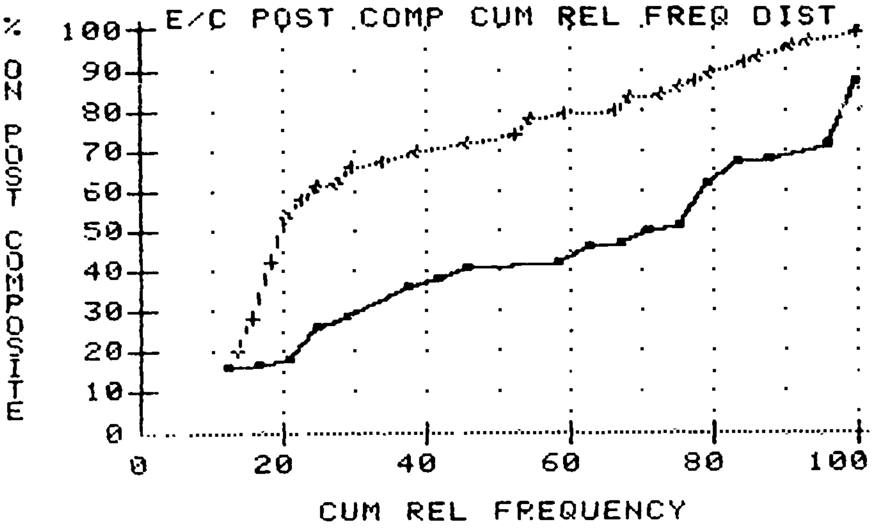

Figure 10. Graph of the cumulative relative frequency distribution of mathematics composite post- test for the sixth grade experimental and control groups. (Solid line = experimental group, broken line = control group.)

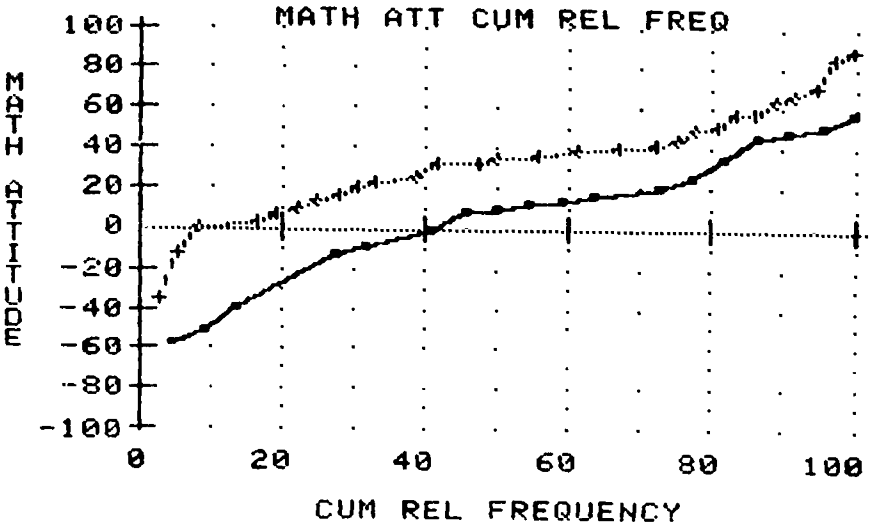

Figure 11. Graph of the cumulative relative frequency distribution of attitude toward mathematics for the sixth grade experimental and control groups. (Solid line = experimental group, broken line = control group.)

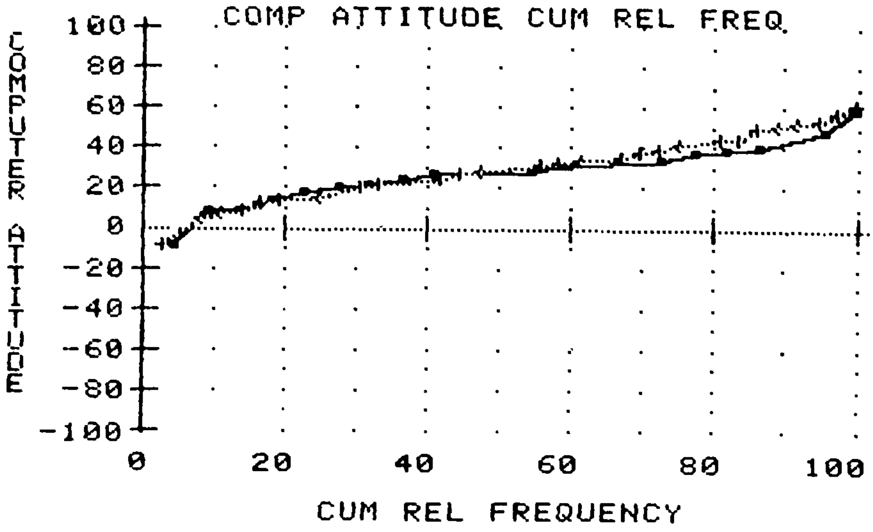

Figure 12. Graph of the cumulative relative frequency distribution of attitude toward computers for the sixth grade experimental and control groups. (Solid line = experimental group, broken line = control group.)

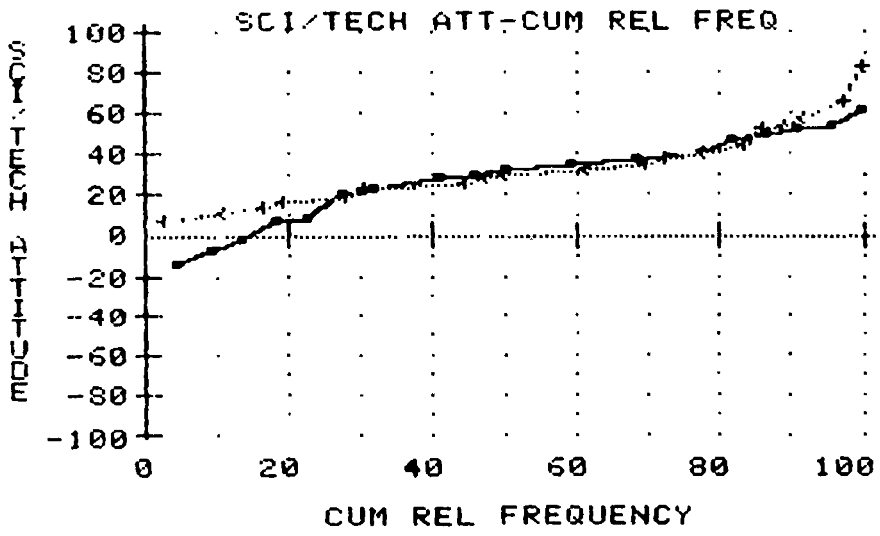

Figure 13. Graph of the cumulative relative frequency distribution of attitude toward science and technology for the sixth grade experimental and control groups. (Solid line = experimental group, broken line = control group.)

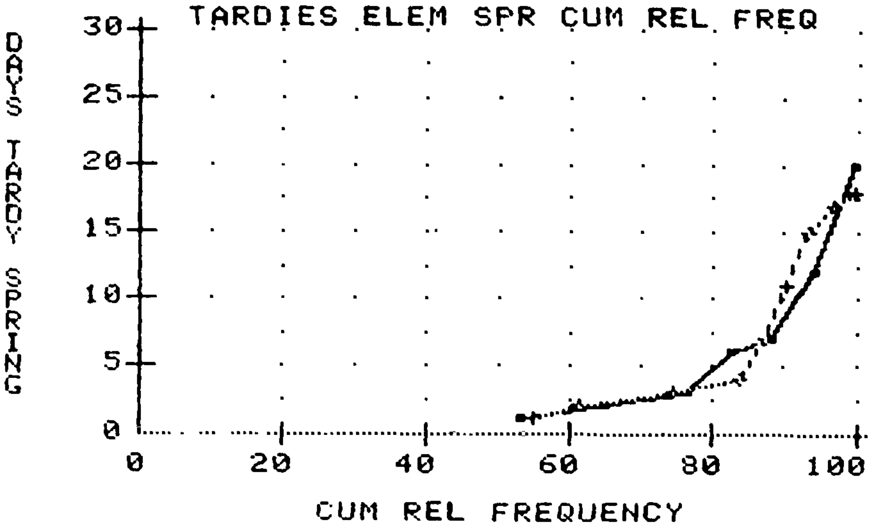

Figure 14. Graph of the cumulative relative frequency distribution of the number of days tardy, Spring semester, for sixth grade experimental and control groups. (Solid line = experimental group, broken line = control group.)

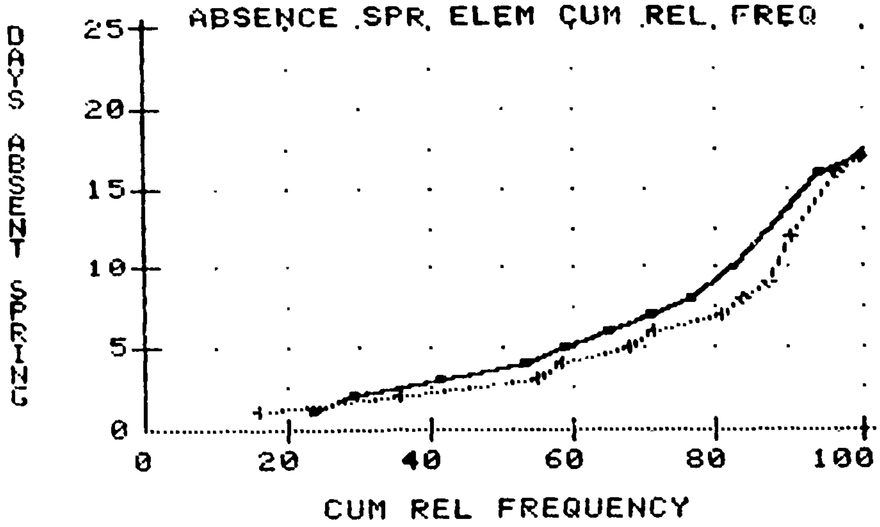

Figure 15. Graph of the cumulative relative frequency distribution of the number of days absent, Spring semester, for sixth grade experimental and control groups. (Solid line = experimental group, broken line = control group.)

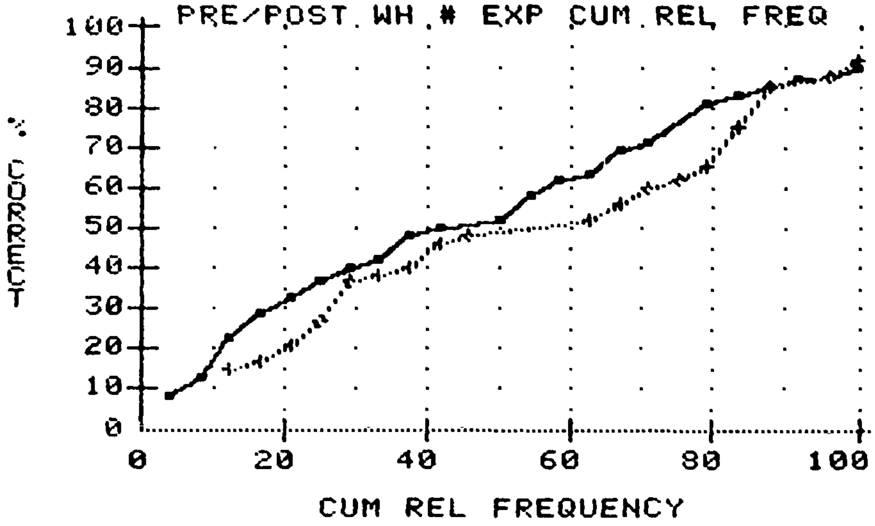

Figure 16. Graph of the cumulative relative frequency distribution of mathematics whole number pre- and post- test for the sixth grade experimental group. (Solid line = pre-test, broken line = post-test.)

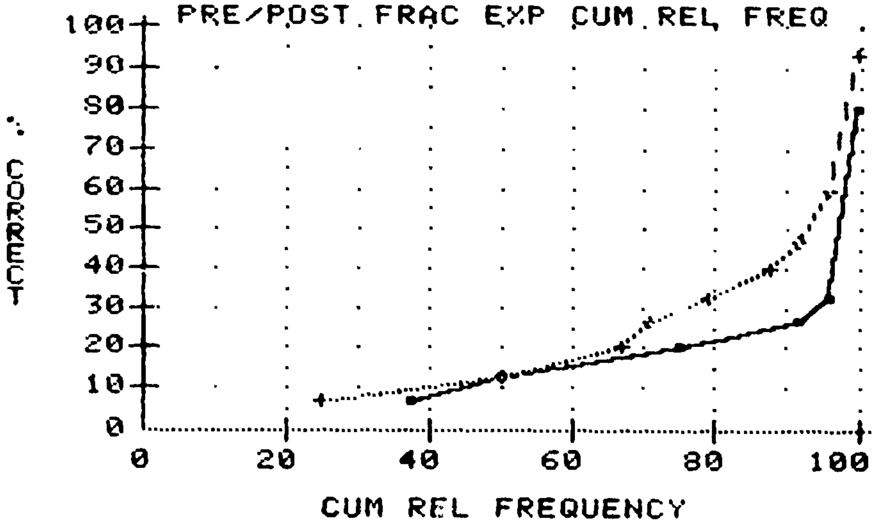

Figure 17. Graph of the cumulative relative frequency distribution of mathematics fractions pre- and post- test for the sixth grade experimental group. (Solid line = pre-test, broken line = post-test.)

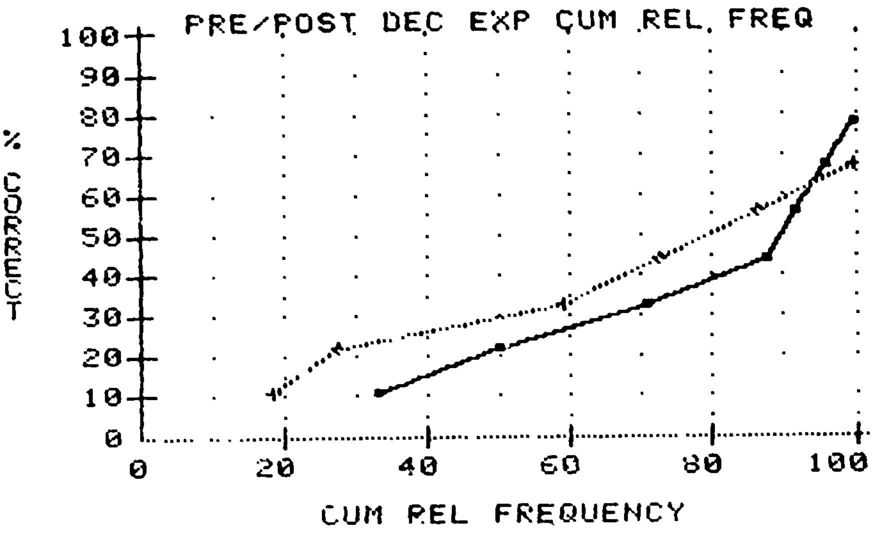

Figure 18. Graph of the cumulative relative frequency distribution of mathematics decimal pre- and post- test for the sixth grade experimental group. (Solid line = pre-test, broken line = post-test.)

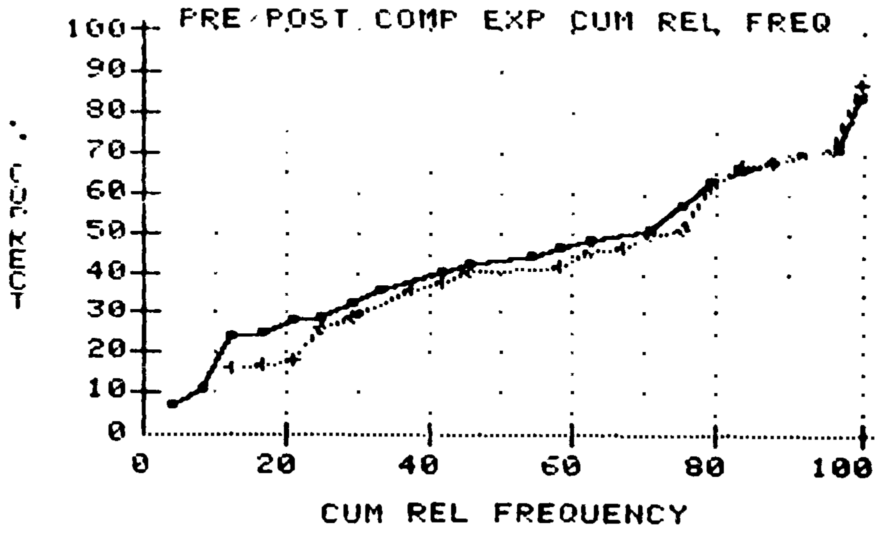

Figure 19. Graph of the cumulative relative frequency distribution of mathematics composite pre- and post- test for the sixth grade experimental group. (Solid line = pre-test, broken line = post-test.)

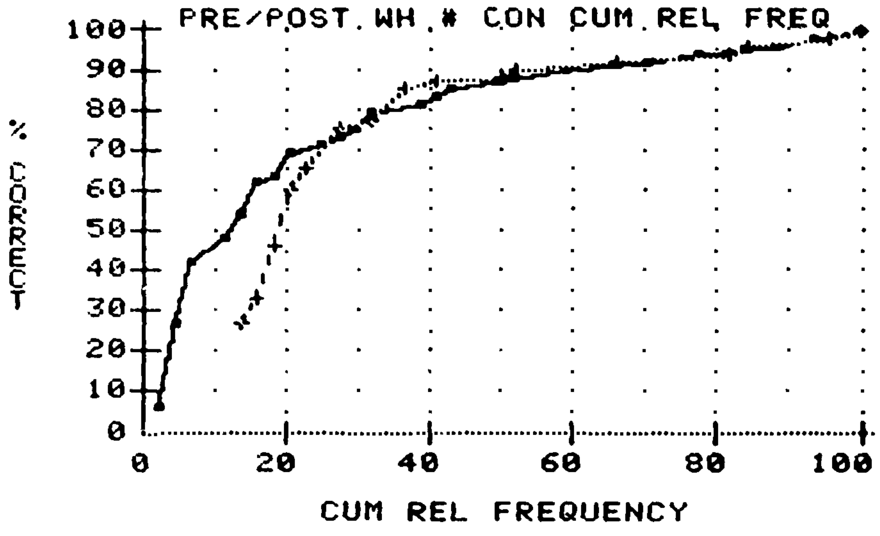

Figure 20. Graph of the cumulative relative frequency distribution of mathematics whole number pre- and post- test for the sixth grade control group. (Solid line = pre-test, broken line = post-test.)

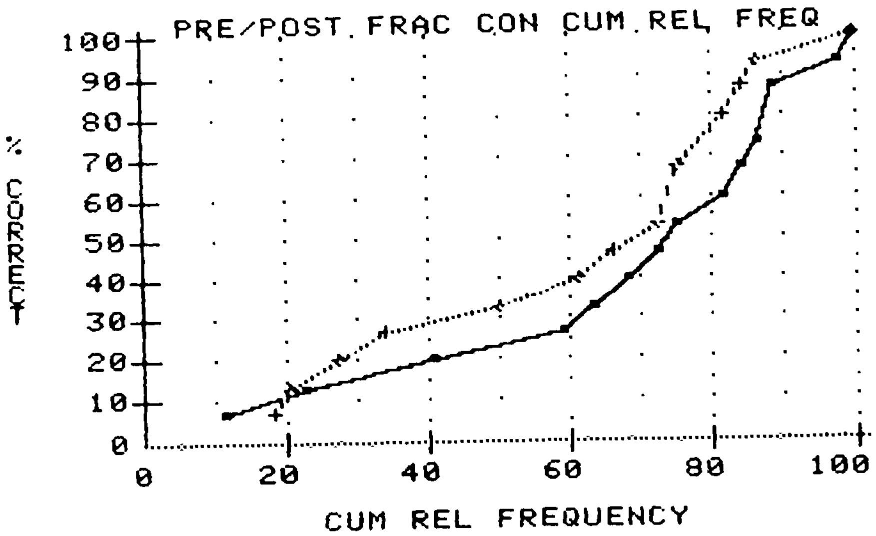

Figure 21. Graph of the cumulative relative frequency distribution of mathematics fraction pre- and post- test for the sixth grade control group. (Solid line = pre-test, broken line = post-test.)

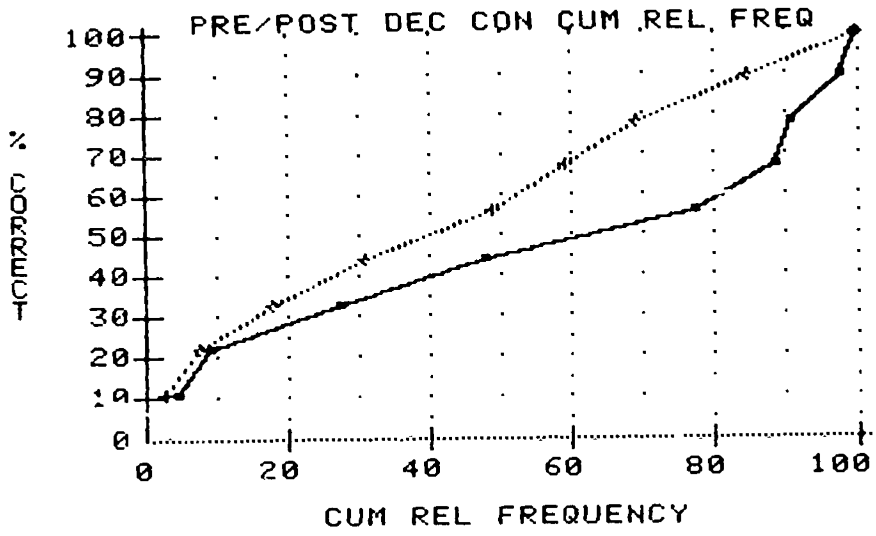

Figure 22. Graph of the cumulative relative frequency distribution of mathematics decimal pre- and post- test for the sixth grade control group. (Solid line = pre-test, broken line = post-test.)

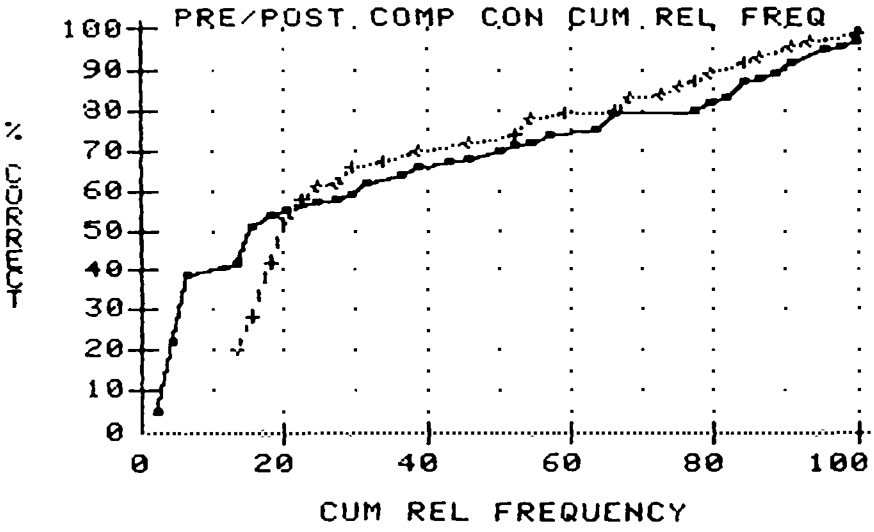

Figure 23. Graph of the cumulative relative frequency distribution of mathematics composite pre- and post- test for the sixth grade control group. (Solid line = pre-test, broken line = post-test.)

