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ABSTRACT

Two self-contained fourth grade classrooms were compared during a 1-year study conducted in a small rural community in Indiana. Pre-test measures consisted of the previous year's third grade scores on the Cognitive Abilities test and a self-developed inventory of attitude toward school and computers. The control group (n=28) received instruction throughout the study via traditional teaching methods with one computer available to the class. The experimental group (n=29), with a student/computer ratio of 2:1, began the year by learning keyboarding and becoming familiar with the computer system and the available variety of software, as well as attending to the traditional lessons with their teacher. After this initial instruction, these students spent a minimum of two hours per day at the computer, either alone, or with a partner, working with software from all areas of typical daily instruction. The measures of posttest performance for the two groups compared computer skills mastered; problem solving ability; and the Iowa Test of Basic Skills Reading, Math, and Composite Subtests. Both the raw scores on these measures and the scores adjusted for differences in intelligence were compared. Student attitudes toward school and computers, and teacher perceptions of student abilities were also compared. Although the experimental group had significantly higher scores on the computer skills test, none of the other measures produced significant results. Five appendixes and two supplemental analyses provide the study data and statistical analyses, sample measuring instruments, and a list of computer skills objectives. Ten references are included. (EW)

THE EFFECTS OF COMPUTER-ASSISTED INSTRUCTION ON ACHIEVEMENT, PROBLEM-SOLVING SKILLS, COMPUTER SKILLS, AND ATTITUDE

A Study of an Experimental Program

at Marrs Elementary School

Mount Vernon, Indiana

(a project made possible by an
Indiana Department of Education Grant)

by

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ABSTRACT

Two self-contained fourth grade classrooms were compared during a one year study. Computers were introduced into an experimental classroom with a student/computer ratio of 2:1. The control classroom had a student/computer ratio of 28:1.

Measures of posttest performance compared for the two groups were computer skills mastered; problem solving ability, Iowa Test of Basic Skills Reading, Math, and Composite Subtests.

The raw scores on these measures were compared as well as the scores when they were adjusted for differences in intelligence.

Gains in attitude toward school and attitude toward computers were also compared.

Teachers' perception of student abilities were also compared.

Results indicated a significantly higher score on the computer skills test for the experimental group ($p < .0001$). However, no other measures produced significant results.

BACKGROUND OF THE PROBLEM

Within the educational and occupational communities, it is evident that the "information age" is upon us, and that the adults of tomorrow will have a definite advantage in the work force if they are computer literate. Small (1984) believes that computer illiteracy may very well be the major handicap of those who will live in the 21st century.

Rationale

The fundamental responsibility of defining computer literacy and deciding how or how not to teach it is, of course, placed upon the schools. Major questions are raised about the tremendous cost of promoting computer literacy by providing computers for all classrooms. As many systems exist for equally distributing computers throughout the schools as there are schools. Distribution methods range from: (a) computer labs to which students are sent weekly for group instruction, to (b) one or two computers per classroom, at which students work independently or in small groups, to (c) several computers per classroom, at which students receive ample opportunity for independent instruction, to (d) no computers at all. Papert (1984) expressed his opinion on the present state of computers in the classroom:

> . . . there's a lot of ballyhoo in the press about this computer revolution--that computers are everywhere in the schools. But, in fact, there is scarcely one for every 100 children--which is no computer at all if you average it out. A very small number of schools are thinking in terms of one for every 30 children because that means each child can get an hour a week at the computer--which is a little better. But think of one hour a week for the pencil, and it's obvious that this is still absurd.

Proponents of classroom computers argue that albeit the obvious limitations of not enough computers in the classroom and not enough time allowed for their use, individual computer experience may enhance students' intellectual abilities and problem-solving skills, may increase self-esteem, intrinsic motivation, and independent learning because of immediate feedback of students' responses. Critics argue that computer experience is likely to produce highly distractable and impulsive students; that social interaction skills will not be promoted; and that creativity may be stifled and intrinsic motivation undermined (Lepper, 1985).

Numerous states and school systems have launched state or system-wide experimental studies to assess the effects of computer-assisted instruction (CAI) on student achievement and attitude toward school and computers.

One such study was conducted in Arkansas during the 1984-85 school year, called IMPAC (Instructional Microcomputer Project for Arkansas Classrooms). IMPAC provided the experimental self-contained elementary classrooms with six computers per room, and the experimental junior high classes with computer labs. Both systems accompanied the traditionally taught daily classroom, with computer time per student at 20 minutes per day. (IMPAC concentrated on math, reading, and language arts basic skills).

The results indicated that the most gains occurred at the elementary level, but that academic gains were in some cases equal to those of the control groups. At any rate, they were not statistically significant. Gain from peer tutoring and instructional T.V. were also equal to and in some cases, were even greater than computer gains. A notable positive effect of IMPAC was an improvement

in attitude toward school and computers of the experimental groups (McDermott, 1985).

A similiar study was conducted through the Washington, D.C. public schools. It was actually a pilot test run of Houghton-Mifflin's Dolphin program, a CAI system which teaches and reinforces math, reading, and language art skills. The study compared Dolphin and non-Dolphin public schools in grades 4, 5, and 6, using standardized achievement test results from the preceding and Dolphin years against one another. An attitude questionnaire measuring student attitude toward school was also administered as a post-test. The experimental group received 15 minutes of computer time daily, working in pairs in a lab situation. The control group received none.

Basically, there were slight differences in achievement in favor of the experimental group, as exhibited by classroom test scores, student records, and classroom observations, but the two groups were not statistically significant on the achievement test. There did appear to be significant differences of attitude in favor of the experimental group in the areas of learning about reading, wanting to continue the Dolphin program, and liking to go to school. Similar results to the Dolphin study were obtained from an investigation conducted by Ngaiyaye and VanderPloge (1986) with below grade-level students. The researchers asked three questions: (a) Does CAI improve achievement for the educationally disadvantaged?, (b) Is CAI significantly superior to conventional teaching approaches?, and (c) Does CAI effectiveness vary with the program design?

The subjects were below grade-level achievers, grades 2-8, in an urban school system with low socioeconomic indicators. Three experimental groups each were assigned a different computer system: (a) vendor-based, whereas all materials in the program were designed by the vendor, (b) district-based, in which the school district developed or decided upon the materials to be used by its schools, and (c) school-based, whereas the individual schools chose or developed materials based upon the needs of their students. The control group was taught by conventional methods, without the use of computers. Standardized achievement test batteries from the preceding and current year were measured against one another to ascertain possible achievement gains from computer usage and type of computer usage.

The results of the study were surprising. The achievement test scores of the three experimental groups were no higher than those of the control group, and there was no significant difference among the experimental groups using the various computer systems.

Questions may be raised as to what actually would make CAI more effective, since the educationally disadvantaged did not make significant gains in the previously mentioned studies, and since the type of program did not seem to have any measurable effects. The time spent at the computer may have an effect. The "time on task" with the IMPAC study was 20 minutes per day per child, but with six computers per classroom, the computer to child ratio was 5:1. The Dolphin study allowed 15 minutes per day per child, with a computer to student ratio of 2:1.