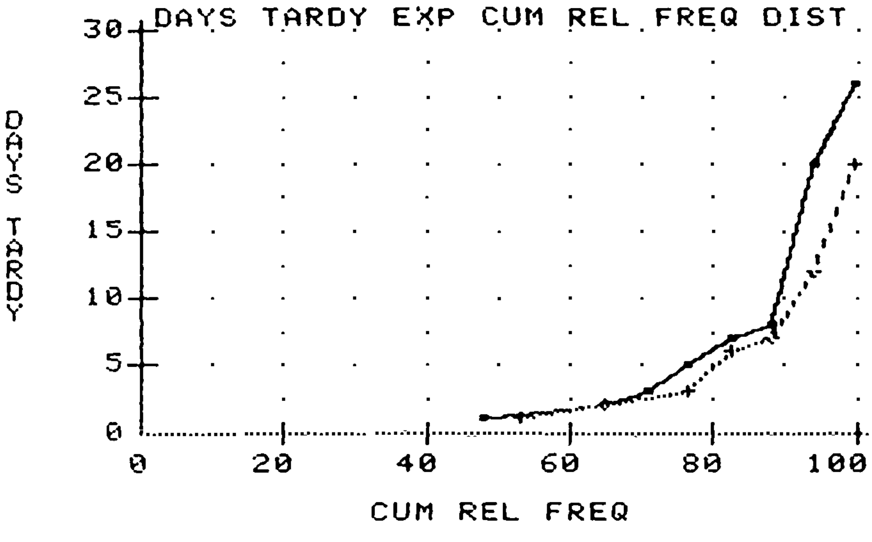

Figure 24. Graph of the cumulative relative frequency distribution of the number of days tardy for for the sixth grade experimental group. (Solid line = Fall, broken line = Spring.)

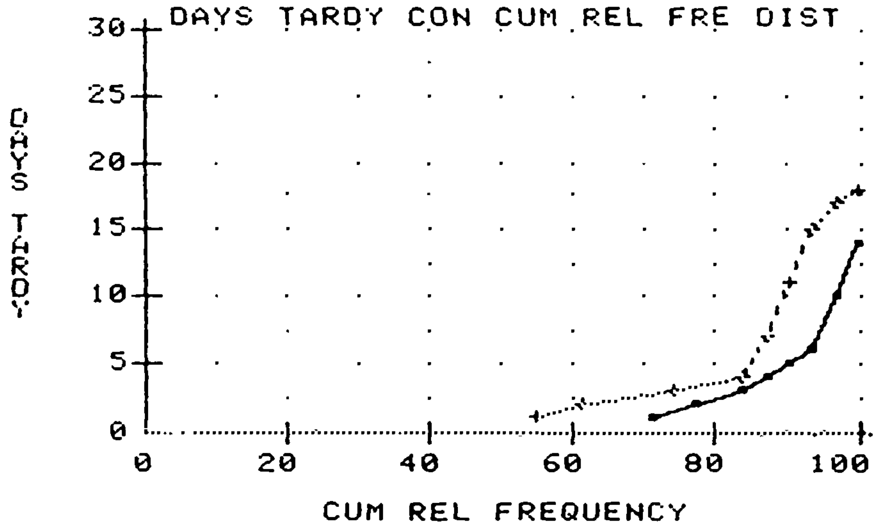

Figure 25. Graph of the cumulative relative frequency distribution of the number of days tardy for the sixth grade control group. (Solid line = Fall, broken line = Spring.)

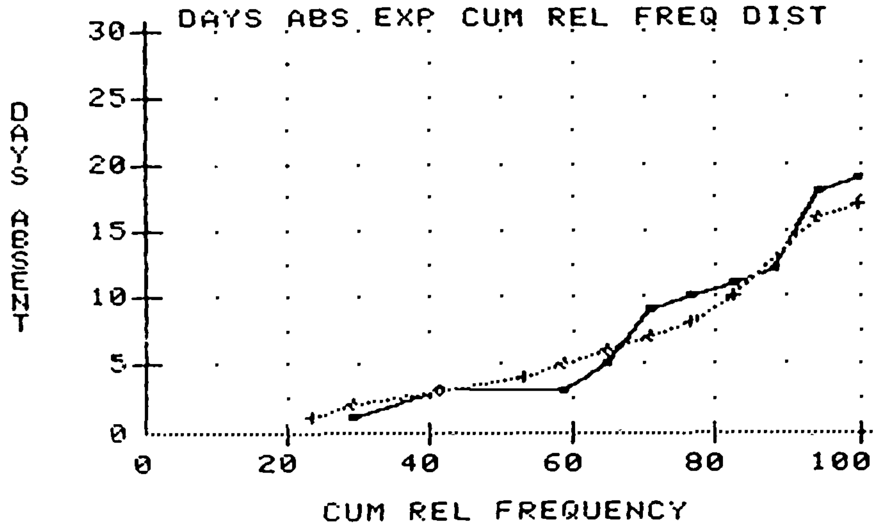

Figure 26. Graph of the cumulative relative frequency distribution of the number of days absent for the sixth grade experimental group. (Solid line = Fall, broken line = Spring.)

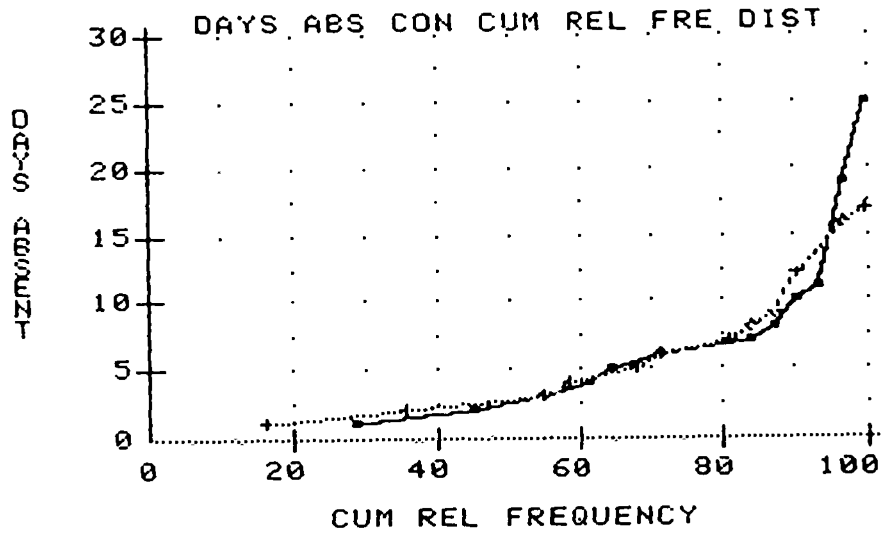

Figure 27. Graph of the cumulative relative frequency distribution of the number of days absent for the sixth grade control group. (Solid line = Fall, broken line = Spring.)

Table 7

Correlations between scores on high school instruments.

Instrument/	Instrument/Measure Number								
Measure	2	3	4	5	6	7	8	9	10
Pre-tests									
1. Stanford Test of Academic Skill	.51*	.45*	.23	.35*	.50*	.35*	-.25*	-.14	-.23
2. Math Attitude		.55*	.53*	.73*	.59*	.58*	-.21	-.39*	-.35*
3. Computer Attitude			.58*	.49*	.70*	.65*	-.14	-.38	-.28
4. Science and Technology Attitude				.61*	.61*	.77*	.10	.00	-.09
Post-tests									
5. Math Attitude					.67*	.71*	-.02	-.32*	.25
6. Computer Attitude						.78*	.06	-.19	.07
7. Science and Technology Attitude							.03	- .15	.06
Other measures									
8. Days Absent Fall								.41*	.83*
9. Days Absent Spring									.84*
10. Days absent 1981-82									

* Significant at *p* =< .05.

Table 8

Results for high school.

Variable	Mean Performance						F	df	p
	Experimental Group			Control Group					
Pre-tests:	Mean	S.D.	n	Mean	S.D.	n	ANOVA		
Stanford math test	39.69	7.68	29	36.06	8.69	18	2.249	1,45	.141
Mathematics attitude	27.34	26.29	29	12.61	18.25	18	4.336	1,45	.043
Computer attitude	37.28	20.02	29	15.33	14.15	18	16.446	1,45	.000
Sci/Tech attitude	21.69	23.36	29	14.72	20.82	18	1.071	1,45	.306
Post-tests:							ANCOVA		
Mathematics attitude	34.40	29.36	20	8.17	19.96	6	2.478	1,22	.130
Computer attitude	45.90	22.89	20	13.83	16.46	6	4.233	1,22	.052
Sci/Tech attitude	35.40	23.94	20	24.67	11.34	6	.057	1,22	.813
Days absent 1981-82	13.98	8.35	21	16.45	9.77	22	.136	1,40	.715
Gain scores:							ANOVA		
Mathematics attitude	-3.26	24.36	31	-9.70	18.71	27	1.248	1,56	.269
Computer attitude	-4.06	26.07	31	-5.63	18.20	27	.068	1,56	.795
Sci/Tech attitude	3.52	23.56	31	-2.37	22.24	27	.949	1,56	.334

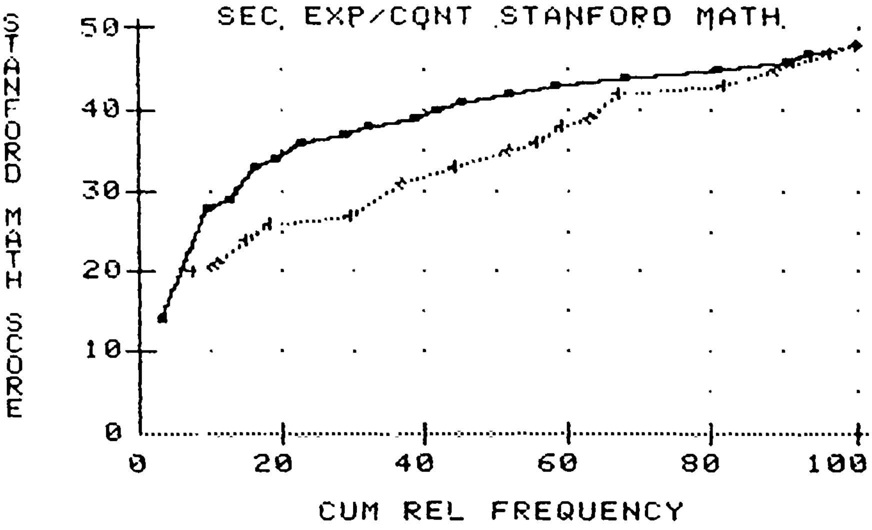

Figure 28. Graph of the cumulative relative frequency distribution of Stanford mathematics test scores for high school experimental and control groups. (Solid line = experimental group, broken line = control group.)

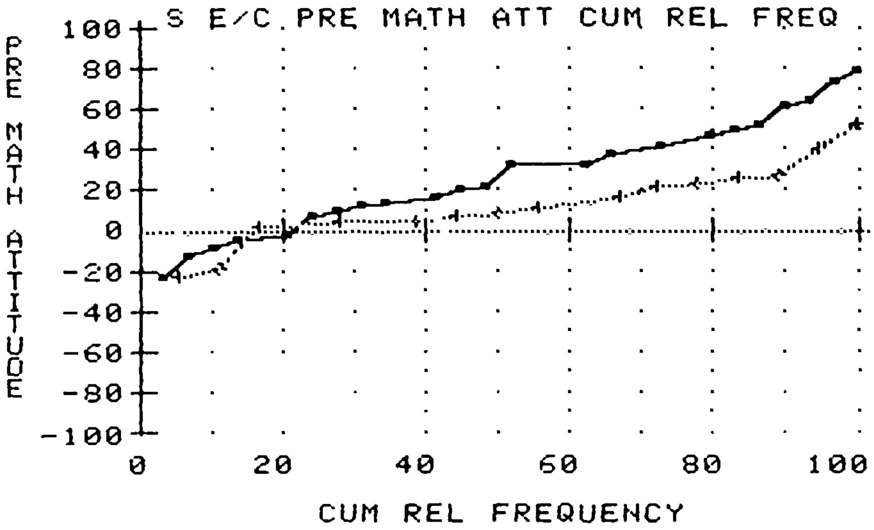

Figure 29. Graph of the cumulative relative frequency distribution of pre- test of attitude toward mathematics for high school experimental and control groups. (Solid line = experimental group, broken line = control group.)

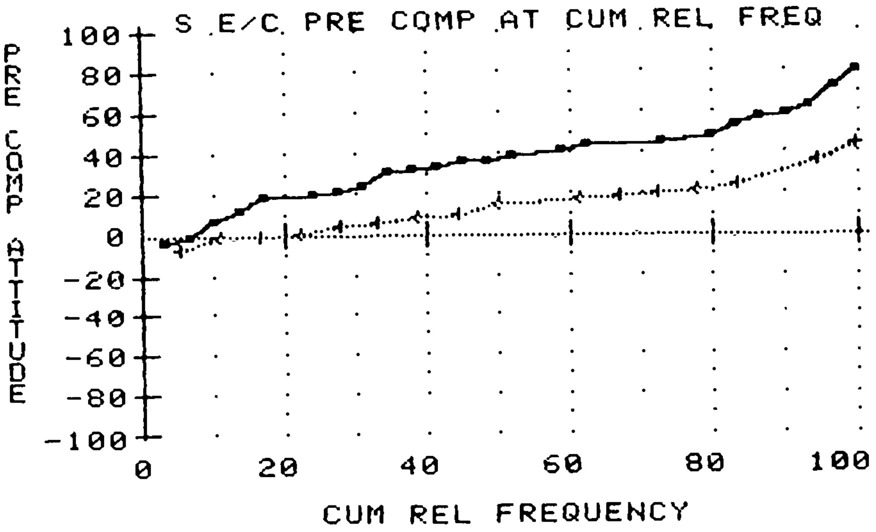

Figure 30. Graph of the cumulative relative frequency distribution of pre- test of attitude toward computers for high school experimental and control groups. (Solid line = experimental group, broken line = control group.)

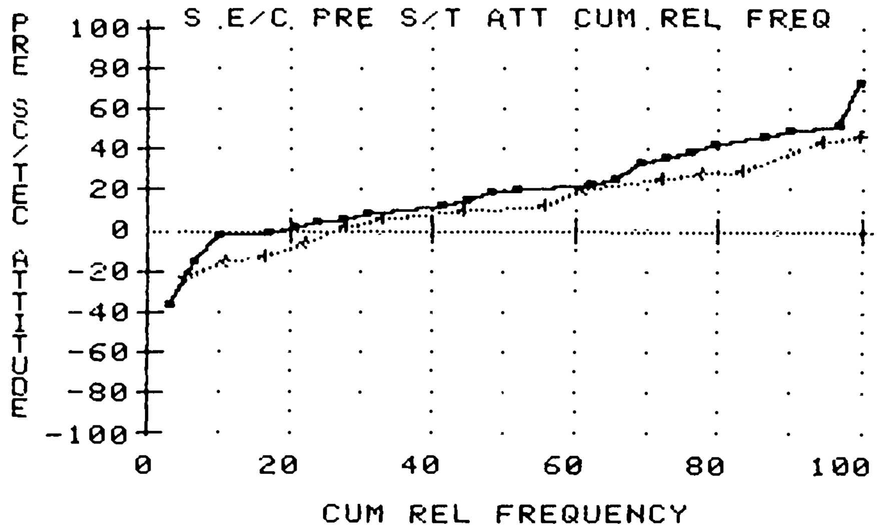

Figure 31. Graph of the cumulative relative frequency distribution of pre- test of attitude toward science and technology for for high school experimental and control groups. (Solid line = experimental group, broken line = control group.)

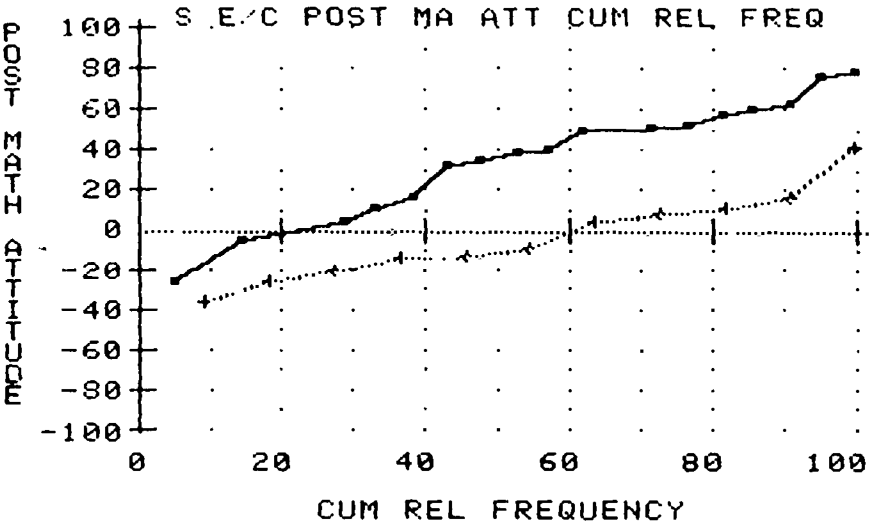

Figure 32. Graph of the cumulative relative frequency distribution of post- test of attitude toward mathematics for high school experimental and control groups. (Solid line = experimental group, broken line = control group.)

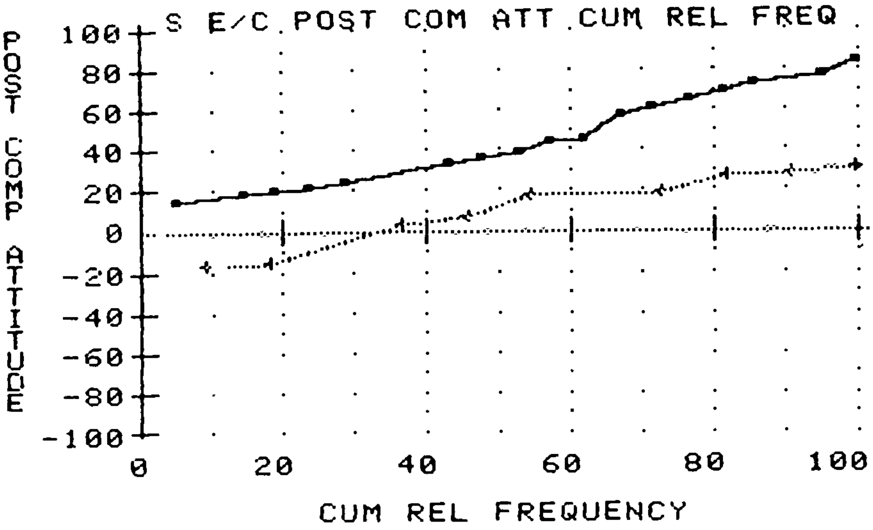

Figure 33. Graph of the cumulative relative frequency distribution of post- test of attitude toward computers for high school experimental and control groups. (Solid line = experimental group, broken line = control group.)

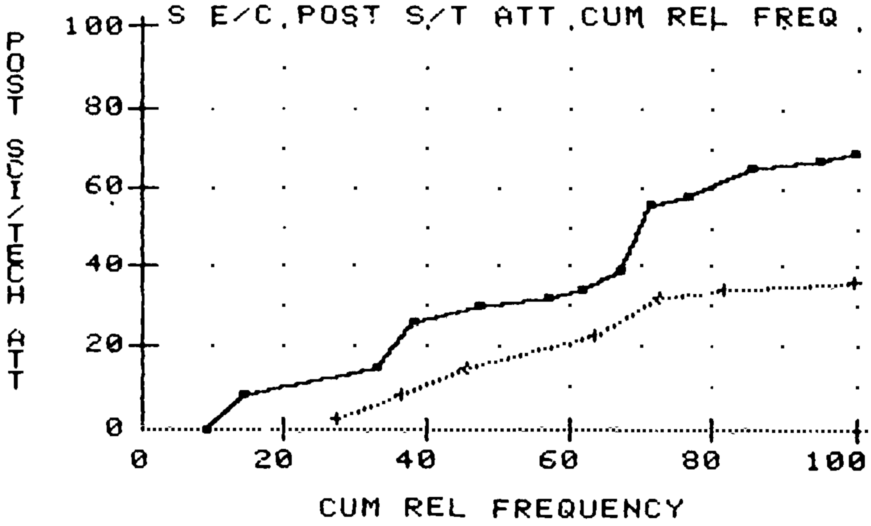

Figure 34. Graph of the cumulative relative frequency distribution of post- test of attitude toward science and technology for for high school experimental and control groups. (Solid line = experimental group, broken line = control group.)

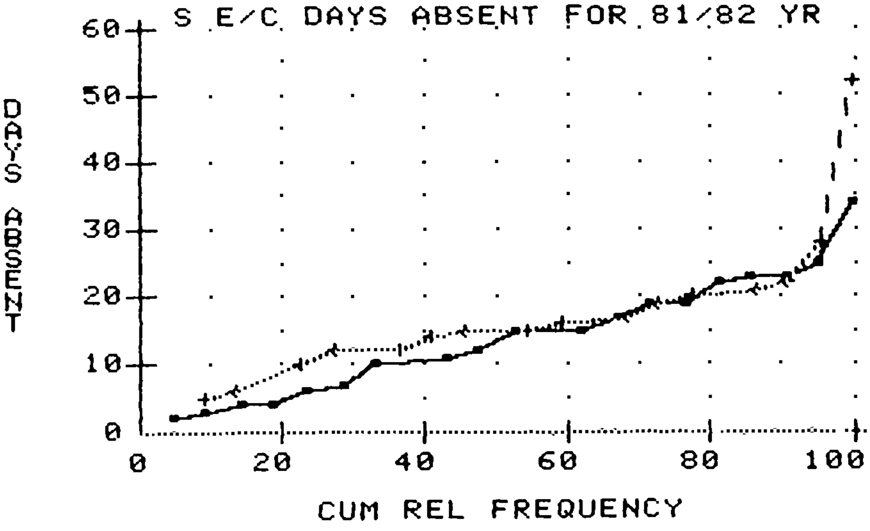

Figure 35. Graph of the cumulative relative frequency distribution of number of days absent for the 1981-82 school year for high school experimental and control groups. (Solid line = experimental group, broken line = control group.)

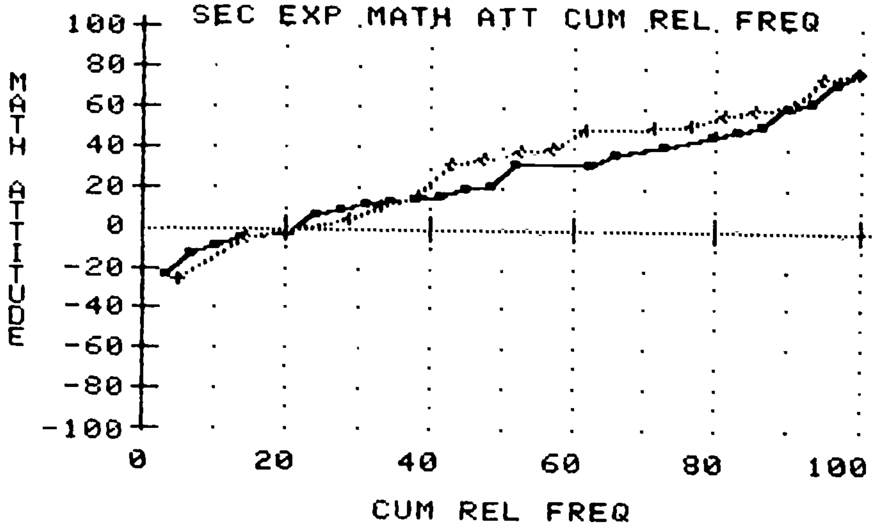

Figure 36. Graph of the cumulative relative frequency distribution of pre- and post- tests of attitude toward mathematics for high school experimental group. (Solid line = pre-test, broken line = post-test.)

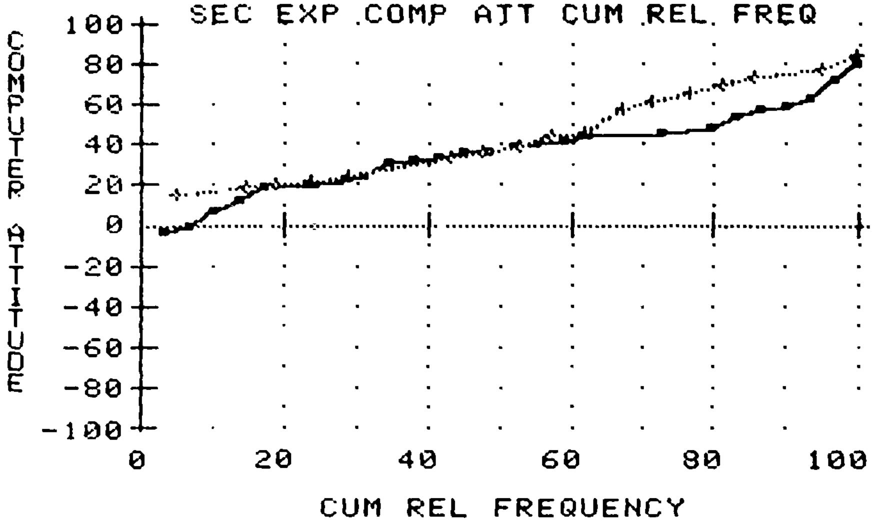

Figure 37. Graph of the cumulative relative frequency distribution of pre- and post- tests of attitude toward computers for high school experimental group. (Solid line = pre-test, broken line = post-test.)

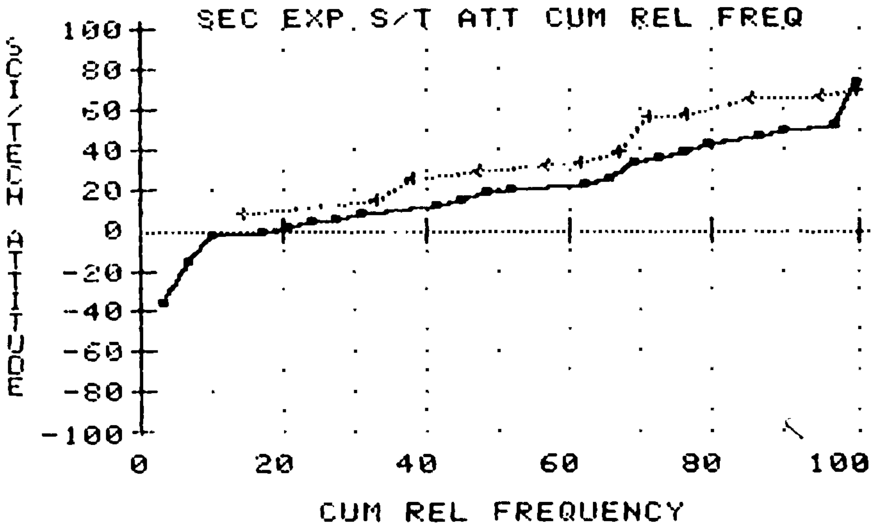

Figure 38. Graph of the cumulative relative frequency distribution of pre- and post- tests of attitude toward science and technology for high school experimental group. (Solid line = pre-test, broken line = post-test.)

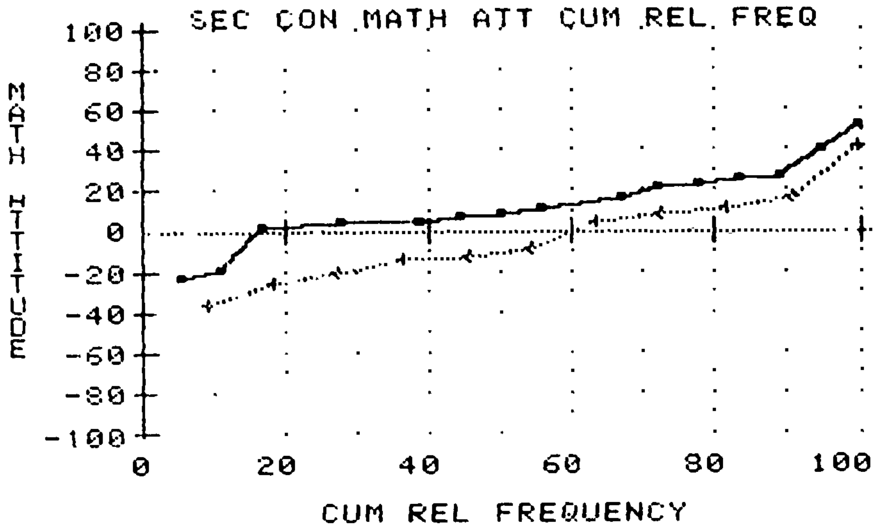

Figure 39. Graph of the cumulative relative frequency distribution of pre- and post- tests of attitude toward mathematics for high school control group. (Solid line = pre-test, broken line = post-test.)

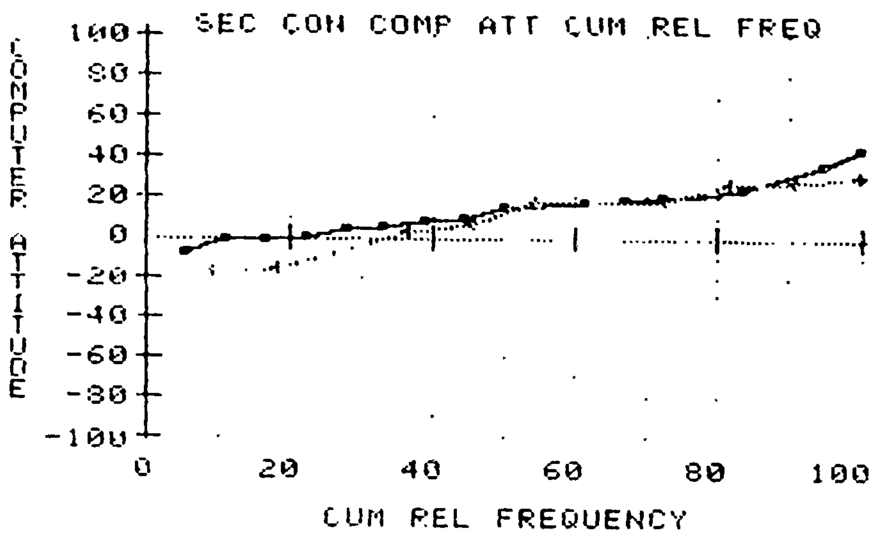

Figure 40. Graph of the cumulative relative frequency distribution of pre- and post- tests of attitude toward computers for high school control group. (Solid line = pre-test, broken line = post-test.)

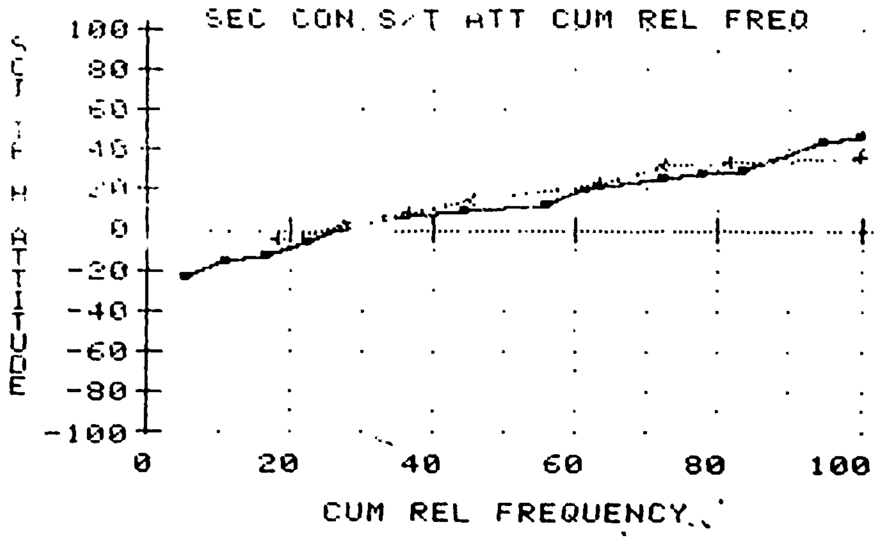

Figure 41. Graph of the cumulative relative frequency distribution of pre- and post- tests of attitude toward science and technology for high school control group. (Solid line = pre-test, broken line = post-test.)

Table 9.

Responses to the parent questionnaire objective response items.

		RESPONSE								
		A		B		C		Total		
Item	Level	n	Row %	n	Row %	n	Row %	n	Col.%	X-square
1.	Elem.	14	93.3	1	6.7	0	0.0	15	53.6	
	Sec.	9	69.2	3	23.1	1	7.7	13	46.4	
	Total	23	82.1	4	14.3	1	3.6	28	100.0	37.50
2.	Elem.	12	60.0	8	40.0	0	0.0	20	62.5	
	Sec.	4	25.0	8	75.0	0	0.0	12	37.5	
	Total	16	50.0	16	50.0	0	0.0	32	100.0	18.13
3.	Elem.	7	50.0	4	28.6	3	21.4	14	53.8	
	Sec.	0	0.0	10	83.3	2	16.7	12	46.2	
	Total	7	26.9	14	53.8	5	19.2	26	100.0	20.82
4.	Elem.	15	100.0	0	0.0	0	0.0	15	56.6	
	Sec.	11	91.7	1	8.3	0	0.0	12	44.4	
	Total	26	96.3	1	3.7	0	0.0	27	100.0	50.14
5.	Elem.	15	100.0	0	0.0	0	0.0	15	55.6	
	Sec.	9	75.0	1	8.3	2	16.7	12	44.4	
	Total	24	88.9	1	3.7	2	7.4	27	100.0	42.94

Chapter 4

PROJECT DIRECTOR'S FINAL REPORT

Introduction and the Pilot Phase

The project titled "Personal Computers and Cross-Aged Instruction" (NSF SED#79-18974) was conducted in four phases; planning, pilot, experimental and analysis phases. The project was based in the School of Education, University of Colorado, Boulder, Colorado with the school based activities taking place in the St. Vrain Valley Schools, Longmont, Colorado. The school based portion of the project lasted approximately eighteen months. The major goals of the project were: 1. to determine the effectiveness of using microcomputers as a tutoring device; 2. to determine the effectiveness of using high school students, along with microcomputers, as tutors for sixth grade students having difficulties in mathematics; and 3. to determine if exposure to microcomputers would motivate high school students to enroll in more mathematics and science courses. The first part of the project, from approximately September, 1980 through December, 1980 was the planning phase. The pilot phase was from January, 1981 through July, 1981 and the experimental phase was September, 1981 through June, 1982. The period after June, 1982 was used for additional data collection, analyses, and writing of the final report. The purposes of the planning and pilot phases were to establish and test procedures, develop curriculum, make informal evaluations, and transform the concept of the research proposal into a functioning research project. This was accomplished by spending the months from September, 1980 to January, 1981 in planning and developing curriculum. Continuous revision continued throughout the entire project, and included consulting with personnel in the schools involved with the project, selecting student participants, making arrangements for transportation and, it seems in retrospect, a thousand other details, such as instituting security procedures for the microcomputers, which would insure a smooth functioning project.

The project was to operate in three schools, all located in the St. Vrain Valley Schools, Longmont, Colorado. Skyline High School was to be the location of the instruction involving high school students, and serve as the central location of the project. Skyline High School had never scheduled any course work in the computer field prior to the project. The school administration of the high school thus viewed the project with a mixed emotions, and some distrust, since the project was fairly autonomous and was not totally under their control. On the other hand, the project was viewed introducing computers into the school. To make the project successful, it was necessary to develop cooperation and support from the high school staff. This cooperation developed quickly, especially when the benefits that would accrue to the high school became more clear. The principal was especially instrumental in helping the project get off to a good solid start. In addition to the principal and other administrators however, the assistance of many people was needed to complete the project. The counselors helped establish the classes and helped with registration. The mathematics and science teachers provided office and teaching space, and worked to coordinate the computer classes with already existing programs in the building. Office personnel helped tremendously with details and the custodial staff was invaluable in helping with electrical cords, fixtures, and whatever was needed to set up and keep the hardware operating.

The scene of the tutoring within the program was two elementary schools, Spangler Elementary School and Columbine Elementary School, each of which are about one mile distant from Skyline High School. Tremendous cooperation between the administration and staff of the high school and those in the elementary schools was necessary. This cooperation concerned the time that classes were to be offered and times when tutoring could take place, setting aside rooms for tutoring, and selection of the high school students and the elementary students to be tutored. This cooperation was always forthcoming from the principals at all three schools, the staff at the high school and sixth grade teachers at both elementary schools. As with the high school, the office staff, librarians, and others at both elementary schools provided assistance which made the project function smoothly. At both the high school and the elementary school levels there were people not directly related to the project whose interest spurred assistance well beyond the call of duty. The project thus became not an isolated program in three schools but a real part of the instructional programs of the schools with a myriad of people helping in a variety of capacities.

The school district administration, from the start, were supportive of the project but did not interfere. When asked for assistance, the district administration gave the necessary aid or direction, but other than that seemed unconcerned about the project, its objectives, or what role it was playing in developing computer education for the district as a whole. The project staff interpreted this to mean that the school administration was comfortable with the project as proposed, as well as the project staff and confident that it was being carried out properly.

As the project developed, two classes in microcomputing were established at Skyline High School for the second semester of the 1980-81 school year. One class had nineteen students and the other had ten. The class sizes were controlled so that each class could work as a whole with the sixth grade students at a particular elementary school. Nine Apple II Plus computers, nine color monitors, three Epson printers, three Apple Graphics Tablets, equipment for interfacing and software were ordered. Thirty sixth grade students at the two elementary schools were identified as participants in the project. This selection was based on the results of a school district testing program which indicated that these students were having difficulties in mathematics. During the first nine weeks of the Spring semester of 1981, the high school students in the pilot phase were taught how to operate Apple II Plus computers, some programming in BASIC, tutoring procedures, the processes by which learning takes place and typical difficulties sixth graders encounter in mathematics. During the second nine weeks of that semester, the project high school students continued to study these topics every other school day. They also produced programs in BASIC that could be used in tutoring the elementary students. The BASIC programs were, as much as possible, directed to the specific problems encountered by the sixth grade students. On alternate days, the high school students were transported to the elementary schools to tutor the sixth grade students on a one-on-one basis. The tutoring took place within the class period of the high school students, which was made to correspond to the time of the mathematics classes at the elementary schools. During the fifty minute class period, the high school students boarded a bus, traveled to the elementary school, tutored for a thirty minute block of time, reboarded the bus, and arrived back to the high school by the end of the class period. As is obvious, this only was accomplished by excellent coordination with the school district transportation department and its drivers. All nineteen students from one of the project's high school classes went to Columbine Elementary School and tutored nineteen sixth grade students. Likewise, the ten students from the other project class went to Spangler Elementary School and tutored ten sixth grade students. Thus, the total amount of time actually spent tutoring elementary students over the eight weeks pilot tutoring period was about ten hours. The distribution of equipment over the three schools was such that four machines were retained at the high school for continued training at the high school, three machines were placed in one elementary school and two were placed in the other. During the pilot phase no machines were transported between schools for tutoring. Thus over the eight week tutoring period, the total computer time available to the elementary students was sixty-seven hours. This time was distributed over the twenty-nine elementary students. Therefore, on the average, each elementary student was able to use a computer (under the direction of a high school student) for at most 2.3 hours over the eight weeks.

On July 16 and 17, 1981 a meeting with project staff and four outside consultants took place to evaluate the pilot phase of the project, its procedures, its data gathering, and to make suggestions on alternative approaches which could be implemented in the experimental phase of the project. Many items were discussed and a variety of suggestions were made. One weakness of the project was discussed at length and all agreed that a structural change had to be made to allow for greater time on the computers for the elementary students. During the remainder of the summer various approaches to achieving that goal were formulated, discussed, evaluated, some discarded and reformulated. An arrangement for transporting computers between schools was chosen as the most feasible given the limited budget of the project. Thus the stage was set for the project. This was to begin the first of September, 1981 and continue throughout the 1981-1982 school year.

The Experimental Phase

The schedule in the experimental phase of the project corresponded very closely to the pilot phase, two classes of computer mathematics were offered at the high school with the student enrollment again being controlled so that each class met the tutoring requirements of the two elementary schools. Students were instructed in computer literacy, computer programming in BASIC, the psychology of learning and typical difficulties encountered by sixth grade students in mathematics. On alternate days the high school students were transported to elementary schools to tutor a sixth grade student. As in the pilot phase, approximately sixty students were involved, thirty at the secondary level and thirty at the elementary level. There were two major differences between experimental and pilot phases. First, the "treatment" time was to last an entire school year in the experimental phase, not just one semester as in the pilot phase. This allowed a complete semester for instruction of the high school students prior to tutoring. This was followed by an entire semester for tutoring (on alternating days). In effect this at least doubled the amount of time available for all aspects of the project from the pilot to the experimental phase. Secondly, available time on computers for the elementary students was more than doubled by extending the length of the time for tutoring and by transporting five machines between schools during the tutoring period.

The experimental phase got off to a very inauspicious start. Because of a clerical error, the offering of the two project classes at the high school was not listed in the materials that were presented to high school students at pre-registration. Consequently, no students registered for the project classes. Students who had pre-registered for other classes were reluctant to disrupt their schedules and "add" the project class. However, in three days time, school and project staff recruited sufficient students into project classes. The attractiveness of classes on computers seemed to account for part of the rapid filling of the project classes "after the fact," a class which was an "elective". However, this situation did result in several rather abnormal outcomes. The majority of the students who enrolled for the project classes were those who for one reason or another had not pre-registered, or had recently transferred to the school. After investigation, one of the main reasons some of these students had not pre-registered was that they were uncertain about returning to school at the time of pre-registration. This resulted in a more transient "experimental group" than was desired. A few students did change established schedules and enrolled in one of the two project classes. These circumstances were to have ramifications for the project as will be discussed below. Elementary school students were not involved in any way during the first semester of the experimental phase.

Students in the project classes were not being trained as computer scientists or accomplished programmers, but were to learn some concepts essential to understanding computers and some introductory programming, along with communication skills associated with tutoring and typical difficulties encountered in sixth grade mathematics. If participants wanted to move beyond this essential base of information, they would have to do this in more specialized courses or in career options. It was hoped that some students would choose to do this. One objective of the project was to determine if subsequent enrollment in fact did take place.

Time in class for the high school students for the first semester amounted to 75 hours of instruction. Sixty percent of that time, or 45 hours, was spent on instruction about computers. Another twelve percent, or nine hours, was used for administrative details, testing, and review of testing. The remaining twenty-eight percent of the time, twenty-one hours, was spent on instruction about the processes of learning, about the tutoring situation, and preparation for tutoring.

No one source, or text, was used as the basis of instruction on computers. This was the case for three reasons: First the Skyline administration had not decided what was to be done with computer education after the project was finished and were thus reluctant to purchase any materials or a text. Secondly, the project staff saw a multiplicity of materials available; texts, audio-visual materials, software, most of which could be incorporated into a more systematic program, if time permitted its development. This was not the purpose of the project. A complete listing of materials used in the project is given at the end of this report. Third, a single text was not used exclusively because most texts don't adequately cover graphics and the project's curriculum included substantial work in graphics, since the Apple has such good graphic capability and since graphics is highly motivating.

Instruction began with an introduction to computers, computer literacy, and some historical perspectives on computing and computing devices. The vocabulary necessary to enter the field was stressed. Some, but not all, of the essential vocabulary covered in class was: Abacus, cursor, prompt, memory, bit, digital, word, binary, analog, central processing unit (CPU), hardware, software, output, input, compute, monitor (visual), diskette, floppy disk, language, BASIC, RAM, ROM, program, arithmetic logic unit (ALU), byte, disk drive and silicon chip. The goal was to make the terminology as clear as possible, through demonstrations or observing specific equipment. The components of microcomputers, specifically the Apple, and their functions were covered, as were such topics as the growth of personal computing, computers as tools for data collecting and problem solving, and the present and possible future impact of computers on individuals and society. Books and magazine articles were the primary sources for this instruction. A short time was spent also on understanding binary numbers and how they are used by computers.

One introductory programming exercise was, to have each student write a "program" for making a peanut butter and jelly sandwich. When the students had done this, materials were provided for others to follow the steps and try to produce a sandwich. When commands were given to spread the peanut butter before bread was taken from the wrapper or the lid of the jar removed, the students began to perceive some of the steps that were omitted and were introduced to logic that is required for programming.