Baron (1986) devised a study which merged the concept of time spent at the computer with group size at the computer. The purpose of the study was to "determine optimal group sizes which

enhance individual student achievement and socialization considering group size time on task variants". Two factors were to be tested specifically:

(a) Effectiveness - How much does each student learn?, and

(b) Efficiency - What group size and contact time is best? The hypothesis of the study was that "group learning is less effective than individual learning, but is more efficient. When computer time is limited or reduced, individual achievement can be aided by student team learning".

Randomly selected 5th and 6th graders from upper-middle class Montreal were assigned to groups of 4, 2, and 1. The subjects were given a pre-test of vocabulary knowledge and an attitude questionnaire which included a history of computer use. The groups were randomly assigned to time treatments of: (a) one half hour treatment per week, (b) two half hour treatments per week, and (c) three half hour treatments per week. The course of study was a vocabulary-building sequence, and the treatments were spread out over a three week period. The subjects were given vocabulary and attitude post-tests.

Baron concluded that there were significant results in vocabulary gain from the subjects which had spent the most amount of time at the computer, regardless of the group size. Therefore, the hypothesis was rejected in terms of group size.

Perhaps an explanation for any gain at all stemmed from the fact that the subjects came from well-educated upper-middle class families, and were more self-motivated to learn under most circumstances anyway. As well, the author gave no information as to the attitude results. It would be interesting to note whether these children had been exposed previously to computers, and whether

their attitudes toward school had improved as a result of CAI, such as the attitudes of the educationally disadvantaged had improved (perhaps as a result of the novelty of the computer experience).

Gordon Hartig (1985) comments on the justification for increased spending on computer equipment, software, and trained personnel by stating that CAI should not be merely as effective as traditional teaching methods, but rather must be more effective, before more time and money are spent on highly individualized systems.

This idea is expanded by Signer (1983) who states that there is a discrepancy between what teachers feel makes CAI effective, such as content and teaching strategies, and what students feel makes CAI effective, such as interest and clarity.

Bernard (1986) believes that the reason that much software is ineffective is because it forces students to choose a "right" or "wrong" answer. For example, a student may not have a solid grasp of the particular concept being taught or reviewed, but may still "guess" the correct answer. Of course, the lack of effectiveness will be exhibited as no achievement gains in posttests. This effect may be a reason for the lack of achievement gains in the previous studies. If CAI is, in fact, effective (regardless of the reason), then students should perform better on skills tests after instruction.

Statement of the Problem

Does exposure to computers in school affect learning and attitude? Is increased time spent at the computer related to school achievement and attitude toward school and computers? The following investigation was conducted to measure the effects of time spent at the computer on math and reading achievement, problem-solving skills, computer skills, and attitude

toward school and computers may further broaden the available knowledge in the domain of CAI.

Hypotheses

1. There is no significant difference in the means of math, reading, and composite achievement test scores between students who have greater access to computers and those who have less.
2. There is no significant difference in problem-solving ability between the two group.
3. There is a significant difference in pre-post attitude gains in attitude toward school and computers in favor of students who spend more time at the computer.
4. There is a significant difference in computer skills in favor of students who spend more time at the computer.
5. There will be a higher frequency of students whose teachers perceive that their computer and academic skills are outstanding among students in the computer (experimental) group as compared to the number in the control group.

Method

The two fourth grade self-contained elementary classrooms at Marrs Elementary School in Mt. Vernon, IN were selected as the sample of the study. Mt. Vernon is a small, rural community in which the majority of the population falls into the lower-middle class socioeconomic range. The experimental group contained 29 subjects. The control group contained 28 subjects. Both groups contained almost equal numbers of boys and girls. The study continued for one academic school year.

Pre-test measures consisted of: (a) the previous year's 3rd grade scores on the Cognitive Abilities test, and (b) a self-developed attitude inventory of attitude toward school and computers. (See Appendix C.)

Posttest measures were: (a) 4th grade scores on the Iowa Test of Basic Skills battery, including reading, math and composite subscores, (b) the same attitude inventory that was used as a pre-test, (c) a computer skills tests, measuring keyboarding accuracy, word processing, and the use of the machine, and (d) a problem-solving test of math and creative thinking problems.

The control group instruction throughout the study consisted of traditional teaching methods, with one computer available to the students in the class.

The experimental group spent the first six to nine weeks of the school year learning and practicing keyboarding, and becoming familiar with the computer system and the available variety of software, as well as attending to the traditional lessons with their teacher. After initial instruction, the students spent a minimum of two hours per day at the computer, either alone or with a partner, working with software from all areas of typical daily instruction. Many practice/drill worksheets were replaced by interactive software programs. Software was employed in the areas of language arts, math, social studies (Indiana History), and enrichment in music, art, creative writing, and programming skills for those students who were interested.

The experimental classroom was equipped with fifteen Commodore 64's which had separate disk drives for individual operation. The computer operated by the teacher was attached to a monitor with a 24-26" screen for group instructional purposes. Four printers were available for the classroom. Students sat at tables with two students per computer.

For the purpose of this study, only the means of scores between the two groups for each test were compared for analysis. Individual progress scores for each of the groups are contained in Appendix A in this report.

A questionnaire was sent to fifth grade teachers to ascertain which of their students in current fifth grade classes were most proficient and which were least proficient in several academic areas. An attempt was than made to ascertain whether membership in the previous year of experimental or control groups had contributed their having been selected.

Analysis

Achievement tests were compared by a one tailed to test. Pre-post differences in attitude for the two groups was compared by a repeated measures analysis of variance.

Analysis of covariance was also performed on the achievement measure with the I.Q. scores of the comparative abilities test scoring as the covariate. Difference in teacher perceptions were compared by a chi-square test.

Results

The means of the groups are contained in Table I Post-Test Achievement Measures. No significant differences be een the experimental and control groups were found in the Iowa Math, Reading, and Composite Tests ($p < .05$) as a result of the CAI, although the means of the experimental group were at least two points higher for all three tests.

Problem solving ability was statistically insignificant as well at ($p < .05$), and the mean score for the experimental group was one point lower than for the control group.

The computer skills posttest was the only variable which showed any positive results at all, and these were highly significant ($p > .01$). The

control group mean was 8.22, and that of the experimental group 16.56. (See Tables 1 and 2).

Table III

Repeated Measure Analysis of Variance Results for Attitude Measures

Measure	F Ratio	Significance
Attitude/School		
Pre-Post	8.27	.005
Control Experimental	3.15	.076
Interaction	0.08	.771
Attitude/Computers		
Pre-Post	6.42	.012
Control Experimental	0.42	.527
Interaction	0.53	.476

Pre-Post Analysis of Affective Measures

Table III contains a repeated measures analysis of variance for the affective measures of attitude toward school and attitude toward computers. It can be noted that each measure contains a significant difference for the pre-post component. However, from Table II, it can be noted that the difference is actually a decrease in attitude for both measures and is probably a reflection of students' attitudes at the end of the school year as compared to the beginning.

Complete results of these analyses are contained in Appendix A of this report.