An introduction to programming on the computers was begun with low-resolution graphics, specifically using the commands GR, COLOR=X, PLOT, HLIN, and VLIN. The idea of programming rather than working in an immediate mode was explained, demonstrated, and explore at this time. The System commands SAVE, LOAD, RUN, and LIST were also introduced at this time. Assignments were such things as producing initials , names and pictures of one kind or another on the screen. As with all later assignments, some students were content to do the assignments, while others always wanted, and of course were permitted and encouraged, to use their own ideas, imagination, and creativity to generate new images, and to incorporate their own ideas in programming. As the students became proficient at producing simple figures on the screen, and also became bored with their simplicity and immobility, instruction turned to use of variables, variable names, sequential ordering of mathematical operations, GOTO statements, and looping, FOR-NEXT loops were used extensively by some students to accomplish flashy displays or apparent movement in their graphics. The STEP command, used in FOR-NEXT loops was also introduced and used at this time.

Following the introduction to programming through graphics, instruction progressed to a short and very rudimentary set of lessons on flowcharting. The symbols for input/output, assignment, decision, end, and connector were presented and demonstrated in a variety of easy to understand programs. As with previous lessons, the first programs that were used to demonstrate flowcharting were not directly related to computer programming. One example was to get input on the weather outside, and if it is cold then get a jacket but if it is warm then don't bother with the jacket. Through this process students accumulated a number of commands; including LET, PRINT, IF-THEN, READ and DATA, and used many more mathematical and variable expressions than they did in programming in low-res graphics. Again, programs to solve simple problems or accomplish certain tasks were assigned. INPUT statements were used and programs like those computing the pay of a worker, allowing the worker to enter the number of hours worked, rate of pay, deductions, etc. were produced. In progressing from the most simple to more complex programs, stress was put on the syntax of programming, uses and positioning of quotation marks, commas, semi-colons and colons. Topics included subsequent to this were; the sequence of mathematical operations, nested loops, and expanding the use of IF-THEN statements. Some of the final topics included during the first semester of computer instruction were string variables and user entered information, including string variables and commands like X$, LEFT$, RIGHT$, MID$, and INPUT statements for both numeric and alphabetic information.

The other major area of instruction during the Fall semester, 1981 was tutoring preparation. To introduce this part of the instruction, students did some Piaget type tasks to stimulate thinking about learning. Student's were taught Piaget's theories about learning as well as an overview of his stages of development. Stress was placed on the idea of concrete forms of learning in order to try to get the high school students to make their tutoring lessons as concrete as possible. Many examples, demonstrations, and a variety of materials were presented to spur discussion. The high school students were genuinely interested in these topics, partially because the processses of learning and memory are hardly ever a topic of discussion or investigation at this level of education. Escher prints and pictures of ambiguity were brought in to make the point that what teachers think they are teaching may be quite different from what is being perceived or learned by the student. Passive learning as different from active learning and memory as opposed to mastery were discussed and demonstrated. The characteristics of sixth grade students, and details about the sixth grade mathematics curriculum were offered. The general emphasis conveyed was that the tutoring situation presented unique opportunities for a high school student to work with an elementary student who was having learning difficulties. It presented the opportunity to determine some of the causes of these difficulties, and attempt to provide remediation. Problem solving, logic, and mastery was to be given greater stress than rote learning and memory.

The test that was administered to the sixth grade students for selection into the tutoring program was examined by the high school tutors. This was done to make them familiar with the types of topics covered in sixth grade and give them a better perspective when evaluating the elementary students' performance on the tests. Each elementary student's test score was discussed, making certain to point out both strengths and weaknesses. Personal and academic information about each student was obtained from the sixth grade teachers. Thus, each high school tutor was presented with as much information about the sixth grade students as possible. Tutors showed great maturity in discussing this information and treating it with respect and confidentiality. It was only after this process was completed that the matching of tutor with student took place. Most of the high school students knew themselves, and were honest enough about themselves, to know what kind of personality they could deal with best. Never was a student assigned without the consent of the tutor. Some of the combinations that came out of this self-assignment were high school athletes working with sixth graders who had been disruptive and seemed to have few outlets for their behavior, students from broken homes working with those whose parents were going through a divorce, and some of the very brightest high school students choosing some of the sixth graders with the most severe difficulties as " a challenge." Finally, in this segment of teaching about tutoring, the required format for lesson plans, evaluation of tutoring sessions, practice and preparation for tutoring were discussed and completed.

The high school students responded well to the instruction concerning computers and tutoring, and were enthusiastic and excited about beginning tutoring. Unfortunately, there was an insufficient number of high school students left to tutor the number of elementary school students selected for tutoring. This was because, by the end of the Fall semester, ten students had dropped out of project classes. One other student had transferred into Skyline and was assigned to a project class because he had some computer background had moved out again before the end of the semester. Of the ten students who started the project class but later dropped out, only one student remained enrolled as a student at Skyline. This meant that the drop-out rate for project classes, because of lack of interest, was less than three percent. Of the remaining nine students who had dropped out before the end of the Fall semester, four moved from the school's attendance area and five dropped out of school totally. Two of these five took jobs and three dropped because of family or other problems. Thus, by the end of the first semester over thirty percent of the students originally enrolled in the two project classes were no longer enrolled at the school. One possible reason for this was stated earlier, the lack of notification to students of the availability of the project classes at the time of pre-registration and the consequent enrollment of students who had not pre-registered or had transferred into Skyline since pre-registraion. Since thirty-three students had been originally enrolled in the project classes, by the end of the Fall semester there were only twenty three left. Thirty sixth grade students had already been selected for tutoring in the two elementary schools. A quick decision had to be made to either reduce the number of students who would be tutored, or open up project class enrollment at the high school level to increase the number of high school tutors. The difficulty with the first choice was obvious; fewer high school students would be participants, thus, fewer sixth graders could be tutored. In addition this choice would require that some of the sixth grade students who had already been notified that they would be in the program, would have to be told otherwise. The second choice offered the possibility of assisting more sixth grade students, but the newly selected tutors would not have had the instruction offered on both computers and tutoring during the first semester. These new students would have to be taught, in accelerated form, what had been taught in the first semester. The decision was made by project staff was to seek additional high school students as tutors and provide the accelerated instruction on tutoring and computers. Thus, nine more high school students were recruited for the project classes, two more elementary students were selected for tutoring, and the Spring semester was ready to begin with thirty-two high school tutors and thirty-two elementary students.

Second semester consisted of ninety school days, forty eight of which the high school students spent at Skyline continuing work with computers and on preparation for tutoring. The forty-two alternate days, with a few exceptions, were spent tutoring in the elementary schools. Instruction on computers at the high school level consisted of review of work covered in the Fall semester and other topics related to topics covered in the Fall semester. High resolution graphics was introduced, using the commands HGR, HCOLOR=X, and HPLOT. Subroutines were often used way to do interesting graphic displays, including animation. Further work was done with the writing of programs, incorporating GOTO, GOSUB, ABS, RND, SQR, and REM statements. Instruction and practice in program documentation and structured programming were also included. Some time was spent on subscripted variables and arrays, but no attempt was made to cover these two topics in depth. Some students grasped these concepts quickly and used them in programs, while others had some difficulty. In addition to these topics students were given the opportunity to learn and use the APPLE graphics tablet, printers, software on plotting and graphing, and a text-editor. About half of the students chose to use text-editing in conjunction with a short research paper on computers which was a requirement in the course. Other time at the high school was devoted to preparation for tutoring, writing programs to be used in tutoring, evaluating software, making decisions about the use of software in tutoring, discussing student progress and planning tutoring lessons.

The tutoring aspect of the Spring semester of the experimental phase had points of similarity and dissimilarity to tutoring in the pilot phase. As noted earlier, the number of days spent tutoring was doubled to forty-two days. As in the pilot phase, each day on which tutoring was to take place, the high school students boarded a bus, rode to the elementary school, tutored for thirty minutes, and returned to Skyline by the end of that particular fifty minute class period. The most significant change in the tutoring portion of the experimental phase as compared to the pilot phase, was the use of the computer equipment. In the pilot phase, equipment was not transported between schools, equipment was permanently assigned to each school. During the experimental phase, one computer was assigned on a permanent basis to each elementary school. Seven of the machines were kept at the high school. The School of Education at the University of Colorado, purchased four monitors and five computer carrying cases and loaned these to the project. This additional equipment allowed placement of extra monitors in the elementary schools and the transporting of up to five computers each tutoring day to each of the elementary schools. In reality, in order to keep some equality between the two schools and the tutoring situation in each of the elementary schools, five computers were transported each tutoring day to Columbine Elementary School and four to Spangler Elementary School. This transporting of computers raised the amount of hands-on computer time to approximately nine hours per elementary student over the course of the semester.

Few equipment related difficulties occurred during the projects, and considering the fact that five machines were transported to two different schools every other day, connecting, disconnecting the machines, the equipment was very dependable and trouble free. Despite even an occasional dropping of a machine, the computers were "down" very infrequently and the repair time on the machines was very short. In the entire 1981-82 experimental phase only four incidents occurred which required "repair." Three of these incidents were merely adjusting of components within the machine, disk speed or a tightening a loose circuit board. The fourth was a true repair and was caused by one student removing a circuit board with the power "on" which caused an integrated circuit (IC) chip to "blow" and thus required the replacement of the chip and its socket. This last incident was the only one of the four which required professional servicing.

Tutoring was totally individualized. Each tutor was responsible for preparing a lesson to meet the needs of the individual student with which s/he was working. The usual plan included several minutes of friendly communication, as an introduction and a way to get both parties into the right frame of mind. The actual lesson of that day would follow; usually the lesson would consist of drill or the introduction of a new concept, expressed in two ways to help insure that it was communicated. Following this was additional time for drill or a game that stressed logic, problem solving or thinking skills. Some students needed assistance with organizational skills, if they were especially weak in that area. Finally, there was a short time to recapitulate the day's main point and then it was time to return to the high school.

Each week tutors tried to include time on problems that had some connection with their student's life or some logic problem in addition to the standard type of paper and pencil problems that are the standard fare of arithmetic instruction. This could be clearly seen in the students choice of computer programs. Some time was spent on programs that were in a sense electronic flashcards. But an equal, and probably greater, time was spent with programs that stressed thinking and problem solving or strategy, like Othello, Mastermind, Bagels, Lunar Landers, Artillery Simulators, etc.

In addition to helping the students improve their mathematics abilities, most of the tutors spent time teaching about the computers themselves. The sixth graders became very proficient in connecting the machines, running programs, and using normal care and precautions while using the computers. For most of the tutors, teaching about the machines meant more than merely teaching how to turn the computer on or off. It meant showing in some way how the information was put into the machine. A five day course, a mini-course for the micro, was developed, again using a variety of sources. For the first day the tutor had pre-programmed something in graphics which could be shown to the student. The program illustrated the points that the color and shape of pictures on the screen could be altered at the discretion of whoever is using the computer. The more proficient high school students tried to make the same point with motion, things can be made to move or remain stationary, based on the desires of the person doing the programming. Day two involved looking at the color demonstrations that came with the computers. After viewing, these, the tutor would enter a simple program and with the tutor's help, change the color of the figure, SAVE the figure to disk, LOAD and RUN it, and change the colors a few more times; or, if they were catching on fast, change the color of different parts of the figure. On the third day of the mini course, the tutor would provide a 40 by 40 grid which corresponded to the layout of the APPLE's low resolution graphics screen and have the student draw on the grid a picture of her/his choice. After the drawing was completed, the tutor would explain that every line must then be entered into the computer's memory by use of the commands PLOT, HLIN, and VLIN. The tutor typically did the first few lines, but by then the student usually understood and was anxious to get at the keyboard. Day four usually was spent finishing the picture from day three. Day five was spent enhancing the finished product, with commands such as a GOTO statement to make the picture keep coming back to life, FOR-NEXT loops to accomplish special effects or start another picture.

The tutors took their roles seriously, even when they were less than serious students at the high school. In the end, the last few days of tutoring, most of the tutors and their students exchanged gifts, hugs and many even exchanged phone numbers. It is rather moving to see a high school student take off a treasured neck chain and give it to a sixth grade student, who understands the value of the gift and the time spent, and thus starts to cry. This scene did happen and as well as others which exemplified the personal bonds that developed during the tutoring part of this project. On the final day of tutoring the principals of the elementary schools provided a small treat for the tutors and their students as a small going away party, a very nice gesture, which was very much appreciated by all involved.

Project Director's Overall Reaction

Pappert, in the book MINDSTORMS commented on his early experiences with gears which, he postulated, helped him develop a desire to manipulate and understand things. He wrote, "If any 'scientific' educational psychologist had tried to measure the effects of this encounter, he would probably have failed. It had profound consequences but, I conjecture, only many years later. A 'pre- and post-' test at age two would have missed them."

Although the project reported here included pre- and post-tests on a variety of variables (reported elsewhere in this report) including mathematical achievement and attitude, it has initiated changes which were unmeasureable, some which may never be known and certainly could never predict.

In direct terms the project reached approximately one hundred and twenty students in its year and a half existence. This included sixty Skyline students who learned some computer programming, became more computer literate, and had the opportunity to expand their worlds by helping to teach another person. These sixty students included at least two who enrolled in college computer science courses for the 1982-1983 school year. It included students who, on their own, went to "their" elementary school to tutor when they had missed all of their other high school classes for that day. It included high school students who were talking about using the money they made at summer jobs to buy a computer. It included students who were considering careers in education or child care. It also included an extraordinary student, who, when trying to talk his way into an independent study course on computers in addition to the project's course, said, "Computers are far out-I'd rather have a computer than a car." Understanding the consuming interest high school students have in cars and mobility, this statement quickly gave birth to an independent study course.

The one hundred-twenty students directly influenced by the project also include sixty elementary students who had difficulty in school and received some very intensive, personalized help. The high school students noticed changes in these kids and wrote about them. Some of their comments are given below.

"When I began XXX seemed a little shy. He really wanted to prove to me that he was willing to learn. Now he is not shy at all and he is really learning his math."

"XXX, as you know, has leukemia and has often been able to succeed with pity from teachers, friends, or family. This is not good for him and now, as he is getting older, (and with help from me) he is starting to realize that it could be a problem. He has seemed to ask more questions rather than just sit around or guess on his answers. He still has a short attention span but it is getting better."

"I've noticed that she's not using her fingers as much when I ask her a multiplication problem. . . . She is interested in the half hour we are together, she does wander off sometimes but I guess all kids do that."

"His attitude has changed a lot because when he first came in he really didn't care about mathematics that much. Now he comes to class to learn to do math. . . . The most he is interested in is playing ith the computer."

The teachers of these sixth grade students also noticed changes and made comments which included the following.

"I have seen a positive change in XXX. He does seem to like mathematics more and is willing to work harder. He does seem to understand the concepts, too."

"XXX was doing four pages of work per day. Since she's been in the computer class she has been doing eleven pages. She is super motivated."

The project seems to have had many effects on the students involved. Since the project stressed one-on-one tutoring, there were benefits to both the elementary and secondary students in the area of emotional growth and increased self-confidence which will never be known or measured.

The benefits of the project, however, didn't affect only the one hundred-twenty students directly involved. The ripples of its effects spread much wider. A Columbine teacher wrote; "I feel that this class has really helped most of my children, even the ones who weren't chosen. By increasing the motivation of some in my class, it somehow pulled the rest of the class up too."

When the computers were not being used by the project they were used for a variety of other purposes. School district personnel used them to predict future enrollment patterns. Gifted and talented students at both elementary schools used them. They were used at the high school by biology and physics classes and almost constantly by students not in the project, to look at software or teach themselves programming. The greatest use, the one that may have the greatest long term effects, was the use of the machines for teacher and administrative inservice education classes.

Alan Kay wrote in SCIENTIFIC AMERICAN, "Unlike conventional mediums, which are passive in the sense that marks on paper, paint on canvas, and television images do not change in response to the viewer's wishes, the computer medium is active; it can respond to queries and experiments and can engage the user in a two-way conversation." If teachers can learn to use this medium and feel comfortable with it because the inservice classes offered with project equipment, then the effects of this project will continue on and reach many, many students.

In conclusion, I believe that the project has had profound effects on the staff and the students involved. That its effects have spread, and will continue to spread, to many people beyond its immediate reach, and will have a tremendous impact of education in this school district for years to come.

Paul Canny, Project Director

Principal Investigator's Note: Mr. Canny whose title was "Project Director" was the person most directly involved in the day to day conduct of the in school activities of the project. He was the teacher of the project classes, the primary person arranging logistics for the school based portion of the project and had to sit astride the fine line of diplomacy of being a half time teacher in the St. Vrain Valley Schools and being half time with the project. Without his involvement the project would not have achieved any measure of success.

Chapter 5

Conclusions and Recommendations

The project reported here was initiated with an open competition preliminary proposal submitted to the NSF in December, 1978. An invitation for the final proposal was received in late Spring, 1979. The grant was awarded in June, 1980.

The project was designed to raise the mathematics achievement of sixth graders through tutoring by high school students and using microcomputers in the tutoring process. In addition the project attempted to positively affect the enrollment in science and mathematics courses on the part of the high school student tutors. Secondary objectives were to evaluate microcomputers as a tool in the context of tutoring and develop effective applications of computers in instruction.

To accomplish these objectives high school students were trained for one semester to be tutors using microcomputers. In following semester these students tutored on a one-on-one basis, sixth graders in need of assistance in achieving in mathematics. Tutoring took the place of 40% of the sixth graders' regular mathematics instruction.

Experimental and control group of comparable size were used at both the sixth grade and high school levels. The experimental groups were selected based on criteria specified earlier in this report. For the sixth graders the data used were: a). pre- and post- treatment mathematics achievement; b). post- treatment attitude toward mathematics, computers, and science and technology; and c). number of days tardy and absent in the Fall and Spring semesters. For the high school students the data used were: a). pre-treatment mathematics achievement; b). pre- and post- treatment attitude toward mathematics, computers, and science and technology; c). number of days absent during the school year; and d). number of mathematics and science courses in which the high school students enrolled during five semesters (before, during and after the treatment period). Due to the transiency of the student body at the high school, the last of this data was so incomplete that it was of no use to the project. Parents of subjects in project classes were surveyed for their observations on their child's involvement in the project. High school subjects were also asked for written reactions.

The grant award was received one year later than the proposed time for beginning the project. Because of a total adminstrative change in the school system in that year and the preceeding six months, nearly all the arrangements for involvement in the schools had to be changed. This caused some delay in the project and when the award finally received an additional delay was caused by additional administrative arrangements. Any one of these difficulties were sufficient to cause the project to operate in less than optimal conditions. The school system however was committed to completion of the project and activity finally began in mid-October, 1980 with the selection of the project director (PD), Mr. Paul Canny. With the delays, the PD had to accomplish in two and one-half months which was to have taken six months. The pilot period (one semester) began in January, 1980, the meeting with consultants took place in July, 1980 at which time the first year report (Swadener, 1980) was completed. The experimental period (one academic year) took place in 1981-82, the Fall semester was the pre- tutoring period, the Spring semester was the tutoring period. Project classes took place in the St. Vrain Valley Schools, Longmont, Colorado. The facilities of the University of Colorado- Boulder were used for support, data analysis and writing.

After the project began, events which caused difficulty to the project continued, the most serious was a lack of high school subjects. Most of these events were truly beyond the control of project staff, could not be foreseen and therefore could not have been avoided. They did however, cause serious problems in carrying out the original plan of the study.

With this as a base, the remainder of this chapter will present conclusions based on the experience of the project staff and the data that were collected. Recommendations will complete this report.

Conclusions

1. Insufficient staff time was available to carry out the original design of the project.

The project was authorized 1.25 full time equivalent (FTE) staff for each of two academic years. These FTE were allocated in the following way: a). Project Director, .50 FTE; b). Principal investigator (PI), .25 FTE; and c). Research assistant (RA), .50 FTE.

The duties of the PD were to teach the two project classes each of three semesters, make necessary in school arrangements, and serve as a liason between the project and the administrations of the schools and school system. Most of the relations within schools were very positive, but there were some incidents that consumed time needed for the instructional activities of the project. The PD was assisted as much as possible with his tasks by the PI and RA but since the latter two persons were not employees of the school system they were able to provide only limited assistance in may cases.

The PD was an employee of the cooperating school district, .50 FTE with the project and .50 FTE as a regular sixth grade teacher in a school different from the three involved with the project. Given the fact that the PD had to divide his time between four schools he did exceedingly well in providing smooth relations between the administrations of the schools and the project. In fact, however, the PD was too busy to do all that was necessary. This was in part due to the newness of the administration in the school system and the turmoil caused by administrative change.

Early in the project it was seen that tasks of the PD would have to be limited. Some of the original thoughts of what would result from the project were thus dropped. Specifically, the project was to produce resource and/or teaching units for teachers, based on the experience in the project classes. This aspect of the project was quickly discarded as too time consuming, and not directly contributing to the primary objectives of the study. Therefore developing the units was discarded.

For each of two academic years, the PI was .15 FTE with the project and an additional .10 FTE as a university contribution to the grant. With all that needed to be done, much of it beyond the two academic years of the project, and with other demands, much of the work of the project came outside allocated time and caused difficulties.

The RA position was filled with a different person for each of the two years of the project (Mr. James Podolak and Mr. William Blubaugh). These persons were graduate students at the university and consequently (and properly) their major priority was their graduate studies. Ideally a person with full familiarity with the project would be in this position. Practically this was impossible and the persons involved had to take time to become familiar and comfortable with duties and procedures associated with the project. Both persons in this position did an excellent job but limitations caused by their backgrounds and time committments caused some difficulty.

2. The combinational strategy of mathematics tutoring using microcomputers, by high school students, had no noticeable effect on the mathematics achievement of the sixth graders above that caused by the regular classroom instruction.

The "gain" scores in mathematics achievement, the mean performance by group, and the pattern of the distribution of pre- and post- treatment mathematics achievement scores for the sixth grade experimental group was very much similar to that of the control group. Evidently, the atmosphere and activities of the regular sixth grade class instruction in mathematics were much more influential with respect to mathematics achievement than was the tutoring provided by the project.

3. Any gain, or loss in mathematical achievement at the sixth grade level was caused by factors other than tutoring.

The bases for this statement are the striking similarity in the distrbutions of mathematics achievement scores for both the experimental and control groups and the pattern of mean mathematics achievement for the two groups.

4. Most of the effort in teaching mathematics at the sixth grade level is expended in teaching fractions and decimals.

Both groups of sixth grade students increased in performance in fractions and decimals and decreased in performance on whole numbers and composite mathematics between pre- and post- testing (nine months). Thus, the apparent emphasis on fractions and decimals seemed to be at the expense of achievement in whole numbers, which caused a decrease in composite mathematics achievement over the period of the school year. This reinforces the results of "time on task" research.

5. Mathematically low achieving sixth graders have a pattern of attendance similar to other sixth graders, with respect to the number of days tardy and the number of absences.

There was no difference betwen the two groups on the attendance variables for the semester prior to the treatment provided by the project.

6. A relationship exists between the sixth graders involvement in tutoring in mathematics and their tendancy to be punctual in attending school but not their tendancy to attend school.

The experimental group decreased in the number of tardies by nearly one day the semester tutoring took place as compared to the semester previous, whereas the control group increased by one day. This combination resulted in a two day change when the two groups are compared.

7. Sixth graders have positive attitudes toward mathematics, computers, and science and technology.

8. Involvement in mathematics tutoring using microcomputers does not influence sixth graders attitude toward mathematics, computers, nor science and technology.

There was no significant change in attitude in the experimental group.

9. Involvement in tutoring of sixth graders in mathematics, using microcomputers, may positively affect high school students attitude toward computers, but has little or no effect on their attitude toward mathematics, attitude toward science and technology, or school attendance.

The only significant change noted in the high school students was that of attitude toward computers, not attitude toward mathematics not toward science and technology. This researcher anticipates that if an efect on attitude toward computers exists, the effect was due to involvement with comuters not involvement in tutoring. However since the number of students in one of the cells for the statistical tests for this were very low, it is difficult to say with conviction that existed a real difference in attitude toward computers.

10. With respect to the viability of the use of microcomputers as an instructional tool in the circumstances used within this project:

    A. This project provided no evidence that the use of microcomputers made a difference in mathematics achievement.

    B. The use of microcomputers may have affected the attitude of high school students but not the sixth graders.

    C. If one the purposes of schooling is to spur interest (as opposed to attitude) then there is no question that microcomputers are appropriate and highly desireable.

All parents and students (with one exception in each case) were excited and interested in using the microcomputers within the project.

11. The presence of microcomputers in schools, without any concerted effort, spurs staff development to an extent that is difficult to match with any other media.

The presence in the schools, of the nine microcomputers from the project resulted in nearly 25,000 hours of teacher inservice work during an eighteen month period. This was not a part of the project and was not anticipated. The policy of the project staff was to allow the cooperating school system to use the equipment when it was not being used within the project. Through teacher and school interest many inservice classes for were hastily arranged and subscribed. Even students not associated with the project initiated several projects using the equipment. This 25,000 hours of teacher inservice work using the equipment of the project could prove to be the most beneficial aspect of the project in the long run. On this basis alone the project can be considered a profound success. It should be mentioned that prior to the project, none of the three schools had any computers.

12. With respect to the original objectives of the project:

A. The project was not able to increase the mathematics achievement of mathematically low achieving sixth graders through a strategy of cross- aged tutoring using microcomputers.

B. Due to incomplete data, the project staff is not able to make any statements about whether cross- aged tutoring using microcomputers affects enrollment in science and mathematics classes.

C. Microcomputers are a valuable instructional tool for increasing interest in schooling. Based on the results of this study, microcomputers are highly motivating. But we could demonstrate little with respect to achievement or attitude gains.

D. Did the project develop an effective application of the instructional use of microcomputers? What this project demonstrated was that the use of microcomputers <u>cannot</u> be considered a quick and easy enhancement to the instructional situation. The PI feels that there will have to be a considerable restructuring of the standard classroom before the true potential of microcomputers can be realized. This project provided a small bit of evidence with respect to this statement. Much needs to be done in most all areas.

E. As mentioned above, perhaps the most important outcome of this project is the amount of involvement with microcomputers of teachers not associated with the project. The process of teacher familiarization with the operation and use of microcomputer in instruction is difficult and very time consuming. Because of this it will take a long time for teachers to accomodate a technology which is infiltrating instruction, either by design or otherwise.

Recommendations

The recommendations below are based on the experience of the project staff more than on the quantitative results of this study. The conclusions above speak for themselves.

1. In projects which involve both universities and schools it is recommended that project personnel primarily based in the schools, be hired by the school or school system with monies for the position coming from the project. This procedure was used in this project and it alleviated many potential problems.

2. Projects in which a school teacher is used to teach classes, should hire that teacher full time (1 FTE) in the project even though a full teaching schedule is not used.

3. The principal investigator of a project of this nature should be at least .5 FTE with the project for each semester of the project, and full time in intervening summers. In addition the PI should be at least .50 FTE for a reeasonable period of time after major data collection activities cease.

4. Research assistant(s) assigned to projects of this kind should be appointed for twelve month periods.

5. Research should be done on the outcomes of professional development on microcomputers. This project spawned thousands of hours of teacher inservice classes but the project did not have the resources to monitor the effects of these classes.

6. Schools and school systems desiring to become involved in the instructional use of microcomputers should very carefully examine the theoretical and empirical bases of specific uses. What may seem like a set of logical assumptions and arrangements for a given idea frequently does not result in the desired outcomes. This project had both a theoretical and empirical base, yet did not accomplish most of its goals.

7. One distinct advantage of the use of the instructional microcomputers is providing motivation and heightening interest. These uses should be encouraged in creative ways, but such use should be carefully monitored for results.

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APPENDIX A

CONSENT FORMS

ELEMENTARY CONSENT FORM - ENGLISH

Dear Parent/Guardian: January 10, 1982

Your child is invited to participate in an experimental program entitled "Personal Computers and Cross-Aged Instruction." The project is being directed by Mr. Paul Canny of the St. Vrain Schools in association with Dr. Marc Swadener of the School of Education, University of Colorado-Boulder and the Board of Education, St. Vrain Schools.

The program involves tenth and eleventh grade students from Skyline High School who will tutor a group of sixth grade students, who for various reasons have difficulty with mathematical skills and concepts. The tenth and eleventh grade students will spend considerable time in becoming aware of the difficulties which sixth grade students frequently have with mathematics. The high school students will be trained prior to your child's involvement.

The aim of the project is to increase the mathematics achievement of the sixth grade students; to encourage a more positive attitude about their abilities in mathematics; to encourage interest in mathematics and science for the high school students, and; to assess the effectiveness of using personal computers as a tool for achieving these goals.

If you are interested in having this type of tutoring for your child and if you approve of his/her involvement in the program, please fill out the attached form and have the child return the form to his/her teacher by January 20, 1982. If you have any questions concerning the project you may contact Mr. Canny at 772-0832 or 651-0123 or Dr. Swadener at the School of Education, University of Colorado-Boulder, phone 492-7739.

You should be aware that you may withdraw your consent at any time and at that time your child will no longer be a participant in the program. There is no risk to you or to your child in being involved in this project since the purpose is to aid their understanding and achievement in mathematics. No discredit will be involved in withdrawing your child should you feel that is necessary.

Your child will be identified by name in the project only for the purposes of the internal procedures of the project. No reference to individuals will be made in any reports required in this project.

Questions concerning your child's rights as a subject in this project can be directed to the Human Research Committee of the Graduate School, Univeristy of Colorado-Boulder. Upon request you may receive a copy of the University's General Assurance on Human Research from the Human Research Committee Secretary, Graduate School, University of Colorado, Boulder, Colorado 80309.

Student's Name: ____________________

I, as parent or guardian of the above named student, give my permission for him/her to participate in the program of tutoring titled "Personal Computers and Cross-Aged Instruction."

Parent/Guardian Signature: ____________________ Date ________

Administrator's Signature: ____________________ Date ________

(Traduccion en Espanol en el reverso.)

ELEMENTARY CONSENT FORM - SPANISH

Estimados Padres: 10 Enero 1982

Sus hijos estan invitados a participar en un programa entitulado "Personal Computers and Cross-Aged Instuction." El proyecto es dirigido por el Senor Paul Canny del Distrito Escolar del Valle St. Vrain en azosacion con el Doctor Marc Swadener de la Universidad del Colorado en Boulder y el Borde de Educacion, Escuelas del St. Vrain.

El experimiento invuelve a los estudiantes del diez y once grados, quienes trabajaron con estudiantes del grado seis, que por alguna rason tienen diffícultad con conceptos en la matematicas. Los estudiantes del diez y once pasaran bastante tiempo o buscando las dificultades que estos ninos tienen en matematicas. Los estudiantes del diez y once aprenderan varios metodos para con los estudiante del grado seis e incluyeron el usa del varias maquinas, como el calculador y computadoras para que aprendan los ninos.

La meta de este proyecto es de desarollar los conceptos en matematicas del los estudiantes del grado seis, dar mas animo y una atitud positiva en las abilidades en matematicas, dor animo e interes en las ciencis y matematicas a los estudiantes del grado diez y once, y evaluar si es efectivo el uso de micro-computatores como un metodo en ensenar estos conceptos.

Si esta interesado en que sus hijos participi en en este programa y aprueba, favor de llenar la forma que acompana esta carta y favor dedevolverla al maestro(a) antes del 20 Enero 1982. Tambien si tiene preguntas sobre el programa puede llamar al Sr. Canny al telefono 772-0832 o 651-0123 al Dr. Swadener en 492-7739 en la Escuela de Education en la Universidad de Colorado-Boulder.

Estamos de acuerdo que puede sacar a su hijo(a) cualquier tiempo que usted quiera. No hay niguna perdida de que su hijo(a) participe en este programa, porque el programa esta designado para aumentar la sabinduria de los estudiantes en las matematicas y no seratada malo si decide sacar al estudiante del programa una ves que este dentro de este.

El estudiante sera identificado por el nombre nade mas, y niguna referencia se hara cuando los reportes se escriban.

Preguntas tocanta sus derechos como participante pueden ser dirgidoa al comite "Human Research Committee" de la Escuela de Maestria (Graduate School), Universidad de Colorado. Cuando quiera puede recibir una copia de seguro General del esta Institucion del Human Research Committee Secretary, Graduate School, University of Colorado, Boulder, Colorado 80309.

Nombre de Estudiante:--

Yo, como padre del estudiante nombrado arriba doy permiso pare que el participe en el programa "Personal Computers and Cross-Aged Instruction" describido el la carta que acompana esta forma.

Padres:________________________________ Fecha ____________

Authorizacion administratriva:________________________ Fecha ____________

(This form is in English on the reverse side.)

HIGH SCHOOL CONSENT FORM

Dear Parent/Guardian:

August, 1981

Your child is invited to participate in an experimental program titled "Personal Computers and Cross-Age Instruction." The project is being directed by Mr. Paul Canny of the St. Vrain Schools in association with Dr. Marc Swadener of the School of Education, University of Colorado-Boulder and the Board of Education of the St. Vrain Schools. Major funding for the project is through a grant to the University of Colorado from The National Science Foundation. The experiment involves the use of microcomputers as a tool to motivate greater interest in mathematics and science for able tenth and eleventh grade students. These high school students will spend considerable time becoming proficient in using the microcomputer and will examine the difficulties sixth graders have with mathematics. After this period the tenth and eleventh grade students will tutor on a one-to-one basis sixth graders, who for various reasons have difficulty with mathematical skills and concepts. Microcomputers will be used as a tool in the tutoring situation.

The goals of the project are to increase the mathematics achievement of the sixth grade students, encourage a more positive attitude about their abilities in mathematics, encourage interest in mathematics and science for the highs school students and assess the effectiveness of using the microcomputer as a tool in achieving these goals.

If your child is interested in this project, and if you approve of his/her involvement, please fill out the attached form and have your child return the form to his/her mathematics teacher on August 28, 1981. If you have any questions concerning any aspect of the project you should feel free to contact Mr. Canny at 776-5722 or Dr. Swadener at 492-7739 or 492-8742 at the University of Colorado.

All students who express interest in participating in the program will be considered. However only thirty students will be selected. Students who are selected will be notified of their acceptance by September 1, 1981.

You should be aware that you may withdraw consent for your child's participation at any time, without any discredit to your child. At that time your child will no longer be a participant in the project. There is no risk to your child in being involved in the project since it's purpose is to aid their understanding and interest in mathematics and science.

Your child will be identified by name within the project only for the internal procedures of the project. No reference to individual student participants will be made in any reports resulting from this project.

Questions concerning your childs rights as a subject in this study can be directed to the Human Research Committee of the Graduate School of the University of Colorado and upon request you may receive a copy of the University's General Assurance from the Human Research Secretary, Graduate School, University of Colorado, Boulder, Colorado 80309.

(Please complete the form on the back side of this page as soon as possible.)

HIGH SCHOOL CONSENT FORM (cont.)

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I (name) ______________________________ am interested in being a participant in the project "Personal Computers and Cross-Age Instruction." If selected I will be part of the program for the 1981-1982 school year.

Student's signature:____ Grade ___________

I, as parent/guardian, give my permission for the above named student to participate in the "personal Computers and Cross-Age Instruction" project for the 1981-1982 school year.

Parent/guardian Signature:____________________________________ Date:___________

(Please have your child return this form to his/her mathematics teacher at Skyline High School as soon as possible.)

Administrator's Approval: ____________________________________ Date ___________

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APPENDIX B

ELEMENTARY ATTITUDE INSTRUMENT

School of Education Box 249
University of Colorado-Boulder

APPENDIX B, Page 113
EL-COMMATTECHATT 3:83 P:1

Directions: Circle the answer that best describes how you feel.

- SD If you Strongly Disagree
- D If you Disagree
- NO If you have No Opinion
- A If you Agree
- SA If you Strongly Agree

		STRONGLY DISAGREE		NO OPINION		STRONGLY AGREE
1. I like to make things.	1.	SD	D	NO	A	SA
2. I enjoy using the computer.	2.	SD	D	NO	A	SA
3. People don't need computers.	3.	SD	D	NO	A	SA
4. Using a computer is a waste of time.	4.	SD	D	NO	A	SA
5. I get lost with numbers.	5.	SD	D	NO	A	SA
6. I am excited about machines in my future.	6.	SD	D	NO	A	SA
7. I like numbers.	7.	SD	D	NO	A	SA
8. I like to use a compass that shows direction.	8.	SD	D	NO	A	SA
9. The computer makes me think too much.	9.	SD	D	NO	A	SA
10. Science has caused many problems.	10.	SD	D	NO	A	SA
11. The computer is another teacher.	11.	SD	D	NO	A	SA
12. I am afraid of machines.	12.	SD	D	NO	A	SA
13. Math is easy for me.	13.	SD	D	NO	A	SA
14. Anything is better than math.	14.	SD	D	NO	A	SA
15. Fixing things is fun.	15.	SD	D	NO	A	SA
16. Math is usually boring.	16.	SD	D	NO	A	SA
17. I am happy when I can make a computer do what I want.	17.	SD	D	NO	A	SA
18. Using computers is more for boys than for girls.	18.	SD	D	NO	A	SA
19. Science changes things too fast.	19.	SD	D	NO	A	SA
20. I like to weigh things.	20.	SD	D	NO	A	SA
21. I like math the best.	21.	SD	D	NO	A	SA
22. I am good at running a computer.	22.	SD	D	NO	A	SA

(Continue on the next page)

		STRONGLY DISAGREE		NO OPINION		STRONGLY AGREE
23. I can't think straight with numbers.	23.	SD	D	NO	A	SA
24. Science will solve many problems.	24.	SD	D	NO	A	SA
25. Math is fun.	25.	SD	D	NO	A	SA
26. Computers are more for girls than boys.	26.	SD	D	NO	A	SA
27. Machines will solve many problems.	27.	SD	D	NO	A	SA
28. I don't like math problems.	28.	SD	D	NO	A	SA
29. I can't do math problems.	29.	SD	D	NO	A	SA
30. I feel helpless around a computer.	30.	SD	D	NO	A	SA
31. Computers are a tool just like a hammer or saw.	31.	SD	D	NO	A	SA
32. Math is a game.	32.	SD	D	NO	A	SA
33. Math is hard work.	33.	SD	D	NO	A	SA
34. I need training for working with machines.	34.	SD	D	NO	A	SA
35. I would stay after school to work with the computer, if I could.	35.	SD	D	NO	A	SA
36. Girls do just as well as boys in computer jobs.	36.	SD	D	NO	A	SA
37. Working with the computer makes me want to learn.	37.	SD	D	NO	A	SA
38. I don't like working on a computer.	38.	SD	D	NO	A	SA
39. Math doesn't excite me.	39.	SD	D	NO	A	SA
40. I would hate to go to another classroom without a computer.	40.	SD	D	NO	A	SA
41. I like math.	41.	SD	D	NO	A	SA
42. I would like a job that doesn't use any math.	42.	SD	D	NO	A	SA
43. Being able to work with a computer is important.	43.	SD	D	NO	A	SA

(Continue on the next page)

		STRONGLY DISAGREE		NO OPINION		STRONGLY AGREE
44. Times goes by quickly when I'm using the computer.	44.	SD	D	NO	A	SA
45. Science is not making things better.	45.	SD	D	NO	A	SA
46. Computers are making people do things they don't want to do.	46.	SD	D	NO	A	SA
47. I never liked math.	47.	SD	D	NO	A	SA
48. I want to understand my math.	48.	SD	D	NO	A	SA
49. I don't work well with computers.	49.	SD	D	NO	A	SA
50. I like machines.	50.	SD	D	NO	A	SA
51. I like easy math problems best.	51.	SD	D	NO	A	SA
52. I am upset when doing math.	52.	SD	D	NO	A	SA
53. People need more control over science.	53.	SD	D	NO	A	SA
54. I liked math better before I began using a computer.	54.	SD	D	NO	A	SA
55. I would like to do some extra reading in math.	55.	SD	D	NO	A	SA
56. Every country needs math.	56.	SD	D	NO	A	SA
57. Working with computers makes me uneasy.	57.	SD	D	NO	A	SA
58. I learn a lot with a computer.	58.	SD	D	NO	A	SA
59. I feel up tight when someone talks to me about computers.	59.	SD	D	NO	A	SA
60. I like to use a calculator.	60.	SD	D	NO	A	SA
61. My computer teacher helps me more than any teacher.	61.	SD	D	NO	A	SA
62. Working with the computer is confusing.	62.	SD	D	NO	A	SA
63. Computers are best at repeating things.	62.	SD	D	NO	A	SA
64. I am afraid to ask questions in math class.	64.	SD	D	NO	A	SA

(Continue on the next page)

		STRONGLY DISAGREE		NO OPINION		STRONGLY AGREE
65. Answering a difficult math problem is fun.	65.	SD	D	NO	A	SA
66. I have a good feeling toward math.	66.	SD	D	NO	A	SA
67. I don't do well in math.	67.	SD	D	NO	A	SA
68. Computers will make as many jobs as they do away with.	68.	SD	D	NO	A	SA
69. I would enjoy fixing something that runs on electricity.	69.	SD	D	NO	A	SA
70. I like to use a meter stick.	70.	SD	D	NO	A	SA
71. I would like to spend less time in school doing math.	71.	SD	D	NO	A	SA
72. If I don't get a math problem right away, I never get it.	72.	SD	D	NO	A	SA
73. I like using computers in school.	73.	SD	D	NO	A	SA
74. I like doing the assignments for my computer class.	74.	SD	D	NO	A	SA
75. People need more control over machines.	75.	SD	D	NO	A	SA
76. Most people should study math.	76.	SD	D	NO	A	SA
77. I would enjoy a job that involves machines.	77.	SD	D	NO	A	SA
78. I need to learn about machines.	78.	SD	D	NO	A	SA
79. I work more with other students when we're working with computers.	79.	SD	D	NO	A	SA
80. I would like to have my own computer.	80.	SD	D	NO	A	SA
81. I haven't learned any more math by using the computer.	81.	SD	D	NO	A	SA
82. I like to use a computer.	82.	SD	D	NO	A	SA
83. I would like to know more about jobs with machines.	83.	SD	D	NO	A	SA
84. Computers treat everyone as a number.	84.	SD	D	NO	A	SA

**** THANK YOU ****

APPENDIX C

MATHEMATICS TEST FOR SIXTH GRADE

1. Add: $321 + 753 + 108 + 842 =$

A. 1914 B. 2024 C. 1934 D. 1924 E. None of these

2. Multiply:

$$\begin{array}{r} 6.8 \\ \times\ 3.6 \\ \hline \end{array}$$

A. 24.48 B. 2448 C. 2.448 D. 244.8 E. None of these

3. Multiply:

$$\begin{array}{r} 59 \\ \times\ \ 4 \\ \hline \end{array}$$

A. 236 B. 56 C. 326 D. 206 E. None of these

4. Subtract: $804 - 236 =$

A. 568 B. 632 C. 668 D. 678 E. None of these

5. Subtract:

$$\begin{array}{r} 793.1 \\ -\ \ \ 7.8 \\ \hline \end{array}$$

A. 796.3 B. 786.3 C. 794.7 D. 78.53 E. None of these

6. Divide: $6 \overline{)\ 948}$

A. 108 B. 158 C. 168 D. 101 E. None of these

7. Multiply:

$$\begin{array}{r} 2.18 \\ \times\ \ \ .3 \\ \hline \end{array}$$

A. 65.4 B. 654 C. 6.54 D. .654 E. None of these

8. Divide: $60 \overline{)\ 540}$

A. 9 B. 19 C. 80 D. 90 E. None of these

9. Add:

$$\begin{array}{r} 53 \\ 41 \\ +\ \ 2 \\ \hline \end{array}$$

A. 94 B. 95 C. 103 D. 96 E. None of these

(Continued on next page.)

10. Add: $\begin{array}{r} 398 \\ +\ \ \underline{\ \ 6} \end{array}$

A. 414 B. 394 C. 404 D. 304 E. None of these

11. Add and simplify the answer (lowest terms): $\frac{4}{5} + \frac{8}{10} =$

A. $\frac{4}{5}$ B. $1 \frac{2}{10}$ C. $1 \frac{3}{5}$ D. $\frac{16}{25}$ E. None of these

12. Divide: $4 \,\overline{)\,164}$

A. 4 R1 B. 41 R10 C. 40 R4 D. 410 E. None of these

13. Multiply and simplify the answer (lowest terms): $\frac{2}{3} \times \frac{5}{8} =$

A. $1 \frac{1}{15}$ B. $\frac{5}{12}$ C. $\frac{7}{11}$ D. $\frac{7}{24}$ E. None of these

14. Divide: $17 \,\overline{)\,935}$

A. 550 B. 55 C. 58 D. 42 E. None of these

15. Divide: $60 \,\overline{)\,664}$

A. 110 R4 B. 11 R4 C. 114 D. 1 R64 E. None of these

16. Multiply: $\begin{array}{r} 72 \\ \times\ \underline{\ 6} \end{array}$

A. 442 B. 482 C. 432 D. 54 E. None of these

17. Subtract: $\begin{array}{r} 326 \\ -\ \underline{187} \end{array}$

A. 139 B. 239 C. 261 D. 149 E. None of these

(Continued on next page.)