Table IV

Analysis of Covariance for Adjusted Means of Posttest Achievement Means

Posttest	Covariate	Covariate Mean		Posttest Mean		Adjusted Mean		F Ratio	Significance
		Control	Exp.	Control	Exp.	Control	Exp.		
Reading	Verbal IQ	106.4	107.4	54.8	54.1	55.1	53.8	0.22	0.65
Composite	Verbal IQ	106.4	107.4	52.4	54.4	52.7	54.1	0.60	0.45
Math	Quant. IQ	103.9	105.9	51.9	53.0	52.4	52.6	0.01	0.91
Problem Solving	Quant. IQ	103.8	106.3	30.5	29.2	30.9	28.9	1.26	0.27

Table IV contains the results of the analysis of covariance performed on the dependent measures. It will be noted that the Experimental Group scored higher on each of the covariate measures.

The table also contains the results for each of the Posttest means. These means were adjusted to compensate for differences in the appropriate covariable measure. The adjusted means also appears in Table IV.

After the means had been adjusted, there is little difference in any of the dependent measures. None of these differences is large enough to be statistically significant.

The complete results of this analysis is contained in Appendix A of this report.

Table V

Chi Square Analysis of Teachers' Perception of Student Abilities

Area of Teachers' Perception	Number in Top 5 Control	Exp.	Number in Bottom 5 Control	Exp.	Chi-Square	Significance
Interest in Computers	3+2=5	2+3=5	3+2=5	2+2=4	0.06	0.81
Ability with Computers	1+2=3	3+3=6	5+1=6	0+2=2	2.95	0.09
Computer Knowledge	1+2=3	3+3=6	4+1=5	1+2=3	1.45	0.23
Math Ability	3+2=5	2+2=4	5+1=6	0+2=2	0.70	0.40
Problem Solving Ability	3+1=4	2+3=5	4+1=5	1+2=3	0.55	0.46
Composition	2+2=4	2+3=5	4+1=3	1+3=4	0.22	0.64
Intelligence	2+2=4	2+3=5	4+1=3	1+3=4	0.22	0.64

Teachers' Perception of Student Abilities

The Chi Square analysis of the fifth grade teachers' perception of students' abilities is contained in Table V. Teachers were asked to rank students according to their abilities in each of seven areas and an analysis was made of which groups, Experimental or Control, the students were in during their fourth grade.

None of the analysis proved to be statistically significant although ability with computers approached significance favoring the Experimental group.

The complete results of these analyses are contained in Appendix C of this report.

Summary

It should be noted that the difference between means approached significance favoring the experimental group in composite achievement (p=.07), Gains in attitude toward school (p=.07), and teachers' perceptions of student ability with computers (p=.09).

Discussion, Conclusions, and Recommendations

The findings of this study have many implications for CAI. For example, the lack of difference in achievement correlates with the results of the previous studies reviewed. Variables to be considered in these studies which may have affected results are the quality and relevance of the software used, the general expertise and attitude of the teachers and administrators involved, and the lack of random selection of subjects.

It should also be noted that the experimental group was handicapped by the absence of their teacher. The teacher was ill for two months during the middle of the school year.

In the area of problem-solving ability, the general "right" and "wrong" nature of instructional software may account for the lower mean of the experimental group. Perhaps the control group, through traditional teaching methods, was exposed to more problem solving and creative thinking than the experimental group with the more structured CAI. The enrichment software obviously did not affect the thinking abilities of the experimental group, as well.

The decreased attitudes of both groups may have been due to the "end of the year" syndrome. Teacher attitude and behavior due to the experimental conditions may have actually had a negative effect on the group. There could be a "burnout" factor involved

on the part of the students.

Increased computer time had a positive effect in computer skill, as does most situations in which one practices often. The amount of the difference in computer abilities of the two groups was a very profound one.

Because every school has a different method for computerizing its classrooms, the results of future studies will continue to vary. More research needs to be conducted to determine the effects of the many variables involved.

The program should be continued with additional research analysis. In this way, the results of the program under more optimal conditions can be determined.

CAI is here to stay. At the present time, under the constraints of budget, trained personnel, available space and software, each school must try to meet student and community needs as best it can.

Table I

Means and Standard Deviations of Results for the Experimental and Control Groups

	$\bar{X}$		S.D.	
	Control	Experimental	Control	Experimental
Math	50.48	52.82	8.55	7.86
Reading	52.85	54.46	13.73	9.64
Composite	50.70	54.43	9.62	9.15
Prob. Solve	29.31	28.39	6.45	6.13
Computer Skill	8.22	16.56	1.93	3.61
Att./School Pre	44.33	45.00	8.58	11.46
Att./School Post	39.32	41.93	7.76	8.28
Att./Computer Pre	52.91	52.69	4.12	4.33
Att./Computer Pre	48.71	50.53	8.05	6.70

Table II

	T-Value	Probability
Math	1.0569	0.1478
Reading	0.5056	0.3106
Composite	1.4717	0.0717
Prob. Solve	-0.5342	0.3010
Computer Skill	10.5055	0.0001
Att./School Pre	0.2329	0.4059
Att./School Post	1.2159	0.1136
Att./Computer Pre	-0.1767	0.4274
Att./Computer Post	0.8663	0.2002

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Appendix A

Results of Analyses of Variance

and Analyses of Covariance

for Study Data

Analysis of Covariance for ITBS READING

with I.Q. as Adjusting Variable

DEPENDENT VARIABLE: 2

COVARIATE: 1

GROUP 1:

99	56
123	92
108	68
113	41
131	68
89	33
108	57
116	45
128	78
88	32
93	33
98	44
105	57
107	61
134	59
93	63
105	48
107	49
106	57
107	63

GROUP 2.

105	52
126	57
91	41
113	85
81	49
99	47
114	65
123	59
115	47
109	59
121	63
119	73
90	56
114	47
117	59
102	49
95	53
99	47
94	45
105	42
98	54
103	49
107	49

ANALYSIS OF COVARIANCE

SOURCE	ADJ. SS	DF	VAR.EST.
BETWEEN	19.22	1	19.22
WITHIN	3540.14	40	88.50
TOTAL	3559.35	41	

F-RATIO	0.22
SIGNIFICANCE	0.6485

GROUP	COVARIATE MEAN	DEPENDENT MEAN	ADJUSTED MEAN
1	106.40	54.80	55.14
2	107.39	54.09	53.79

GROUP	COVARIATE STD.DEV.	DEPENDENT STD.DEV.	N
1	11.75	14.73	20
2	13.99	10.00	23

Analysis of Covariance for ITBS COMPOSITE Scores with I.Q. Verbal as Covariante

DEPENDENT VARIABLE 2

COVARIATE 1

GROUP 1:

99	52
123	72
108	57
113	42
121	65
89	36
108	57
116	46
128	67
88	48
93	36
98	49
105	51
107	60
104	56
93	54
105	53
107	44
106	54
107	62

GROUP 2.

105	53
126	62
91	42
143	78
81	41
99	52
114	65
123	57
115	51
109	54
121	66
119	69
90	52
114	48
117	63
102	53
95	50
99	47
94	43
105	53
98	54
103	54
107	49

ANALYSIS OF COVARIANCE

SOURCE	ADJ. SS	DF	VAR.EST.
BETWEEN	22.00	1	22.00
WITHIN	1473.12	40	36.83
TOTAL	1495.11	41	

F-RATIO 0.60

SIGNIFICANCE 0.4515

GROUP	COVARIATE MEAN	DEPENDENT MEAN	ADJUSTED MEAN
1	106.40	52.40	52.70
2	107.39	54.39	54.13

GROUP	COVARIATE STD.DEV.	DEPENDENT STD.DEV.	N
1	11.75	9.79	20
2	13.99	9.13	23

Analysis of Covariance for ITBS MATH Scores

with Quantitative I.Q. as Covariate

[illegible] 2

GROUP 1:

112	58
109	59
100	[illegible]
86	38
111	71
106	38
100	59
104	47
119	63
114	52
95	39
111	50
102	51
111	56
106	53
83	56
101	57
100	45
102	45
106	57

GROUP 2.

109	52
113	59
102	48
116	70
87	36
112	52
112	63
104	52
106	47
116	54
125	62
125	62
98	47
93	43
90	58
111	48
104	51
95	52
100	43
117	61
109	56
97	56
91	[illegible]

ANALYSIS OF COVARIANCE

SOURCE	ADJ. SS	DF	VAR.EST.
BETWEEN	0.60	1	0.60
WITHIN	1982.41	40	47.96
TOTAL	1983.01	41	

F-RATIO 0.01

SIGNIFICANCE 0.9074

GROUP	COVARIATE MEAN	DEPENDENT MEAN	ADJUSTED MEAN
1	103.90	51.85	52.36
2	105.[illegible]	53.04	52.60

GROUP	COVARIATE STD.DEV.	DEPENDENT STD.DEV.	N
1	8.84	8.86	20
2	10.58	7.80	23

Analysis of Covariance for the PROBLEM SOLVING Test with Quantititave I.Q. as the Covariate

DEPENDENT VARIABLE: 2

COVARIATE: 1

GROUP 1:

112	31
109	53
100	27
86	27
111	32
100	32
104	27
119	38
114	29
95	17
111	23
102	32
111	36
106	31
83	30
101	25
100	25
102	31
106	36

GROUP 2:

109	[illegible]
113	35
102	29
116	27
87	21
112	32
112	25
101	26
105	23
116	[illegible]
125	[illegible]
125	[illegible]
98	[illegible]
93	18
90	32
111	[illegible]
103	32
95	[illegible]
120	26
117	[illegible]
109	[illegible]
94	[illegible]

ANALYSIS OF COVARIANCE

SOURCE	ADJ. SS	DF	VAR EST.
BETWEEN	38.32	1	38.32
WITHIN	1156.79	38	30.44
TOTAL	1195.11	39	

F-RATIO 1.26

SIGNIFICANCE .2682

GROUP	COVARIATE MEAN	DEPENDENT MEAN	ADJUSTED MEAN
1	103.79	30.47	30.85
2	106.27	29.23	28.98

GROUP	COVARIATE STD.DEV.	DEPENDENT STD.DEV.	N
1	9.07	6.84	19
2	10.65	5.47	22

Repeated Measure Analysis of Variance

for Attitude Toward School

--- A=1, B=1 ---

55	54	36	46	28	
41	32	42	53	32	51
44	42	36	38	51	52
52	54	52	38	33	54
48					

--- A=1, B=2 ---

48	47	50	47	31	
51	42	54	44	46	50
35	48	52	37	51	46
43	59	50	50	32	50
53	52	39			

--- A=2, B=1 ---

32	51	41	49	33	
41	28	26	38	30	45
52	41	30	42	48	51
46	37	26	39	43	41
31					

--- A=2, B=2 ---

46	42	46	46	30	
48	43	53	33	38	50
40	56	45	30	43	52
56	34	40	44	28	31
48	50	34			

ANOVA

DF	VARIANCE ESTIMATE	F-RATIO	SIGNIFICANCE
ROWS:			
1	538.24	8.27	0.0052
COLUMNS:			
1	201.70	3.15	0.0756
INTERACTION:			
1	5.10	0.08	0.7735
RESIDUAL:			
96	65.05		
TOTAL			
99	78.64		

ROW VAR.	N	MEAN	STD DEV.
1.	50	45.58	7.92
2.	50	40.94	8.5.

COLUMN VAR.	N	MEAN	STD DEV.
1.	48	41.77	8.68
2.	52	44.63	7.98

COMBINATION	N	MEAN	STD DEV
R1 & C1:	24	44.33	8.56
R1 & C2:	26	46.73	7.24
R2 & C1:	24	39.21	8.18
R2 & C2:	26	42.54	8.26

Repeated Measures Analysis of Variance for Attitude Toward Computers

--- A=1, B=1 ---

62	51	51	58	55	
57	42	57	50	53	50
52	56	55	53	54	48
52	48	51	51	50	55
56					

--- A=1, B=2 ---

57	58	55	53	38	
50	53	53	51	58	46
56	55	50	52	57	53
50	57	53	57	50	54
53	53	46			

--- A=2, B=1 ---

56	27	38	55	55	
51	52	48	53	32	47
53	51	52	54	44	51
52	55	56	50	50	53
56					

--- A=2, B=2 ---

46	43	48	55	52	
51	51	55	55	46	55
52	55	56	29	51	55
57	52	56	48	57	58
49	37	46			

ANOVA

DF	VARIANCE ESTIMATE	F-RATIO	SIGNIFICANCE
ROWS:			
1	237.16	6.42	0.0124
COLUMNS:			
1	15.33	0.42	0.5273
INTERACTION:			
1	19.53	0.53	0.4702
RESIDUAL:			
96	36.94		
TOTAL:			
99	38.57		

ROW VAR.	N	MEAN	STD DEV.
1:	50	52.74	4.17
2	50	49.66	7.45

COL. VAR.	N	MEAN	STD DEV.
1.	48	50.79	6.18
2	52	51.58	5.06

COMBINATION	N	MEAN	STD DEV.
R1 & C1:	24	52.79	4.89
R1 & C2:	26	52.69	4.33
R2 & C1:	24	48.79	6.16
R2 & C2:	26	50.46	6.81

Appendix B

Chi Square Analyses for Teachers' Perception of Student Abilities

Chi Square Analysis for Teachers' Perception of Student Interest in Computers

NUMBER OF OBSERVATIONS	17
CHI-SQUARE	0.0586
YATES' CORRECTION	0.0475
DEGREES OF FREEDOM	1
SIGNIFICANCE LEVEL	0.8087
CONTINGENCY COEF.	0.0555
CRAMER'S PHI PRIME	0.0556

Chi Square Analysis for Teachers' Perception of Student Ability with Computers

NUMBER OF OBSERVATIONS	17
CHI-SQUARE	2.9514
YATES' CORRECTION	1.9159
DEGREES OF FREEDOM	1
SIGNIFICANCE LEVEL	0.0858
CONTINGENCY COEF.	0.3846
CRAMER'S PHI PRIME	0.4167

Chi Square Analysis for Teachers' Perception of Student Computer Knowledge

NUMBER OF OBSERVATIONS	17
CHI-SQUARE	1.1462
YATES' CORRECTION	0.5124
DEGREES OF FREEDOM	1
SIGNIFICANCE LEVEL	0.2291
CONTINGENCY COEF.	0.2830
CRAMER'S PHI PRIME	0.2917