18. Multiply and simplify the answer (lowest terms): $\frac{4}{5} \times \frac{5}{9} =$

A. $\frac{9}{45}$ B. $\frac{9}{14}$ C. $\frac{4}{9}$ D. $1\frac{11}{25}$ E. None of these

19. Multiply: $\begin{array}{r} 76 \\ \times\ \underline{95} \end{array}$

A. 171 B. 6690 C. 7220 D. 1064 E. None of these

20. Divide: $28\overline{)\,981}$

A. 351 B. 3 R51 C. 45 R21 D. 35 R1 E. None of these

21. Subtract: 6072 - 95 =

A. 6087 B. 5987 C. 6023 D. 5977 E. None of these

22. Multiply: $\begin{array}{r} 82 \\ \times\ \underline{56} \end{array}$

A. 4592 B. 902 C. 5042 D. 4482 E. None of these

23. Subtract: $\begin{array}{r} 2.3 \\ -\ \underline{.47} \end{array}$

A. 1.97 B. 2.93 C. .24 D. 1.83 E. None of these

24. Divide: $55\overline{)\,279}$

A. 50 R4 B. 4 R59 C. 5 R4 D. 5 R14 E. None of these

25. Divide: $6\overline{)\,549}$

A. 913 B. 91 R9 C. 91 R3 D. 90 R9 E. None of these

26. Subtract: $\begin{array}{r} 52 \\ -\ \underline{34} \end{array}$

A. 28 B. 18 C. 22 D. 86 E. None of these

(Continued on next page.)

---

27. Multiply:

$$\begin{array}{r} 91 \\ \text{x}\ \underline{27} \end{array}$$

A. 2456 B. 1807 C. 819 D. 2457 E. None of these

---

28. Add and simplify the answer (lowest terms):

$$\frac{2}{3} + \frac{2}{7} =$$

A. $\frac{20}{21}$ B. $\frac{2}{5}$ C. $\frac{2}{21}$ D. $\frac{4}{21}$ E. None of these

---

29. Multiply and simplify the answer (lowest terms):

$$\frac{1}{2} \times \frac{7}{8} =$$

A. $\frac{1}{2}$ B. $\frac{4}{5}$ C. $\frac{7}{16}$ D. $1\frac{3}{4}$ E. None of these

---

30. Divide:

$$20\,\overline{)\,360}$$

A. 180 B. 13 C. 130 D. 18 E. None of these

---

31. Add:

$$\begin{array}{r} 37 \\ +\ \underline{\ \ 2} \end{array}$$

A. 49 B. 38 C. 35 D. 40 E. None of these

---

32. Subtract:

$$\begin{array}{r} 65 \\ -\ \underline{36} \end{array}$$

A. 101 B. 31 C. 39 D. 29 E. None of these

---

33. Divide:

$$2\,\overline{)\,573}$$

A. 231 R1 B. 231 R 3 C. 285 R3 D. 286 R1 E. None of these

---

34. Multiply:

$$\begin{array}{r} 918 \\ \text{x}\ \underline{\ \ \ 7} \end{array}$$

A. 6426 B. 6326 C. 6476 D. 6376 E. None of these

(Continued on next page.)

35. Add: $\begin{array}{r} 32.5 \\ +\ \underline{48.7} \end{array}$

A. 81.2 B. 71.2 C. 80.2 D. 80.12 E. None of these

36. Divide: $14\overline{)\ 252}$

A. 180 B. 12 C. 13 D. 17 E. None of these

37. Multiply: $\begin{array}{r} 346 \\ \times\ \underline{\ \ 5} \end{array}$

A. 1500 B. 1530 C. 1700 D. 1730 E. None of these

38. Subtract: $6003 - 706 =$

A. 5307 B. 5297 C. 6703 D. 6709 E. None of these

39. Multiply and simplify the answer (lowest terms): $\frac{2}{3} \times \frac{3}{4} =$

A. $\frac{5}{7}$ B. $\frac{8}{9}$ C. $\frac{5}{12}$ D. $\frac{1}{12}$ E. None of these

40 Add: $406 + 724 + 85 + 9 =$

A. 1204 B. 1104 C. 1224 D. 3880 E. None of these

41. Multiply: $\begin{array}{r} 48 \\ \times\ \underline{20} \end{array}$

A. 860 B. 8160 C. 1008 D. 1060 E. None of these

42. Multiply: $\begin{array}{r} 608 \\ \times\ \underline{\ 53} \end{array}$

A. 661 B. 4864 C. 5224 D. 32 224 E. None of these

(Continued on next page.)

43\. Add:

$$\begin{array}{r} 723 \\ 140 \\ +\quad 4 \\ \hline \end{array}$$

A. 967 B. 863 C. 867 D. 872 E. None of these

44\. Add:

$$\begin{array}{r} 93.82 \\ +\ \ 8.75 \\ \hline \end{array}$$

A. 10.257 B. 102.57 C. 101.157 D. 101.57 E. None of these

45\. Divide:

$$2\overline{)\,78}$$

A. 49 B. 34 C. 340 D. 39 E. None of these

46\. Add and simplify the answer (lowest terms):

$$\frac{3}{4} + \frac{1}{6} =$$

A. $\frac{1}{8}$ B. $\frac{1}{3}$ C. $\frac{2}{5}$ D. $\frac{11}{12}$ E. None of these

47\. Subtract:

$$\begin{array}{r} 75 \\ -\ 54 \\ \hline \end{array}$$

A. 11 B. 129 C. 22 D. 21 E. None of these

48\. Multiply:

$$\begin{array}{r} 897 \\ \times\quad 3 \\ \hline \end{array}$$

A. 2671 B. 2491 C. 2691 D. 2471 E. None of these

49\. Subtract:

$$\begin{array}{r} 579 \\ -\ \ 76 \\ \hline \end{array}$$

A. 503 B. 493 C. 655 D. 403 E. None of these

50\. Add:

$$\begin{array}{r} 445 \\ +\ \ 67 \\ \hline \end{array}$$

A. 512 B. 502 C. 402 D. 412 E. None of these

(Continued on next page.)

51. Multiply:

$$\begin{array}{r} 64 \\ \times\ 8 \\ \hline \end{array}$$

A. 80 B. 512 C. 482 D. 722 E. None of these

52. Subtract and simplify the answer (lowest terms):

$$\frac{4}{5} - \frac{2}{3} =$$

A. $\frac{3}{4}$ B. 1 C. $\frac{2}{15}$ D. $\frac{8}{15}$ E. None of these

53. Subtract:

$$\begin{array}{r} 35 \\ -\ 19 \\ \hline \end{array}$$

A. 14 B. 53 C. 24 D. 26 E. None of these

54. Divide:

$$4\overline{)\,59}$$

A. 14 R5 B. 12 R1 C. 14 R3 D. 13 R7 E. None of these

55. Multiply:

$$\begin{array}{r} 74 \\ \times\ 50 \\ \hline \end{array}$$

A. 4500 B. 3700 C. 3500 D. 3774 E. None of these

56. Add:

$$384 + 7 + 68 + 19 =$$

A. 548 B. 1954 C. 358 D. 478 E. None of these

57. Multiply:

$$\begin{array}{r} 90 \\ \times\ 33 \\ \hline \end{array}$$

A. 123 B. 540 C. 3267 D. 2970 E. None of these

58. Divide:

$$46\overline{)\,966}$$

A. 21 B. 20 C. 210 D. 36 E. None of these

(Continued on next page.)

---

59. Multiply and simplify the answer (lowest terms): $\frac{2}{3} \times \frac{4}{5} =$

A. $\frac{5}{6}$ B. $\frac{3}{4}$ C. $\frac{6}{15}$ D. $\frac{8}{15}$ E. None of these

---

60. Subtract: $\begin{array}{r} 3.49 \\ -\ \ .8 \\ \hline \end{array}$

A. 2.69 B. .269 C. 3.41 D. 3.69 E. None of these

---

61. Multiply: $\begin{array}{r} 68 \\ \times\ 30 \\ \hline \end{array}$

A. 2040 B. 1840 C. 2440 D. 2108 E. None of these

---

62. Divide: $4\overline{)\,485}$

A. 120 R 5 B. 121 R 1 C. 1211 D. 121 R 5 E. None of these

---

63. Subtract and simplify the answer (lowest terms): $\frac{2}{5} - \frac{1}{10} =$

A. $\frac{1}{5}$ B. $\frac{3}{10}$ C. $\frac{1}{10}$ D. $\frac{1}{2}$ E. None of these

---

64. Multiply: $\begin{array}{r} 69 \\ \times\ 40 \\ \hline \end{array}$

A. 2460 B. 3660 C. 2760 D. 2829 E. None of these

---

65. Add: $\begin{array}{r} 43.44 \\ +\ \ 2.07 \\ \hline \end{array}$

A. 4.551 B. .4551 C. 41.43 D. 45.41 E. None of these

---

66. Multiply: $\begin{array}{r} 43 \\ \times\ 16 \\ \hline \end{array}$

A. 301 B. 678 C. 688 D. 418 E. None of these

(Continued on next page.)

67. Subtract and simplify the answer (lowest terms): $\frac{1}{2} - \frac{1}{6} =$

A. $\frac{1}{3}$ B. $\frac{1}{4}$ C. $\frac{1}{6}$ D. $\frac{2}{3}$ E. None of these

68. Divide: $70\overline{)\,490}$

A. 70 B. 61 C. 7 D. 17 E. None of these

69. Multiply and simplify the answer (lowest terms): $\frac{1}{2} \times \frac{1}{9} =$

A. $\frac{1}{18}$ B. $\frac{1}{9}$ C. $\frac{2}{11}$ D. $4\frac{1}{2}$ E. None of these

70. Divide: $7\overline{)\,91}$

A. 13 B. 130 C. 10 D. 23 E. None of these

71. Add:

$$\begin{array}{r} 10 \\ 61 \\ +\ \underline{\ \ 8} \end{array}$$

A. 89 B. 80 C. 78 D. 79 E. None of these

72. Divide: $3\overline{)\,561}$

A. 287 B. 187 C. 120 D. 180 E. None of these

73. Divide: $3\overline{)\,936}$

A. 310 R6 B. 3120 C. 312 D. 31 R2 E. None of these

74. Add:

$$\begin{array}{r} 815 \\ 70 \\ +\ \underline{\ \ 96} \end{array}$$

A. 981 B. 871 C. 971 D. 881 E. None of these

(Continued on next page.)

---

75. Multiply:

$$\begin{array}{r} .18 \\ \underline{\times\ \ .3} \end{array}$$

A. 5.4 B. 54 C. .54 D. .054 E. None of these

---

76. Subtract:

$$\begin{array}{r} 869 \\ \underline{-\ \ 51} \end{array}$$

A. 920 B. 18 C. 718 D. 818 E. None of these

***** THANK YOU *****

APPENDIX D

HIGH SCHOOL ATTITUDE INSTRUMENT

Directions: Write ONLY on the answer sheet provided. Darken in the appropriate column using the following code.

A - if you Strongly Diagree
B - if you Disagree
C - if you are Undecided
D - if you Agree
E - if you Stongly Agree

1. I enjoy designing and building things.
2. I spend more time working with the computer than its worth.
3. I enjoy using the computer.
4. You can get along perfectly well in everyday life without mathematics.
5. I feel using the computer is a waste of time.
6. Mathematics makes me feel as though I'm lost in a jungle of numbers.
7. I am excited about the role technology will take in my future.
8. I feel at ease in mathematics, and I like it very much.
9. I like to use or would like to use a compass that shows direction.
10. The computer makes me think too much.
11. I feel that science and technology have caused many of our problems.
12. I feel as if the computer is another teacher.
13. I am very much afraid of science and technology.
14. Mathematics is easy for me.
15. I would rather do just about anything than mathematics.
16. I would enjoy fixing something mechanical.
17. Mathematics is easy for me.
18. I am very happy when my computer program "works."
19. Using computers is more for males than females.
20. I feel that science and technology change things too fast.
21. I like to use or would like to use a scale to weigh things.
22. I am happier in a mathematics class that in any other class.
23. I feel confident about my ability to use computers.

(Continued next page.)

ON THE ANSWER SHEET mark:
A - if you Strongly Diagree
B - if you Disagree
C - if you are Undecided
D - if you Agree
E - if you Stongly Agree

24. My mind goes blank, and I am unable to think clearly when working with math.

25. I like to use or would like to use a thermometer to measure temperature.

26. Mathematics is easier for me than it is for most people.

27. Mathematics is fascinating and fun.

28. More females than males have the ability to become computer specialists.

29. For the most part, science and technology will eventually solve many problems such as pollution, disease, drug abuse and crime.

30. I would rather be given the right answer to a mathematics problem than to work it out myself.

31. I often think, "I can't do it." when a mathematics problem seems hard.

32. I feel helpless around a computer.

33. Computers are a tool just like a hammer or lathe.

34. Mathematics is more of a game than it is hard work.

35. The education and training neded to prepare me to work in a technological field would be worthwhile, even if I didn't go into a related field.

36. I would stay after school almost every night to work with the computer if I could.

37. In general, females can do just as well as males in computer careers.

38. Working with the computer in this class has increased my desire to learn.

39. The education and training needed to prepare me to work in a technological field would be worth it in the long run.

40. I feel like screaming when I have to write a program more than once.

41. Mathematics doesn't excite or fascinate me.

42. I would hate to be moved to another mathematics class where the computer was not used.

43. I am no good in mathematics.

44. Mathematics is a subject which I have always enjoyed studying.

(Continued next page.)

ON THE ANSWER SHEET mark:
A - if you Strongly Diagree
B - if you Disagree
C - if you are Undecided
D - if you Agree
E - if you Stongly Agree

45. I would like a job that doesn't use any mathematics.

46. Computerization is extremely important.

47. Mathematics class time "flies by" when using the computer.

48. I feel that science and technology have changed life for the worse.

49. Computers are gaining too much control over people's lives.

50. I have never liked mathematics, and it is my most dreaded subject.

51. It is important to me to understand the work I do in mathematics.

52. It is my guess that I am not the kind of person who works well with computers.

53. I am very satisfied with scientific and technological accomplishments.

54. I like the easy mathematics problems best.

55. I am easily frustrated when doing mathematics problems.

56. I feel that the degree of control that mankind has over science and technology should be increased.

57. I liked mathematics better before I began using the computer.

58. I would like to do some outside reading in mathematics

59. Mathematics is of great importance to a country's development.

60. Writing computer programs makes me very restless.

61. I feel satisfied with what I learn using the computer.

62. I feel up-tight when someone talks to me about mathematics.

63. I like to use or would like to use a calculator.

64. I feel the teacher helps me more in the computer mathematics class than teachers in other classes do.

65. Working with the computer is too confusing.

66. Computers are best suited for doing repetitive, monotonous tasks.

67. When I am in a mathematics class I am afraid to ask questions about things I do not understand.

(Continued next page.)

ON THE ANSWER SHEET mark:

A - if you Strongly Diagree
B - if you Disagree
C - if you are Undecided
D - if you Agree
E - if you Stongly Agree

68. Solving a difficult math problem is exciting.

69. I have a good feeling toward mathematics.

70. I don't do very well in mathematics.

71. Computers will make as many jobs as they do away with.

72. I would enjoy fixing something that runs on electricity.

73. I like to use or would like to use a meter stick for measuring.

74. I would like to spend less time in school doing mathematics.

75. If I don't see how to work a mathematics problem right away, I never get it.

76. I enjoy using mathematics in my classes.

77. I enjoy doing the assignments for my computer mathematics course.

78. When I am in a mathematics class, I am never afraid to ask questions.

79. Most people should study some mathematics.

80. I would enjoy working in a technological laboratory.

81. The education and training needed to prepare me to work in a technical field would open many job opportunities for me.

82. I work more with other students when we're working with computers.

83. I would very much like to have my own computer.

84. I haven't learned any more mathematics by using the computer.

85. I like to use or would like to use a small personal computer.

86. I would like to know more about jobs in technology and engineering.

87. I feel pleased when I complete a computer program.

88. A person today cannot escape the influence of computers.

89. Computers dehumanize society by treating everyone as a number.

90. The education and training needed to prepare me to work in a technological field costs too much.

APPENDIX E

PARENT QUESTIONNAIRE

COMPUTER/TUTORING PROJECT PARENT QUESTIONNAIRE

Dear Parents,

June 1, 1982

The certificate given to your son or daughter today is in recognition of their participation in the computer education and tutoring project at Skyline High School, Columbine Elementary School and Spangler Elementary School. We want to thank you, the parent, for granting permission for your daughter or son to be a participant.

In order for us to evaluate the program we would appreciate it if you would take a few minutes of your time to answer the questions below and have your child return this sheet to the school by Friday, June 4, 1982. Thank you for your support and your helpfulness.

Mr. Paul Canny
Skyline High School

Dr. Marc Swadener
University of Colorado-Boulder

Please underline or circle the answer you choose.

1. What have you noticed about your son's or daughter's interest in math since participating in the project?

   a. Increased interest b. No change c. Less interest

2. In considering math skills, the project;

   a. improved the skills greatly,
   b. improved the skills some or
   c. did not change the level of skills.

3. In considering the use of time in the project, the amount of computer time was;

   a. too much, b. about right or c. not enough.

4. Would your daughter or son participate in a computer program again if given an opportunity?

   a. Yes b. No c. Uncertain

5. What was your son's or daughter's reaction to the project?

   a. Positive b. Negative c. Uncertain

6. If you have any comments about the program, please feel free to make them below.

(Traduccion en Espanol en el reverso.)

COMPUTADOR/TUTOR PROYECTO QUESTIONARIO PARA LOS PADRES

Estimados Padres, 1 Junio 1982

El certificado que esta presentado a su hijo o hija hoy es reconocimiento de la participacion en el proyecto de educacion de computadoras en Skyline High School, Columbine Elementary School y Spangler Elementary School. Gracias a ustedes, los padres, por el permiso que resulto en la participacion de su hijo o hija en el proyecto.

Para evaluar el programa de este ano y para mejorar el programa apreciamos si toman unos momentos para contestar las preguntas bajo y por favor pide a su hijo o hija que regrese esta forma ala escuela por Viernes 4 Junio 1982. Muchisimas gracias por su participacion en el proyecto.

Sr. Paul Canny
Skyline High School

Dr. Marc Swadener
University of Colorado-Boulder

==

Favor de subrayar o poner un circulo alrededor de su respuesta.

1. Que ha notado usted sobre el interes do su hijo o hija en matematica desde su participacion en el proyecto?

   a. mas interes b. sin cambio c. menos interes

2. En consideracion de destrezas matematicas, el proyecto:

   a. mejoro las destrezas mucho,
   b. mejoro las destrezas solamente un poco, o
   c. no cambio el nivel del las destrezas.

3. Considerando el uso de tiempo en el proyecto, la cantidad del tiempo dedicado al uso de la computadora fue:

   a. demasiada, b. sificiante o c. insuficiente.

4. Si se le ofrece la oportunidad de asistir otro proyecto del computadores, participaria sus hijos?

   a. Si b. No c. Incierto

5. Que fue los pensamientos de su hijo o hija sobre el proyecto?

   a. Positivo b. Negativo c. Incierto

6. Si tienen cualquier comentario sobre este proyecto nos hacen el favor de anotar estos comentarios en esta pagina.

(This form is in English on the reverse side.)

APPENDIX F

RESOURCE MATERIALS USED IN PROJECT CLASSES

PARTIAL LIST OF RESOURCE MATERIALS USED IN PROJECT CLASSES

BOOKS

Apple Computer Co., APPLESOFT II BASIC PROGRAMMING REFERENCE MANUAL, Apple Computer Co., Cupertino, CA, 1978.

Apple Computer Co., APPLE II REFERENCE MANUAL, Apple Computer Co., Cupertino, CA, 1979.

Apple Computer Co., THE APPLESOFT TUTORIAL, Apple Computer Co., Cupertino, CA, 1979.

Apple Computer Co., THE DOS MANUAL, DISK OPERATING SYSTEM, Apple Computer Co., Cupertino, CA, 1980.

Apple Computer Co., GRAPHICS TABLET OPERATION AND REFERENCE MANUAL, Apple Computer Co., Cupertino, CA, 1978.

Ashlock, Robert, ERROR PATTERNS IN COMPUTATION, Charles E. Merrill Publishing Co., Columbus, Ohio, 1976.

Doerr, Christine, MICROCOMPUTERS AND THE 3-R'S, Hayden Book Co., Rochelle Park, NJ, 1979.

Dwyer, Thomas and Michael Kaufman, A GUIDED TOUR OF COMPUTER PROGRAMMING IN BASIC, Houghton- Mifflin Co., Boston, MA 1973.

Ehly, Stewart, and Stephen Larsen, PEER TUTORING FOR INDIVIDUALIZED INSTRUCTION, Allyn and Bacon, Inc., Boston, MA 1980.

Golden, Neal, COMPUTER PROGRAMMING IN THE BASIC LANGUAGE, Harcourt, Brace and Javanovich, New York, 1981.

Heiserman, David, PROGRAMMING IN BASIC FOR PERSONAL COMPUTERS, Prentice- Hall, Inc., Englewood Cliffs, NJ, 1981.

Koffman, Ellliot B., and Frank L. Friedman, PROBLEM SOLVING AND STRUCTURED PROGRAMMING IN BASIC, Addison- Wessley Publishing Co., 1979.

Poole, Lon, Martin McNiff and Steven Cook, APPLE II USER'S GUIDE, Osborne/McGraw- Hill, Berkeley, CA 1981.

Reisman, Frederika K., A GUIDE TO THE DIAGNOSTIC TEACHING OF ARITHMETIC, Charles E. Merrill Publishing Co., Columbus, Ohio, 1978.

Spencer, Donald, SIXTY CHALLENGING PROBLEMS WITH BASIC SOLUTIONS, Hayden Book Co., Rochelle Park, NJ, 1979.

Thompson, Robert G., BASIC: A FIRST COURSE, Charles E. Merrill Publishing Co., Columbus, Ohio, 1981.

Underhill, Bob, Ed Uprichard and James Heddens, DIAGNOSING MATHEMATICAL DIFFICULTIES, Charles E. Merrill Publishing Co., Columbus, Ohio, 1980.

Wadsworth, Nat, GRAPHICS COOKBOOK FOR THE APPLE COMPUTER, SCELBI Publications, Elmwood, CT, 1980.

Wadsworth, Nat, INTRODUCTION TO LOW RESOLUTION GRAPHICS, SCELBI Publications, Elmwood, CT, 1979.

Waite, Mitchell, COMPUTER GRAPHICS PRIMER, Howard W. Sams & Co., Indianapolis, IN, 1979.

MAGAZINES/JOURNALS

THE ARITHMETIC TEACHER, National Council of Teachers of Mathematics, 1906 Association Dr., Reston, VA 22091.

CLASSROOM COMPUTER NEWS, Intentional Educations, 51 Spring Street, Watertown, MA 02172.

COMPUTE! THE JOURNAL OF PROGRESSIVE LEARNING, Small Systems Services, Inc., P. O. Box 5406, Greensboro, NC 27403.

THE COMPUTING TEACHER, International Council for Computers in Education, Department of Computer Science, University of Oregon, Eugene, OR.

CREATIVE COMPUTING, P. O. Box 789-M, Morristown, NJ 07960.

EDUCATIONAL COMPUTER, Educational Computer, Inc., P. O. Box 535, Cupertino, CA 95015.