Chi Square Analysis for Teachers' Perception of Student Mathematics Ability

NUMBER OF OBSERVATIONS	17
CHI-SQUARE	0.7012
YATES' CORRECTION	0.1082
DEGREES OF FREEDOM	1
SIGNIFICANCE LEVEL	0.4024
CONTINGENCY COEF.	0.1990
CRAMER'S PHI PRIME	0.2031

Chi Square Analysis for Teachers' Perception of Student Problem Solving Ability

NUMBER OF OBSERVATIONS	17
CHI-SQUARE	0.5542
YATES' CORRECTION	0.0664
DEGREES OF FREEDOM	1
SIGNIFICANCE LEVEL	0.4566
CONTINGENCY COEF.	0.1777
CRAMER'S PHI PRIME	0.1806

Chi Square Analysis for Teachers' Perception of Student Composition Ability

NUMBER OF OBSERVATIONS	18
CHI-SQUARE	0.2222
YATES' CORRECTION	0.0000
DEGREES OF FREEDOM	1
SIGNIFICANCE LEVEL	0.6374
CONTINGENCY COEF.	0.1104
CRAMER'S PHI PRIME	0.1111

Chi Square Analysis for Teachers' Perception of Student Intelligence

NUMBER OF OBSERVATIONS	18
CHI-SQUARE	0.2222
YATES' CORRECTION	0.0000
DEGREES OF FREEDOM	1
SIGNIFICANCE LEVEL	0.6374
CONTINGENCY COEF.	0.1104
CRAMER'S PHI PRIME	0.1111

Appendix C

Examples of Measuring Instruments

Constructed for the Study

OBJECTIVE REFERENCED

PROBLEM TEST

EVALUATION SYSTEM

NAME _____

STUDENT NO. _____ DATE _____

TEACHER _____

SCHOOL _____

SCORE

PROBLEM SOLVING TEST

Section	Items	Skill	Score
I	1-5	Verbal Puzzles	_____
II	6-10	Analogies	_____
III	11-15	Verbal Sequences	_____
IV	16-20	Verbal Reasoning	_____
V	21-25	Numerical Sequences	_____
VI	26-30	Numerical Reasoning	_____
VII	31-35	Numerical Problem Solving	_____
VIII	36-40	Perception of Space	_____
IX	41-45	Mechanical Reasoning	_____

METROPOLITAN SCHOOL DISTRICT OF MT. VERNON

1000 WEST FOURTH STREET MT VERNON, INDIANA 47620

Verbal Puzzles

DIRECTIONS: Choose the best word to complete the sentence or answer the question.

1. The butcher sells
   a. beef
   b. cedar
   c. pencils
   d. glasses
   e. rye

2. The father of my cousin's sister is my
   a. uncle
   b. nephew
   c. father
   d. brother
   e. grandfather

3. Which of these words comes after the others in the dictionary?
   a. apron
   b. night
   c. after
   d. yes
   e. perhaps

4. The difference between a hero and a coward is that a hero
   a. has many friends
   b. is kind
   c. is handsome
   d. has courage
   e. is older

5. The word that goes with pillow, mattress, and sheet is
   a. bedroom
   b. sleep
   c. lamps
   d. blanket
   e. couch

II. Analogies

DIRECTIONS: Choose the word that fits the best.

6. A is to B as first is to
   a. last
   b. second
   c. alphabet
   d. grades
   e. two

7. Cousin is to dozen as niece is to
   a. nephew
   b. accent
   c. half-dozen
   d. sleep
   e. piece

8. Friday is to Thursday as June is to
   a. Saturday
   b. August
   c. Sunday
   d. May
   e. July

9. Vegetables is to corn as flower is to
   a. carrot
   b. berry
   c. banana
   d. rose
   e. pears

10. Sharp is to dull as thick is to
    a. dense
    b. deep
    c. solid
    d. thin
    e. fat

III. Verbal Sequence

DIRECTIONS: Choose the word or letter that should come next.

11. AA Z BB Y CC X DD
    a. E
    b. Y
    c. C
    d. Y
    e. W

12. lion, ion on flam lam ?
    a. ma
    b. no
    c. la
    d. fam
    e. am

13. ADA DAA AAD
    a. EHE
    b. HHE
    c. EEH
    d. HEH
    e. EHH

14. swim walk fly water land ?
    a. air
    b. island
    c. wind
    d. kite
    e. ocean

15. ACC DFF GII J?
    a. F
    b. H
    c. J
    d. K
    e. L

IV. Verbal Reasoning

DIRECTIONS: Choose the best answer.

16. John is older than Carlos. Ann is older than John. Patrick is younger than John. We know that
    a. Ann is older than Patrick
    b. Ann is younger than Patrick
    c. John is older than Ann
    d. Carlos is older than Patrick
    e. Ann is younger than Patrick

17. There are 3 books on a shelf. Two are the same color and one is a different color. If a blue book is taken from the shelf, which CANNOT be true?
    a. the books that are left are red
    b. the books that are left are blue
    c. one of the books left is green
    d. the books that are left are the same color
    e. the books that are left are not the same color

18. Apple long winter snow peach. After all of these words have been found, what word could come next in the dictionary?
    a. firm
    b. pick
    c. worm
    d. after
    e. warm

19. The president has a higher office than the governor. The mayor has a lower office than the governor.
    a. the mayor is higher than the governor
    b. the president is lower than the mayor
    c. the mayor is higher than the governor
    d. the mayor is lower than the president
    e. the governor is higher than the president

20. Peter can run faster than Tom. Ralph is slower than Tom. Ralph is faster than Dave. Which is true?
    a. Peter is faster than Dave
    b. Dave is faster than Tom
    c. Ralph is faster than Peter
    d. Tom is slower than Peter
    e. Peter is slower than Ralph

V. Numerical Sequences

DIRECTIONS: Choose the number that comes next in sequence.

21. 10, 8, 6, 4
    a. 5
    b. 3
    c. 2
    d. 1
    e. 0

22. 12, 6, 10, 5, 8
    a. 4
    b. 10
    c. 12
    d. 16
    e. 24

23. 9, 4, 12, 7, 15
    a. ~~20~~ 10
    b. ~~21~~ 11
    c. ~~22~~ 12
    d. ~~23~~ 13
    e. ~~24~~ 14

24. 7, 6, 5, 4
    a. 2
    b. 3
    c. 4
    d. 5
    e. 6

25. 4, 10, 8, 3, 9, 7, 7, 13
    a. 9
    b. 10
    c. 11
    d. 14
    e. 19

VI. Numerical Reasoning

DIRECTIONS: Answer the questions by choosing the best response.

26. Which number added to 6 makes 4 less than 15?
    a. 9
    b. 11
    c. 5
    d. 7
    e. 3

27 Which number divided by 2 leaves 3 less than 7?
    a. 3
    b. 4
    c. 6
    d. 7
    e. 8

29. What number, if multiplied by 3 is equal to 2 times 5?
    a. 2
    b. 4
    c. 6
    d. 8
    e. 10

30. What number is multiplied by 4 is equal to 2 times 12?
    a. 4
    b. 5
    c. 8
    d. 7
    e. 6

31. What number is 1/4 of 4 times 5?
    a. 2
    b. 3
    c. 4
    d. 5
    e. 6

VIII. Numerical Problem Solving

32. Four boys bought some candy bars. If 2 of the boys bought 2 each and the rest bought 1 each, how many candy bars did they buy?
    a. 4
    b. 5
    c. 6
    d. 8
    e. 10

33. Mary has 45 baseball cards. Her brother Dan has 75. How many cards would Dan need to give Mary so that they would have the same number of cards?
    a. 10
    b. 15
    c. 30
    d. 45
    e. 60

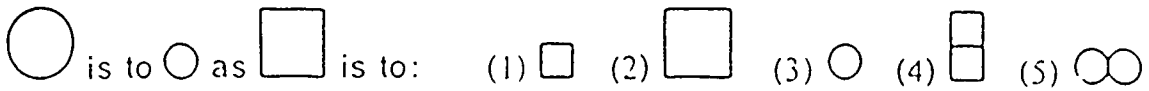
34. If you buy two 50¢ candy bars and one $1.00 candy bar, how much money will you have left from a $5.00 bill?
    a. $1.00
    b. $2.00
    c. $2.50
    d. $3.00
    e. 3.50

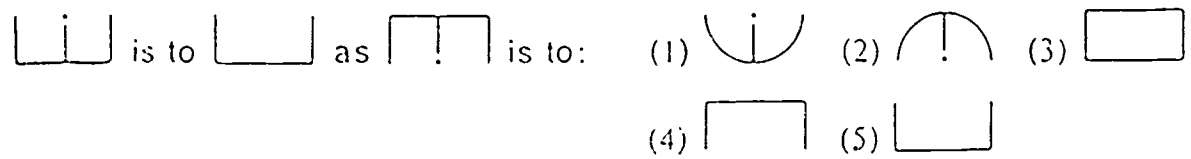
35. Mary's boat can travel 18 miles in three hours. How far can it go in five hours?
    a. 30 miles
    b. 24 miles
    c. 12 miles
    d. 15 miles
    e. 60 miles

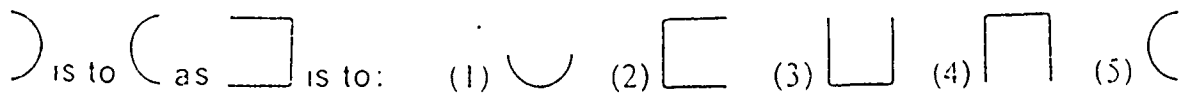
36. Peter can run around the block 3 times in 12 minutes. How many times can he run around the block in 32 minutes?
    a. 2
    b. 7
    c. 8
    d. 9
    e. 10

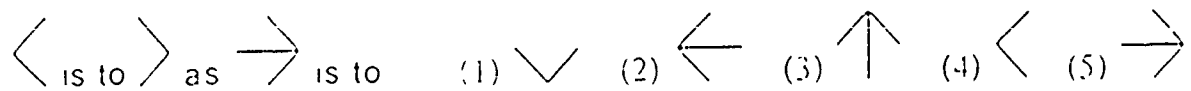
VIII. Perception of Spaces

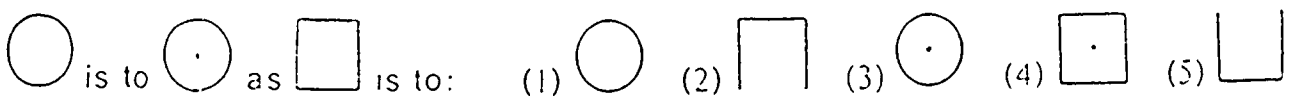
DIRECTIONS: Choose the diagram on the right that matches the puzzle on the left.

36.  is to as is to: (1) (2) (3) (4) (5)

37.  is to as is to: (1) (2) (3) (4) (5)

38.  is to as is to: (1) (2) (3) (4) (5)

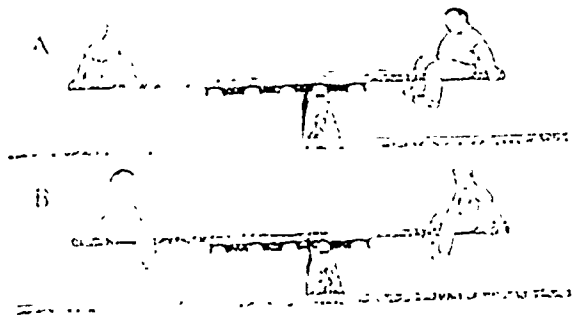
39.  is to as is to (1) (2) (3) (4) (5)

40.  is to as is to: (1) (2) (3) (4) (5)

PLEASE TURN TO NEXT PAGE

IX. Mechanical Reasoning

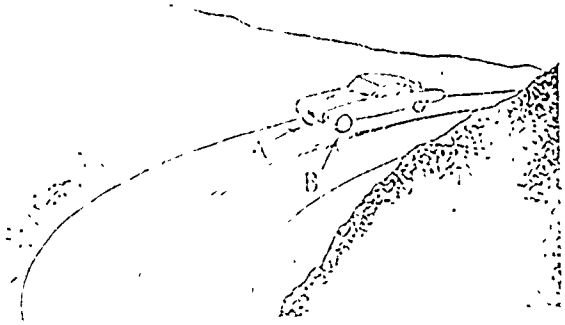
DIRECTIONS: Answer each of the questions below matching a, b, or c.

41. 

Which picture shows how the two boys will balance better?
(If no difference, mark C)

42. 

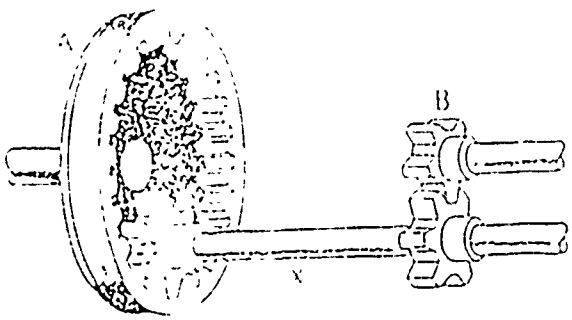
On which part of this race track will a very fast car make the turn?
(If either, mark C)

43. 

As this car goes around the turn, which tire presses harder on the road?
(If no difference, mark C)

44. 

Which gear turns opposite to the drive?

45. 

Which gear turns the same way as shaft "X"?
(If both, mark C)

OBJECTIVE REFERENCED

4

Computer Class:

EVALUATION SYSTEM

NAME _____

STUDENT NO. _____ DATE _____

TEACHER _____

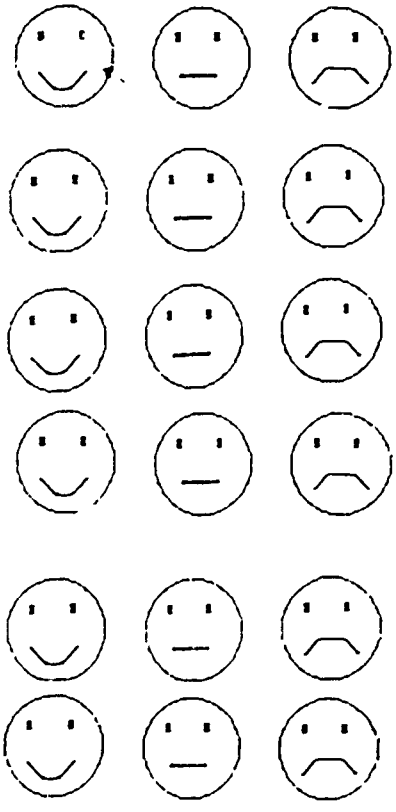
SCHOOL _____

SCORE School Computer

About My School

Directions: During the next few minutes you are going to look at some faces and I am going to ask some questions about how you feel. Some of the faces show children who are happy and glad. Some of the faces show children who are neither happy or sad. Some of the faces show children who are sad. If you feel good about the question, draw a cross (X) through the smiling face. If you feel neither good or bad, draw a cross (X) through the plain face in the middle. If you feel bad about the question, draw a cross (X) through the frowning face.