ELECTRONIC LEARNING, Scholastic Learning, 902 Sylvan Ave., Englewood Cliffs, NJ 07632.

T.H.E. JOURNAL, Technological Horizons in Education, Information Synergy, Inc., P. O. Box 992, Acton, MA 01720.

FILMS/VIDEO MATERIALS

ADVENTURES OF THE MIND: six video tape programs shown on PBS through KRMA-TV, Denver, Colorado, produced by Johns Hopkins University and Children's Television International.

COMPUTER CONCEPTS: three filmstrips, three cassettes and a guide produced by RMI Productions, copyright 1979.

COMPUTERS IN OUR LIVES: a seventeen minute 16 mm film produced by Hearst Metronome News, copyright 1980.

MAP PROJECTIONS IN THE COMPUTER AGE: a ten and one-half minute 16 mm film produced by Coronet Films, copyright 1980.

THE THINKING MACHINE: a 16 mm film published by teh Bell Telephone System and available from The Colorado Center for Education, 2323 West Baker Avenue, Englewood, CO 80110.

ARTICLES

Discover Magazine, "Walking Away from Paralysis," DISCOVER MAGAZINE, May 1981, pp. 26-30.

Glavitsch, Hans, "Computer Control of Electic- Power Systems," SCIENTIFIC AMERICAN, November 1974, pp. 34-44.

Ingber, Dina, "Computer Addicts," SCIENCE DIGEST, July 1981, pp. 88-114.

Kidder, Tracy, "The Ultimate Toy," THE ATLANTIC, August 1981, pp. 24-33.

Knuth, Donald E., "Algorithms," SCIENTIFIC AMERICAN, April 1977, pp. 63-80.

Nevins, James L. and Daniel E. Whitney, "Computer Controlled Assembly," SCIENTIFIC AMERICAN, February 1978, pp. 62-74.

Omni, "Computer Lib," OMNI, November 1978, pp. 58-62.

Omni, "Cybernetic War," OMNI, May 1979, pp. 45-49, 104.

Omni, "Silicon Valley Spies," OMNI, April 1981, pp. 92-100.

Science Digest, "Join the Computer Community," SCIENCE DIGEST, September 1981, pp. 40-42.

Science Digest, "Superbrain: Our Brain's Successor," SCIENCE DIGEST, March 1981, pp. 58-62.

Stire, Harry, "Home Computers Mean Power," SCIENCE DIGEST, August 1981, pp. 12-13.

TIME, "The Robot Revolution,", TIME MAGAZINE, December 8, 1980, pp. 72-83.

APPENDIX G

HIGH SCHOOL STUDENT COMMENTS

High School Student Comments

Secondary students in the experimental group were asked to respond to several questions at the end of the 1981-82 school year. These questions were:

1. Please list the things you liked about the class.
2. List the things you didn't like.
3. List your reactions to tutoring now that it is over.
4. List the things you learned about yourself and others.

The students did not have to sign their name to the responses. The complete content of student responses to these items is reproduced below. There has been no editing of the wording, punctuation or spelling of the responses, they are reproduced as given by the students. Specific names however have been replaced with XX to prevent identification of individuals.

A. I liked just learning new commands and writing programs. I liked working together on programs. I really enjoyed tutoring and wish I could do it next year. XX was a real good student. XX taught me a lot just by tutoring him. I wish I could keep on tutoring XX on computers.

B. I am glad that I took this class, even though I didn't do as well as I should have. I am glad that I had an opportunity to learn what I did about computers and BASIC. My only complaint is that the class will not be given again, because I think this would have been one of the most liked classes. I enjoyed tutoring because it let you reach others that could not be reached by their elders. I really enjoyed myself! Thanx XX

C. This class was very enjoyable for me. I plan on majoring in computers at CSU. I wish that I would have been able to spend more time on the computer second semester but with tutoring we had to spend much of our classroom time making things for our students. I think it would be a good idea to have an advanced computer class next year for those students, like us, who are too far ahead for a beginning class. I enjoyed the tutoring and I wish that I could do it again next year. And it would also be nice if Mr. Canny would teach here next year. Good luck with your marriage!

D. I liked using the computer. I enjoyed tutoring. I liked programming. I liked playing the games. I really like the class all year long. I didn't like the grades I got. I didn't like getting a B on my research paper when it was typed and in early, and seeing a paper not typed and in late getting an A. I didn't like getting a C- in tutoring when the teacher doesn't even know what we got accomplished. You have to go among things a certain way with certain students and I feel I did so with my student. I'll bet money on it that I had the best relationship with my student than anybody else.

E. I really liked to go tutoring. I liked working with my student. Going tutoring was fun but everyother day was very boring. Maybe we could have went only two times per week. I like I learned a lot by doing this. I wish I could do it again.

F. I really lik· the course because it was interesting. I liked learning how to work and run the computers and the people that were in the class were fun to be around. I thought that the tutoring was a good idea and a good experience for everyone. I thought that the grade I got was unfair. I also learned that the teacher has some aqainst some of the students. I felt I've tried to get along with the teacher, but I am sure some of it was my fault but not all. It's a good class and I would encourage other students to take a calss of this kind if they had the opportunity to.

G. First of all I improved my spelling. I think computers are the way the world is going. I believe in being prepared. These kind of classes can adjust to different speeds of learning. I only wish that demonstrations would stress this kind of education as much as the traditional courses because I find it hard to put 100% into all my classes and therefore must make priority decisions. Tutoring was a very good experience for me and I think I helped someone else. I hope I am able to continue on in this kind of education. Thanks XX

H. I think that the program (tutoring) was very successful and also educational for all the parties involved. The class itself was very educational and I learned quite alot. Computers are a big part of our world today and everyone should know how to use one. Thanx Mr. Canny!

I. I liked the fact that we were given so much freedom in which to do our programs and what to teach our students and what to write our research papers on.

J. This computer class, and any like it, are absolutely necessary for students who wish to have a significant part in tomorrow -- not enough good things can be said so all those compliments won't be listed - and that's unfair but there are a lot of them. The only bad thing is that certain students felt they were insulted by being assigned students who didn't want to learn - (Guess who)

K. I learned that kids can learn stuff they new but where just lazy to do it. And that a computer can be done by almost anyone you don't have to have a degree in college to make up & program

L. I liked learning how to program and work with computers, tutoring was alright sometimes, yet it got boring. It was hard to have patience in teaching when you had to teach the same thing everyday. It is kind of a relief that it is over because it didn't seem like I helped my student much.

M. I liked using the computer and working with the students down at Columbine. The thinks I didn't like was turning in the lesson plans, because it's a pain.

N. I liked working with the students and working on the computer. I didn't like when I made an error.

O. I liked working with computers, programming computers, computer games, graphics tablet and the line printer. I disliked the report, student was sometimes smart mouthed, lesson plans always changed so the log was irrelevent. I didn't think the tutoring used the computer as much as it should being a computer math class. Sometimes it is hard to work with 6th graders just because of the age group they are, but over all tutoring was fun and using the computer was even better. I isn't impossible to teach someone who is totally stuborn.

P. I don't like that you don't let me come in Friday morning. Prople have different attitudes. Brushed up on math skills. Kids can have different ways of learning. I learned it's not easy to teach kids.

Q. I liked getting to know the kids we worked with but I didn't like some of their attitudes toward learning. My kid was really nice but as soon as I mentioned work he said he didn't feel like doing anything. It was discouraging because I didn't feel like I was helping him. I thought the tutoring was a good idea but I don't know how much the kids realy learned. If they wanted to learn they did but my kid gave me the impression that he didn't really care one way ot the other. I think the kids should be screened better somehow so that the ones who want to help get it and the ones who don't care are handled in a different way. XX

R. I enjoyed the class very much, I just wish there was a course to follow up on. There wasn't anything that I disliked really. Tutoring was OK. I don't know if he learned as much as I thought I went over and over on addition, division, multiplication and subtraction and he could tell me the answers pretty quickly before he took the test. But he didn't improve that much. Also he enjoyed programming the computer.

S. What I didn't like about this class was when people came at semester they didn't have to do as much as people that had this class all year. Some of the new people know just as much or even more than I do.

What I like about this class was the way we got to use the computers, the way your guy trusted us with something that is so expensive.

T. I thought this class was a great idea. It gave the kids we tutored a change to see what a computer can do and how to run them a little. I learned that computers can be fun at the same time I learned how to program them. The teacher was pretty neat too.

U. The things I liked about this clas was that the teacher let us do our own thing. He let me (us) go about teaching our student at the pace we wanted. In no way did Mr. Canny rush us which allowed better concentration on our student. My student was quite mature for his age which made it easier to teach. There's no doubt that my student enjoyed working on a computer. I think this whole unit as a group worked real well together. When I really think about it, I come to Longmont new and not one friend. This program allowed me to make friends and I'm thankful.

The only think that I didn't like was that the student didn't have that much work to do. Maybe computers should be used once a week. Otherwise, Thanks for a good time Mr. Canny!

V. In my opinion I think everything we did was great. I really didn't dislike anything. I really enjoyed tutoring and working and meeting the kids. I thought almost everyone worked hard and put a lot of effort into helping their student improve their mathematics skills. I learned a lot about now others react to certain teaching methods and also how capable I am to teach them.

I think Mr. Canny did an excellent job in teaching the course.

W. I enjoyed learning to work on the computer and learning to type in programs. The only thing I really didn't enjoy was having to write a term paper. I really enjoyed tutoring this semester. I loved working with XX (when she worked) and I feel I got something out of it also. I wish I could have gotten into the class at the beginning of the year and that we also could have tutored all year long. I am kind of disappointed in myself for not being able to get more work in than I did.

X. I think the course was very worthwhile. It was really fin working with the students. I think the course should be carried on for the students, so they can learn more. I liked working with the comptuer and just working with the student. There was nothing I didn't like. I feel that I can teach somone something now. I learned I can learn from what I teach.

Y. I was fun playing the games and learning to use the computer, making our own programs. It (tutoring) was harder that I thought, fun. People learn at different speeds.

Z. I liked this course very much and I wish I could take it again next year. I really enjoyed programming and hope to do it as a profession. I really enjoyed tutoring. I like to help people out. XX realy improved, I felt, in his math skills. I really think this tutoring program is a good idea. It really helps students out. Have a great summer Mr. Canny.

AA. The only thing I didn't like was having to write a report and lesson plans. I think tutoring is fun. I learned a lot of patience through this class.

BB. Well to start out with I did enjoy the class. I felt it was entertaining as well as educational. The computers were OK to work with but I did enjoy the tutoring the best. Computers just aren't my bag. But now I do understand how helpful computers can be and how useful they will be in the future. I had no idea computers were so complicated. The only things I didn't like in here was working with the computers so much, and having to do two programs. There just wasn't enough time. But I didn't mind doing the programs I did. And it made me happy when it worked and like I said I realy did enjoy the tutoring. It was as blast. Well I learned that I become very frustrated when I work with computers and I also learned XX is very handy with the computer. I think because XX was so good you expected too much out of the rest of the class like me. But after everything I enjoyed the class and the teacher.

APPENDIX H

RESPONSES TO ITEM 6 ON PARENT QUESTIONNAIRE

Responses to Item 6 on Parent Questionnaire

The parent questionnaire contained six items as given below. A compilation and summary of responses to the first five of the items is given in Chapter 4. This appendix gives a listing of all the responses to item six. The responses are given complete and unedited. Misspellings, punctuation errors, and wording are as they were on the returned questionnaires. Names are given as XX so that the identification of individuals will remain unknown.

Items on the questionnaire.

1. What have you noticed about your son's or daughter's interest in math since particpating in the project?
   a. Increased interest b. No change c. Less interest
2. In considering math skills, the project;
   a. improved the skills greatly,
   b. improved the skills some, or
   c. did not change the level of skills.
3. In considering the use of time in the project, the amount of computer time was;
   a. too much, b. about right, or c. not enough.
4. Would your daughter or son participate in a computer program again if given the opportunity?
   a. Yes b. No c. Uncertain
5. What was your son's or daughter's reaction to the project?
   a. Positive b. Negative c. Uncertain
6. If you have any comments about the program, please feel free to make them below.

Responses to item six on the parent questionnaire.

Resposnses by parents of elementary subjects.

A. Very Beneficial. Keep it up!

B. XX was very interested and always looked forward to the program with a positive attitude. I never had to ask him about it. He would tell me about it. When it first started he was very excited.

C. XX always had something good to say about his calss.

D. I've never seen him so excited about a project before.

E. I was very pleased that he had help. He really needed it. Thanks alot.

F. It help my son alot.

Responses by parents of high school subjects.

A. She seemed to enjoy the class very much.

B. I have had two students participate in this program. One as a tutor and one as a student. The program has been great for both. Thank you for offering such an opportunity.

C. This project has opened the door to a computer world, our son never knew existed until he participated in the project. He is excited about computer programming and has had an opportunity to do some. Thanks for offering such a stimulating course of study.

D. XX enjoyed this class. It stimulated an already growing interest in math and computers. We hope that in the future Computer Education will given at more than the elementary level.

APPENDIX I

MISCELLANEOUS DOCUMENTS

UNIVERSITY OF COLORADO, BOULDER
School of Education
One hundred years of Teacher Education

May 12, 1982

Dr. Jerry Trowbridge
St. Vrain Schools
395 S. Pratt Pkwy.
Longmont, CO 80501

Dear Dr. Trowbridge:

Below is outlined the equipment ordered on NSF grant SED 7918974 along with a proposal for turning over portions of this to St. Vrain Schools. Please read this and if you approve of this arrangement, sign in the place indicated.

I. The equipment originally ordered on the NSF grant that is to be divided between the University and St. Vrain Schools.

1. 6 Heath/Zenith color monitors
2. 3 Amdek Color monitors
3. 3 Apple II graphics pads w/interface
4. 3 Epson MX-80 printers w/interface
5. 6 Apple II+ 48K microcomputers w/language system
6. 3 Apple II+ 48K microcomputers w/language system
   Videx Keyboard Enhancer and Videx Videoterm card
7. 9 Apple II Disk Drives with controller
8. 9 Supr-Mod II RF Modulators

II. We propose that in accordance with the NSF grant the following be turned over to St. Vrain Schools.

1. 5 of #1
2. 2 of #2
3. 2 of #3
4. 2 of #4
5. 5 of #5
6. 2 of #6
7. 7 of #7
8. 7 of #8

The equipment in I above be picked up by Dr. Swadener from Skyline High School on June 9, 1982 about 1:00 p.m. for use at the University until August 18, 1982. The equipment in II above may be picked up at the School of Education by a designated person from St. Vrain Schools at 1:00 on August 18, 1982 at which

Dr. Jerry Trowbridge
May 12, 1982
Page 2

time paperwork transferring this equipment to the property of St. Vrain Schools will be ready for required signatures. Any maintenance on this transferred property subsequent to the transfer date would be the sole responsibility of St. Vrain Schools.

Marc Swadener

Marc Swadener - Principal Investigator NSF grant SED 7918974

Richard Turner

Richard Turner - Dean, School of Education

Larry Nelson - Director CUB Contracts and Grants

Approved

Jerry Trowbridge, St. Vrain Schools

date 6-1-82

MEMORANDUM

TO: Dr. Jerry Trowbridge, Assistant Superintendent For Instruction

FROM: Randy Donahoo, Supervisor of Instructional Media and Computing

DATE: May 14, 1982

RE: NSF Grant Microcomputers

Attached is a proposal from Dr. Marc Swadener regarding disposition of the nine Apple II computers and peripherals. It has been authorized by the appropriate CU officials.

I suggested to Marc that you would be the appropriate individual to authorize this transaction for the school district. My recommendation is that you sign the letter and add the following statement:

> The details of the above arrangement are acceptable to the St. Vrain Valley Schools under the condition that on August 18, 1982, all equipment being transferred to District ownership will prove to be in good operating condition. (Please allow time and space for equipment inspection by District personnel).

RD:kg
Attachment

School of Education
University of Colorado
Campus Box 249
Boulder, Colorado 80309

August 12, 1982

In accordance with the specifications in NSF grant SED79-18974 and a letter sent to the St. Vrain Schools dated May 12, 1982, ownership of the property specified below is transfered from the University of Colorado to the St. Vrain Valley Schools, Longmont, Colorado. This equipment was purchased with funds from the above grant. The listing of the equipment to be transfered is in the same order as it was specified in item 11 of the letter to Dr. Jerry Trowbridge dated May 12, 1982. The contents of this letter were approved by Dr. Trowbridge as indicated in the attached copy of the letter. All CU property tags have been removed from the equipment.

ITEM	ITEM	SER #	CU PROPERTY #	NOTES
1.	ZENITH color monitor #DC13-PF-5	9660678	87222	
	ZENITH color monitor #DC13-PF-5	9660965	87229	
	ZENITH color monitor #DC13-PF-5	9660923	87238	
	ZENITH color monitor #DC13-PF-5	9660243	87223	
	ZENITH color monitor #DC13-PF-5	9658654	87226	
2.	AMDEK color monitor model CM13L	YID000664	87969	
	AMDEK color monitor model CM13L	YID000694	87968	
3.	APPLE graphic pad model A2M0029	12218	87221	Includes interface board
	APPLE graphic pad model A2M0029	8969	87220	Includes interface board
4.	EPSON MX-80 printer w/GRAFTRAX	337093	87201	Includes interface board
	EPSON MX-80 printer w/GRAFTRAX	341699	87200	Includes interface board
5.	APPLE II+ 48 K microcomputer	A2S2-164243	87972	Includes language system
	APPLE II+ 48 K microcomputer	A2S2-163372	87210	Includes language system
	APPLE II+ 48 K microcomputer	A2S2-122680	87212	Includes language system
	APPLE II+ 48 K microcomputer	A2S2-162091	87214	Includes language system
	APPLE II+ 48 K microcomputer	A2S2-163396	87974	Includes language system
6.	APPLE II+ 46 K microcomputer	A2S2-1634308	87206	w/lang. syst. & VIDEX enhancer
	APPLE II+ 48 K microcomputer	A2S2-163504	87973	w/lang. syst. & VIDEX enhancer
7.	APPLE disk drive w/3.3 controller	336705	87213	
	APPLE disk drive w/3.3 controller	336704	87215	
	APPLE disk drive w/3.3 controller	336792	87216	
	APPLE disk drive w/3.3 controller	336702	87227	
	APPLE disk drive w/3.3 controller	307953	87211	
	APPLE disk drive w/3.3 controller	336646	87217	
	APPLE disk drive w/3.3 controller	307949	87209	

8. The seven RF modulators are included in the items in numbers 5 and 6 above.

The signature below, of an official of the St. Vrain Schools, acknowledges the reciept of all of the above named equipment, that it is in operating order, this transfer fulfills the specifications in the above named grant for the transfer of equipment and signifies that all maintenance of this equipment after this transfer becomes the sole responsibility of the St. Vrain Schools.

Robert D Larson
Mr. Randy Donahoo
(or other designated person)
St. Vrain Schools
Longmont, Colorado

Date 8 12 82

W Marc Swadener
Dr. Marc Swadener
Principal Investigator
NSF grant SED 79-18974
University of Colorado
Boulder, Colorado

#1

CU 87222

CU 87229

CU 87238

CU 87223

CU 87226

#2

CU 87969

CU 87968

#3

CU 87221

CU 87220

#4

CU 87201

CU 87200

#5

CU 87972

CU 87210

CU 87212

CU 87214

CU 87974

#6

CU 87206

CU 87973

#7

CU 87213

CU 87215

CU 87216

CU 87227

CU 87211

CU 87217

CU 87209

LONGMONT DAILY
TIMES-CALL
109th YEAR SINGLE COPY 15 LONGMONT COLORADO 80501 U S P S 318 830 WEDNESDAY APRIL 25, 1979 NO 99 40 PAGES

Computer education program

District being considered for grant

By MARILYN FRITZLER

R2-D2, C-3pO, and a legion of fellow robots Imagine them coursing through the St Vrain Valley taking out your trash, doing a week's collection of dirty dishes and maybe polishing off a little of that tedious paperwork.

The picture is delightful, and one Randy Wallace, math coordinator for the St Vrain Valley School District, is hopeful will become at least technically possible.

The district is being considered by the National Science Foundation (NSF) for a [illegible] grant to fund a computer education program designed to improve students' problem-solving and general math skills.

The NSF is in the final stages of screening grant applicants and Wallace said, "It appears very likely we will get it." Final word on the award of the grant should be received by the district from NSF in September, Wallace said.

The grant would provide for the purchase of six computers to be housed initially at Niwot High School next fall. During the 18-month program, Niwot sophomores would tutor Sixth graders from Burlington Elementary School in writing programs for computers, Wallace said. Choice of those schools was made by Kathleen Gilbert who, with Marc Swadener, a Colorado University math professor, will act as project coordinators.

There will be little cost to the district, Wallace said, other than to provide office space and files.

Eventually, the NSF-funded computers will be moved around between the district's schools, Wallace said, as is the comparable computer the district now owns. That computer which is rotated between schools every 10 weeks, is now at Mead.

If the NSF grant is awarded to the district, students first would be screened and tested for participation in the project and the necessary computer equipment purchased, Wallace said. During the next semester, computer programs would be written and run through the computers.

Afterward, Wallace said, math and problem-solving skills of students will be assessed to see what effect the computer project has had on their abilities. The results of that study will be presented at national conferences on education, Wallace said.

The computer project is expected to improve the basic math skills of underachieving sixth graders and increase enrollment in high school math and science classes, Wallace said.

An electronics expert from Denver will help students design a "microprocessor interface with a music system, a voice synthesizer, or a small robot," Wallace said. Those three systems combined would allow students to talk to a robot through the computer, he said.

School Board
In Other Action

In other business during its regularly scheduled meeting Wednesday, the St. Vrain Valley School Board conducted the following business. All votes were unanimous.

The board;

BONDS MARKETED — Heard Superintendent Keith Blue report that the $4 million remaining from the $17 million building bond issue voters approved last year had been marketed Tuesday at 10.33 percent interest. The money should be available to the district in June, he added.

ALTERNATIVE SCHOOL — Heard a report on an effort to consolidate alternative high school programs offered at Main Street School and Erie Junior/Senior High School at Old Columbine next fall.

The programs provide extra help for students who have dropped out of school or are having trouble in school, providing extra teachers and counseling for the students. The board will formally consider the plan at the May 26 board meeting.

FOOD SERVICE COSTS — Heard a report on utilities used in the hot lunch program. According to the report, the kitchens use $40,936 in electricty, gas, heating and lighting each year to produce the meals. The utility bill is presently is being paid by general fund dollars.

The board asked administrators to report on how much student lunch prices would have to increase to pay for utilities. The lunch program is self-sufficient, paying for all salaries and costs associated with the program except for utilities, administrators reported.

DRIVER'S ED VAN — Approved eliminating the driver education simulator van used by Erie, Frederick and Lyons high school students. Instead, the district will bus the students to the driving range at Longmont High school.