1. How do you feel when it's time to go to school?
2. How do you feel when you think about school next year?
3. How do you feel when you think about the way teachers treat you?
4. How do you feel when it's time to get out your books and start to work?
5. How do you feel when school is over at the end of the day?
6. How do you feel about having a chance to learn something new?



7. How do you feel when your neighbors ask you if you like school?

8. How do you feel when your summer vacation is over and it's time for you to go back to school?

9. If your teacher said, "We are not going to have school today," how would your face look?

10. You and your friends are talking about school How would your face look?

11. At home during dinner, you tell your parents about school. How would your face look?

12. How do you feel when school is called off because of snow?

13. How do you feel when you have to ask a teacher for help?

14 Your class is taking a test Show how you feel about tests?

15 If you were going to tear down a school to build a highway, how would your face look?

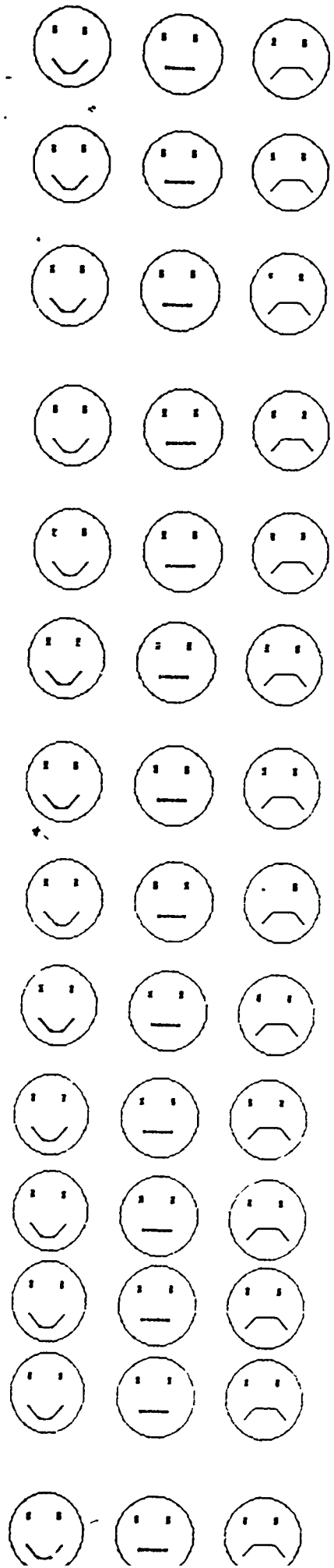
16. Your teacher hands out report cards to the class Which is your face?

17 At lunch time, you and your friends are talking about school. Which is your face?

18. How would you feel if the school burned down?

19 It is the end of math class The teacher says, tomorrow we will have more time to study Which face shows how you feel?

20. How would you feel if the law said that you didn't have to go to school any more?



ABOUT COMPUTERS

Directions. Please listen as your teacher reads each of the sentences below.
Place a cross (X) on the word that agrees with how you feel about it

21.	I am crazy about computers.	YES	DON'T KNOW	NO
22.	If I had my way, everybody would have to study computers	YES	DON'T KNOW	NO
23.	Computers are one of the most useful things I know.	YES	DON'T KNOW	NO
24	Computers amaze me	YES	DON'T KNOW	NO
25	Computers help you learn in school	YES	DON'T KNOW	NO
26.	I enjoy computers	YES	DON'T KNOW	NO
27	Computers are interesting	YES	DON'T KNOW	NO
28.	Computers aren't perfect, but I like them	YES	DON'T KNOW	NO
29.	I like computers a little	YES	DON'T KNOW	NO
30	I like computers about as much as I don't like them	YES	DON'T KNOW	NO
31.	Computers are ok for some people, but I don't like them	YES	DON'T KNOW	NO
32	Computers aren't bad, but they are boring	YES	DON'T KNOW	NO
33	Computers are bad sometimes	YES	DON'T KNOW	NO
34	Computers don't work very well	YES	DON'T KNOW	NO
35	Computers don't interest me	YES	DON'T KNOW	NO
36	Nobody likes computers	YES	DON'T KNOW	NO
37.	Computers are like a disease	YES	DON'T KNOW	NO
38	Life would be better without computers	YES	DON'T KNOW	NO
39	Computers are a waste of time and money	YES	DON'T KNOW	NO
40.	I hate computers	YES	DON'T KNOW	NO

Apperdix D

Summary Table of Data

Obtained in the Study

File: Marrs School
1
Report: MARRS (Control)

Student #	Section	Computer Skills Material	Attitude/School Post Test	Attitude/School Pre Test	Attitude/Computer Post Test	Attitude/Computer Pre Test	Problem Solving	Iowa Reading	Iowa Math	Iowa Composite	I.Q. Verbal	I.Q. Quantitative	I.Q. Nonverbal
		AtS	AtS	AtC	AtC	PR	Io	Io	Iow	IQ	Cod	Code
1	a	5	32	55	56	62	31	56	58	52	99	112	112
2	a	9	51	54	27	61	50	92	59	70	123	109	119
3	a	13	41	36	38	51	27	68	49	57	108	100	122
4	a	-	49	46	55	58	27	41	38	42	113	86	92
5	a	8	33	28	55	55	-	-	-	-	-	-	-
6	a	7		-	42	-	19	48	49	49	-	-	-
7	a	7	34	-	60	-	28	39	42	39	-	-	-
8	a	7	41	41	51	57	32	68	71	65	131	111	104
9	a	8	28	32	52	42	-	33	38	36	89	106	101
10	a	9	26	42	48	57	25	34	39	36	-	-	-
11	a	8	38	53	53	60	32	57	59	57	108	100	104
12	a	8	30	32	32	53	27	45	41	46	116	104	102
13	a	10	45	51	47	50	38	70	63	67	128	119	131
14	a	9	52	44	33	62	31	56	59	54	-	-	-
15	a	9	47	42	51	56	29	32	52	40	88	114	106
16	a	8	30	36	52	55	17	33	39	36	93	95	88
17	a	7	42	38	54	53	23	51	42	42	-	-	-
18	a	5	47	51	44	54	23	44	50	49	98	111	100
19	a	8	51	52	51	48	32	57	51	51	105	102	106
20	a	8	46	52	52	52	36	61	56	60	107	111	133
21	a	8	37	54	55	49	31	59	53	56	104	106	99
22	a	11	26	52	56	51	30	63	56	54	93	83	100
23	a	13	39	38	50	51	25	48	57	50	103	101	106
24	a	8	13	33	50	50	25	49	45	44	107	100	96
25	a	8	47	54	53	55	31	57	45	54	106	102	117
26	a	6			42		30	59	49	57	-	-	-
27	a	6	31	48	56	56	36	63	57	62	107	106	105
28	a	9	37		49		26	44	46	44	-		-