The van, which is old and difficult to keep functioning, according to administrators, cost the district $2,140 to run last year. Estimated cost of busing the students to Longmont is $3,000.

COSMETOLOGY — Approved an agreement with the Longmont Beauty College, having that school offer cosmetology training to St. Vrain students pursuing a career in that field. Tuition will be $85 a semester for each student, which will be paid by the district, according to the agreement.

TEACHER DENIED — Approved an arbitrator's

Ann Friebel, president of the St. Vrain Valley Education Association, said [illegible] association board has accepted the arbitrator's decisions becuase they believe in due process and binding arbitration.

COMPUTER PROGRAM — Approved initiating a one-semester computer program at the Career Development Center beginning next fall. Students interested in continuing computer classes would then attend Boulder vocational schools.

However, the district has not finished an agreement with the Boulder district for tuition payments for the students. The seven new computers needed for the course, which will cost $4,500 each, will be purchased through grants and the CDC budget.

GRANT ACCEPTED — Accepted a $10,500 grant from the State Board for Community Colleges and Occupational Education to purchase computers for a new computer course at [illegible] Career Development Center.

COMM[illegible] SCHOOL MO[illegible]D — Approved moving the Central Elementary School program to Longmont Estates and Hygiene Elementary. The program, which provides after-school programs for youth and adults, wasn't attended by students like other community school programs are, said Jim Roorda, director of vocational, adult and community services said.

Additionally, the city's senior citizen center and a recreation center are located near the school, providing similar activities, he said.

LOAN EXTENSION — Approved an extension for a construction loan for the building trades students at Career Development Center. The $58,000-loan, which will extend from May 1 to Oct. 28, was extended because the house students are building is not completed.

STAFF CHANGES — Approved the resignation of two teachers, a custodian, a secreatary and two teachers' aides, professional and maternity leave for two teachers and the retirement of a cook and clerk.

Appointed a substitute custodian, two summer maintenance workers and a substitute bus driver.

SCIENCE REPORT — Heard professor Marc Swadener of the University of Colorado and Loma Linda Elementary School science teacher Paul Canny report on a two-year joint project between the district and CU sponsored by the National Science Foundation.

Longmont Times Call
about Sept. 1980

BEST COPY AVAILABLE

Longmont Times Call
Late April, 1981

Students learn with computers

By MARGE LASTICK
Times-Call Staff Writer

Stacy Alford and Dean Haakonson are trying to kill each other. And Leanne Kennedy is promoting the violence.

"Try a bigger angle with the same ammunition," she advises Alford. But the next minute, Kennedy, a Skyline High School student, has switched sides and is urging Haakonson to fire his shell at a shorter angle with a little extra power.

Intent on destroying each other, the foes — both sixth graders at Spangler Elementary School — eagerly take their mentor's advice. "I know exactly what I have to do," says Haakonson with an evil gleam in his eye.

As the assailant's shell manages to overcome a strong wind, makes it over the mountain and appears to be right on target, he clenches his fists and whispers, "go, go." Meanwhile, Alford, the obviously frightened would-be victim cries, "You'd better miss me."

Kennedy, not sure where her loyalty lies, seems half-relieved, half-disappointed when the shot falls inches short of its mark. All players clearly are caught up in the battle, being played on the screen of an Apple II computer.

The idea of the simulations is to motivate students in developing strategies to solve mathematical problems, according to teacher Paul Canny. Canny, who teaches mornings at Loma Linda Annex Elementary, has been teaching an afternoon computer class at Skyline since January.

A National Science Foundation grant, awarded to the St. Vrain Valley School District last spring, paid for that position and for nine new Apple II units. Four still are at Skyline where 27 sophomores and juniors have learned to use a variety of software programs and now are beginning to write their own.

Under a pilot tutorial program, the other five are at Spangler and Columbine elementary schools. Every other day for the past month, the high school experts have been visiting the two schools to teach sixth graders how to use computers.

Each is paired with an individual who has been having trouble in math, according to Canny. Not all get to use the machines every day, and the high school students act as traditional tutors the rest of the time.

The tutoring part obviously isn't as much fun. One sad-looking boy is completing a dry lesson on fractions and decimals while listening to others scream in the background: "This machine is a rip-off, it always misses" and "Wait till next time, you're going to die." "At least, I get the computer on Monday," he says.

"We're here to help them with whatever they're doing," said tutor Janice Householder. Sometimes, she said, it is frustrating, "but now we know how teachers feel."

And the computers are more than just fun. Haakonson said he certainly has learned his angles from the artillery game, one of the most popular of 50 or so different programs. While the simulations don't necessarily correspond to specific classroom lessons, Canny said all tie in with math in general.

"They learn how to solve problems, to work out strategies for winning and learning," he said. Canny added that the computers aren't intended to replace or duplicate paper-and-pencil drills. He said the machines teach some of the same things and more.

A lemonade stand program, for example, involves many variables such as time of day and weather conditions, he said. "They have to consider everything if they want to make any money. The whole idea is to put new excitement into learning for kids who have been used to failure."

Canny said the 1 1/2-year research project will be expanded next year and participating students will be tested to see, in fact, if their math skills have improved.

Longmont Times Call
Late April, 1981

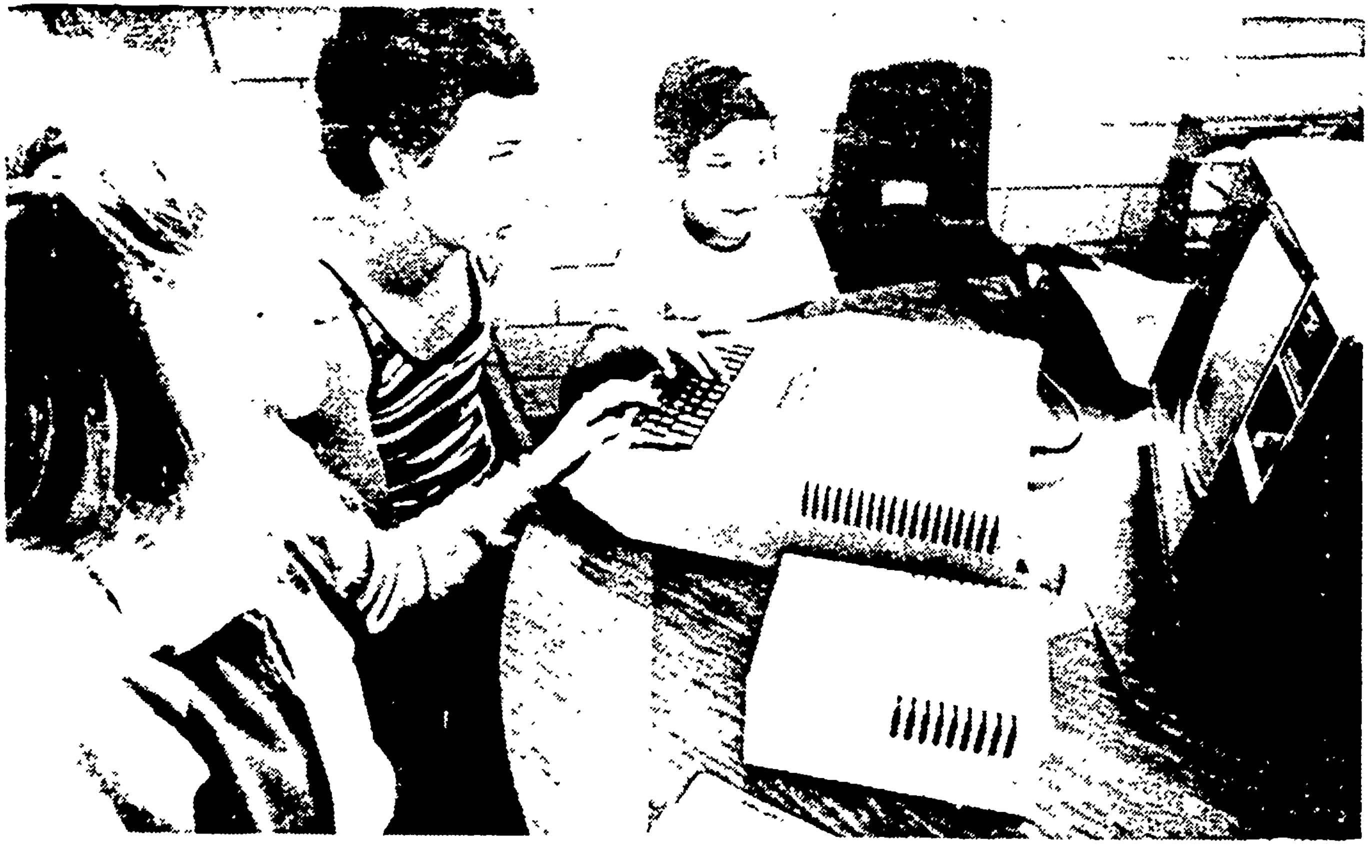


Photo by John Epperson

Above from left to right, Columbine Elementary school students Susan Norris, Carl Leonard and Nacho Gonzales work on a computer program

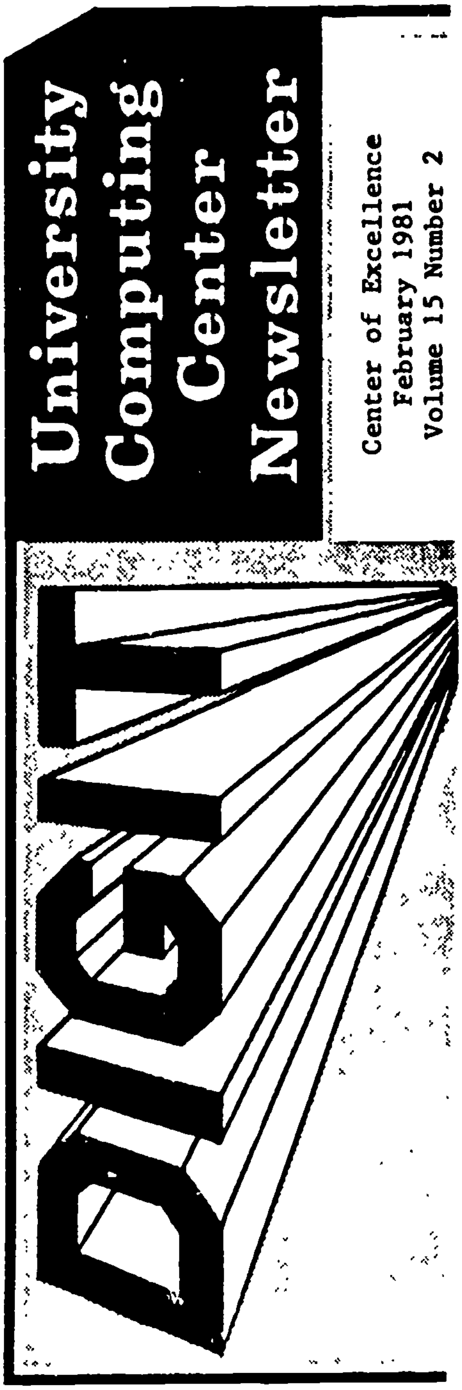
student tutors from Skyline High are using computers to help the younger students with math problems

USER PROFILE

The Laboratory for Research in Science and Mathematics Education, a program within the School of Education, has recently received a two-year, $85,000 grant from the National Science Foundation to establish an experimental program within the St. Vrain schools using Apple microprocessors (microcomputers). Under the direction of Marc Swadener, the project is currently in the pilot test stages with the actual implementation scheduled for the 1981-82 school year.

The two primary objectives of the project are to increase the capabilities of low achievement sixth graders who are in the project, and to increase the proportion of the high school students who continue to take mathematics and science courses. The high school students chosen will be average and above average students currently enrolled in mathematics classes which, when completed, commonly result in a decision to discontinue further mathematics classes. These high school students will spend time studying the mathematical difficulties encountered by low achieving sixth graders and in the operation and fundamental programming of the microcomputers. These students will then tutor the low achieving sixth graders on a one-to-one basis using the microcomputer when appropriate.

As a part of the program, nine Apple microprocessors are being purchased to assist in the tutoring program as interest generating and motivational devices. Although preprogrammed packages will be used initially, it is anticipated that the high school students will become proficient enough to write additional programs that can be used by the sixth graders in developing their math skills. At the end of the two-year grant, most of the Apples will be left with the St. Vrain school district as a means of fostering a continuation of the use of computers in instruction.


University Computing Center Newsletter
Center of Excellence
February 1981
Volume 15 Number 2

The Skyline Sun

Skyline High School
Longmont, Colorado

Volume V, Number 12
March 6, 1981

Computer Class at Skyline

By Marcia Austin

The National Science Foundation is sponsoring a new computer course which started second semester at Skyline High School. The foundation is part of a research project trying to see how well high school students will work as tutors for younger children.

Through the course, the students are learning how to run and program computers. They will then use the skills they have learned to tutor 6th grade students at Columbine and Spangler Elementary Schools that are having problems in math.

Mr. Paul Canny is the teacher for the computer course. Canny has only taught elementary school before and says he is really enjoying teaching in a high school situation.

Canny says his goals for the class are to help students feel more comfortable with math and with the computers, and to do a good job of tutoring the 6th graders.

Mr. Paul Canny helps student Carl Leonard with an assignment.

The computers have been ordered for the class but they haven't come in yet. In spite of this, Canny said, "I think it is working pretty well. The students seem interested in what is going on."

Sara Hugger, junior, said, "The course is interesting. I like it."

Matt Newby, sophomore, feels that the course has a lot to offer. "It is educational and prepares you for a job in computers," he said.

Leanna Kennedy, junior, feels that "more computer courses should be offered, because they prepare you for a job in the future."

After spring break, the class will begin tutoring 6th grade students. Hopefully the computers will be in by then.

Sept. 1981

The Skyline Sun

Skyline High School, Longmont, Colorado
Volume 4, Number 1

Funding Needed For Computers

by Peter Schuerman

This is the last year that Computer Math, in which the students get "hands on" experience with actual computers, will be offered at Skyline. With additional funding, the program can be continued.

The program, funded by the National Science Foundation, was conceptualized by CU professor Dr. Marc Swadaner as an experiment. The Program's goal is to discover whether or not computers are successful math tutoring devices for 6th graders. They also hope to see if these students are motivated to take more interest in mathmatics careers. Skyline's 34 computer math students are taught how to use the computers during first semester, and then tutor 6th graders second semester. Paul Canny, Computer Math instructor, said, "Last year the program had a big effect (good) on the math scores of the 6th graders we tutored."

At present, Skyline's Computer Math class has nine *Apple* computer consoles (these house the computer chips which are the heart of the system, and also include a keyboard used for transmitting information), nine monitors (television screens connected to the consoles. These display words, pictures, etc.), and nine disk drives (these record information on small record-like "diskettes" for later use, so that information can be played back into the computer rather that being typed in). We also have three printers (used for printing information from the computer on paper), and three graphics tablets (used for drawing pictures on the monitor). A console, monitor, and disk drive alone can cost around $3,000.

The program was designed so that at the end of this school year two-thirds of our computer equipment would go to the St. Vrain valley School District to be distributed to its schools, while the remaining third would go to CU.

Next year, if computers are again available for our school, more applications are being planned. One idea is a computer math class without the tutoring. Also, since re-creations of things such as the Three Mile Island incident and labor strike negotiations can be "played" on the computer, computer usage can extend to science and social studies. "We hope", said Paul Canny, "to have a computer available in the library for students to use."

Two Skyline students work on an APPLE computer terminal. These computers could become a permanant part of Skyline. Photo by Dave Manuel

NEWS

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EXPERIMENT USES MICROCOMPUTERS AS TEACHING TOOLS -- Does hands-on experience in using computers for solving math problems enhance interest generally in mathematics and technology? Marc Swadener of the CU-Boulder School of Education is analyzing data gathered in a project in which high school students, using microcomputers as aids, tutored sixth-graders who were having difficulty in arithmetic. Attitudes of the high school students and records of their subsequent enrollment in math and science courses will be studied to determine if the experience increased interest in these areas. The mathematical achievement of the sixth-graders also is being studied. The project, funded by the National Science Foundation, was carried out at Skyline High School and the Spangler and Columbine elementary schools in the St. Vrain Valley School District. Seven of the nine microcomputer systems purchased with grant funds have become the property of the school district.

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Every other school day since January, Columbine School has been invaded. Twenty or so creatures from Skyline School carrying large brown suitcases arrive at the doors of the school. They enter the building, open up the cases, and the Columbine computer class is ready to begin.

The computer class is actually a research project sponsored by the National Science Foundation to study the effects of high school students, using microcomputers, teaching arithmetic to elementary students. The mystery of the invasion is solved, the alien creatures are high schoool tutors and the mysterious boxes contain Apple Computers.

The Skyline students attended class from September until January, learning about computers and techniques of teaching. Starting in late January they have been coming to Columbine every other day and tutoring,one to one, nineteen sixth grade students. The tutoring is on math, trying to help the students do better in their classroom work. Equally important, though, is the teaching of forms of logical thinking and problem solving. The computers are used to help teach these topics and are used as motivational devices, helping the students to understand more and enjoy more the role of mathematics and technology in the world.

Has the project significantly changed the way, and the amount, of mathematics learning at Columbine School? the results aren't in yet, but there are some good indications that it has. A sixth grade teacher has these comments on two of her students who are part of the program. About one she states,"he is much more motivated and works much harder." concerning another student she say,"she is super motivated, does two times as much work."

The computer class will end at the end of May, after having been a part of Columbine for the past vear and a half. But if you are interested in the program its principal directors, Paul Canny from the St. Vrain Schools and Dr. Marc Swadener from C. U., and some of the students will put on a demonstration of the project at the PAC meeting on May 11. Hope to see you there -but watch out for the aliens.

The above article appeared the the Parent Bulletin of Columbine School. It was written by Project Staff.

'Wonder drug' doesn't improve students' math skills

By LINDA CORNETT
Camera Staff Writer

Self-proclaimed "computer nut" Marc Swadener has some bad news for those who see computers as a wonder drug for public education.

Swadener, a University of Colorado professor, is just ending a 2½-year study of what intense computer use can do for sixth graders with problems in math

The answer, apparently, is "nothing."

The changes in the students' math skills and attitudes and their feelings about computers before and after the study varied so little from the sixth graders who weren't involved they didn't even show up statistically, he said.

The students, selected from Spangler and Columbine elementary schools in Longmont, spent half an hour every other day during the spring of 1981 working on computers with high school tutors.

● Graduation test opposed
● Lamm offers proposals for improving schools
Page 1B

Parents and educators are "going to have a very hard jolt" if they expect computers in the classroom to solve kids' problems with math, Swadener said "We didn't do them any damage but we didn't do any more for them than the teachers did. The thing that makes the biggest change in education is the teacher."

"I'm very excited about computers," Swadener said (he has two in his office and one at home; his 200-page study report was produced completely on computer), but, "I don't think they'll save education."

There was "anecdotal evidence," as mathematician Swadener calls conversations with teachers and parents, that the students were "excited" by the program and would like to continue it. But, Swadener said, "I can't produce statistical evidence from that."

The machines flunked out in the second half of the experiment, as well.

Swadener had hoped that the computer tutoring would encourage the 30 Skyline High School students to try more science and math courses before graduating.

The information Swadener was able to gather suggests that they did not. (A surprisingly high turnover of students at Skyline prevented Swadener from gathering enough information for a statistical finding on this.)

"I think high school students should get as much science and math as they can. People who end their mathematics studies early on limit their career options significantly," Swadener said.

Still, he said, he wasn't particularly surprised that the students didn't change their course

(See STUDY, Page 6A)

CONT. ON NEXT page

choices after spending one year in his program "It's very difficult to affect enrollment patterns with small efforts." His $85,000 study, he said, was "a drop in the bucket."

Much of that money was used to buy nine Apple microcomputers used in the program. The University of Colorado School of Education kept two, and the St. Vrain Valley School District got the other seven.

The existence of those small computers produced what Swadener considers the most far-reaching result, something not even included in his research proposal.

The teachers of St. Vrain, learning that the computers were available after school hours, put in about 40,000 hours learning how to use and program computers.

"That's the real payoff" of the study, he said. "There's no question that will have a gross effect on the teachers. The effects on the students will be subtle and almost immeasurable but there will be an effect there."

Swadener the computer fan says students (and teachers) benefit from the detailed thinking that computers demand of them and the training in breaking tasks down into small, manageable bits.

However, he adds, "they'll probably cause more problems than they answer," at least initially, because figuring out how to use computers well requires time for planning and programming, time that teachers don't have. Existing programs, he said, are little more than drill and practice with special effects and do little to encourage creative thinking.

Eventually, Swadener predicted, computers will be used for management functions and some industrial programs will be brought into math and English classrooms.

Swadener's report will be sent to the National Science Foundation at the end of February. Copies will also go to St. Vrain and CU.

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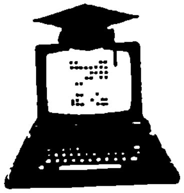

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School of Education

**UNIVERSITY OF COLORADO
BOULDER**

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**SAINT VRAIN
VALLEY
PUBLIC SCHOOLS**

HAS COMPLETED THE 1981-82 EXPERIMENTAL PHASE OF THE PROJECT

PERSONAL COMPUTERS AND CROSS AGED INSTRUCTION

A PROJECT OF THE

SCHOOL OF EDUCATION, UNIVERSITY OF COLORADO-BOULDER

IN COOPERATION WITH THE

ST. VRAIN VALLEY SCHOOLS, LONGMONT, COLORADO

SUPPORTED BY

THE NATIONAL SCIENCE FOUNDATION*

DR. MARC SWADENER-PRINCIPAL INVESTIGATOR

Date

MR. PAUL CANNY-PROJECT DIRECTOR

F PROJECT SED 79-18974

May 4, 1982
Columbine School
Longmont, Colorado

Dear Parents of

Your daughter or son has been a participant in the computer class at Columbine School since January. I hope that your child has enjoyed this class, and also that he or she has learned from it. I feel that the class has been a very profitable experience for all the students who were involved.

The class included tutoring of sixth graders by high school students from Skyline High School. The tutoring involved regular instruction in arithmetic and the use of micro-computers as a learning device.

On the evening of May 11, at the regular PAC meeting. I will be showing how the program operated and talk about some of the benefits of the program. If it is possible I would like your child to attend that meeting and be part of the demonstration of the tutoring.

If your child will be able to attend please fill out the bottom part of this note and return it to your child's teacher by Friday, May 7.

I sincerely hope that your son or daughter can attend and that I can see you at the meeting also.

Sincerely,

Paul G. Canny

My son or daughter has permission to be part of the demonstration of the computer class to the PAC of Columbine School. She/he will be at Columbine at 7:30 pm on the evening of May 11, 1982.

Parent's Signature ______________________

The above form was sent to parents of Columbine students to allow the students to participate in a demonstration of the Project at a Parent-Teacher meeting at the school.