File. Marrs School
1
Report: MARRS (Experimental)

Student #	Section	Computer Skills Material	Attitude/School Post Test	Attitude/School Pre Test	Attitude/Computer Post Test	Attitude/Computer Pre Test	Problem Solving	Iowa Reading	Iowa Math	Iowa Composite	I.Q. Verbal	I.Q. Quantitative	I.Q. Nonverbal
		Ats	AtS	AtC	Atc	PR	Io	Io	Iow	IQ	Coa	Code
1	b	18	46	48	46	57	30	52	52	53	105	109	102
2	b	18	42	47	48	58	35	57	59	62	126	113	103
3	b	17	46	50	48	55	29	41	48	42	91	102	103
4	b	17	46	47	55	53	27	85	70	78	143	116	122
5	b	16	30	31	52	38	21	49	36	41	81	87	97
6	b	17	48	51	51	50	32	47	52	52	99	112	102
7	b	18	43	42	51	53	25	65	63	65	114	112	105
8	b	18	53	54	55	53	26	59	52	57	123	104	109
9	b	18	33	44	55	51	23	47	47	51	115	106	109
10	b	17	38	46	46	58	25	59	54	54	109	116	112
11	b	17	50	50	55	48	28	44	48	47	-	-	-
12	b	17	40	35	52	56	41	63	62	66	121	125	111
13	b	17	56	43	55	55	36	70	62	69	119	125	114
14	b	18	45	52	53	50	31	56	47	52	90	98	95
15	b	18		-		-	14	-	-	-	-	-	-
16	b	17		-	45	-	31	65	57	64	-	-	-
17	b	17	30	37	29	52	18	47	43	46	114	93	100
18	b	18	43	51	51	57	32	59	58	63	117	90	104
19	b	18	52	46	55	53	30	49	48	53	102	111	131
20	b	17	56	43	57	50	32	53	51	50	95	104	91
21	b	18	34	59	52	57	20	57	45	51	-	-	-
22	b	17	40	50	56	53	30	47	52	47	99	95	93
23	b	17	44	58	40	57	23	52	44	44	-	-	-
24	b	18	-	-	-	-	26	45	43	43	94	100	101
25	b	18	28	32	57	50	30	42	51	53	105	117	111
26	b	17	31	50	58	54	38	54	56	54	98	109	115
27	b	-	48	53	49	53	-	49	56	51	103	97	92
28	b	18	50	52	37	53	36	63	65	67	-	-	-
29	b	13	34	39	46	46	26	49	48	49	107	94	107

Appendix E

Computer Skills Test Objectives

COMPUTER SKILLS TEST OBJECTIVES

Keyboarding

1. Find home row.
2. Type students' names.
3. Find function keys on computer keyboard.

Computer Literacy

4. Boot disk containing computer programs.
5. LOAD a program from the disk.
6. COPY a program from one disk to another.
7. RUN a program.
8. Understand that a computer is defined as a programmable machine that allows a person to input information so that it can then process, store, and output the information.
9. Type the name of the part of a computer that
    a. Allows one to enter data
    b. Displays output data
    c. Stores programs so that they can be placed into the computer's memory
    d. Prints information on paper

Word Processing

10. Boot Bank Street Writer
11. Get a file from the data disk.
12. Change a word throughout the data.
13. SAVE the changes.
14. CLEAR the data.
15. RECALL the data.
16. PRINT the data on the printer.

Post Hoc Study #1

The Effect of Class Assignment on Student Achievement

In an attempt to learn more about the effects of the project, a study was conducted to ascertain what effect class assignment may have had on student achievement. The study was a post hoc comparison since it was not included among the original hypotheses.

Scores representing achievement were compared on three subtests of the Iowa Test of Basic Skills (ITBS). Subtests scores compared were Reading, Mathematics, and Composite. The class assignments were as follows.

3rd grade Assignment	4th grade Assignment
A	A
A	B
B	A
B	B

Subjects were randomly assigned to classes in both grades 3 and 4. There was no planned difference in instruction in grade 3. Grade four assignments differed in that those in section A attended classes with one computer in the back of the classroom and those assigned to the B section attended classes with computer for each two students.

Results were analyzed in two ways. First, the scores were treated as raw scores and were analyzed by a one-way analysis of variance. Second,

with the third grade scores as a covariate, an analysis of covariance was performed. Results are contained in Tables 1A and 1B below.

Table 1-A

Analysis of Variance Results for Class Assignment

Group Means

	N	Reading	Math	Composite
3A,4A	10	52.6	52.4	52.9
3A,4B	14	59.4	54.0	55.5
3B,4A	10	50.9	51.3	51.9
3B,4B	9	53.0	51.6	52.7

Analysis of Variance

Subtest	F Ratio	Significance
Reading	1.15	0.34
Math	0.25	0.86
Composite	0.33	0.8.

The results of the Analysis of Variance for the classification group means indicates that there were no differences between group means that were statistically significant at the .05 level. The only difference that approached significance was the difference between reading scores for Groups 3B, 4A (X=50.9) and 3A,4B (X=59.4). Further analysis showed that the difference between these two means was not significant at the .05 level. The level of significance for these differences was P= 0.10, which was not a significant difference.

Table 1-B

Analysis of Covariance Results for class assignments
Group Means

	Reading			Math			Composite		
Group	Gr. 3 (Co. Var)	Gr. 4 (Dep)	Gr. 4 (Adjust)	Gr. 3 (Co. Var)	Gr. 4 (Dep)	Gr. 4 (Adjust)	Gr. 3 (Co. Var)	Gr. 4 (Dep)	Gr. 4 (Adjus)
3A,4A	40.70	52.60	53.10	36.19	52.40	51.35	39.50	52.90	51.95
3A,4B	42.29	50.43	53.36	34.93	54.30	53.90	39.64	55.50	54.39
3B,4A	42.73	50.20	49.42	35.20	51.30	51.09	38.30	51.90	51.96
3B,4B	38.44	58.05	56.74	38.22	51.51	53.04	36.22	52.67	55.37

	F Ratios	Significance
Reading	3.35	.03
Math	0.57	.64
Composite	1.66	.19

Results for analysis of covariance indicated that the difference between reading scores were significant ($p < .03$) and favored the experimental group. Differences between the means of mathematics and composite subtests were not significant at the .05 level.

Post Hoc Study #2

The Effect of Treatment Groups on

Student Achievement Gains

In an attempt to complete further analysis of the project, a study was conducted to ascertain what effect group assignment may have had on gains of student achievement. The study was a post hoc comparison since it was not included among the original hypotheses.

Scores representing achievement were compared on three subtests of the Iowa Test of Basic Skills (ITBS). Subtest scores compared were Reading, Mathematics, and Composite. The class assignments were as follows.

4th grade assignment
A
B

Subjects were randomly assigned to classes in both grades 3 and 4. There was no planned difference in instruction in grade 3. Grade four assignments differed in that those in section A attended classes with one computer in the back of the classroom and those assigned to the B section attended classes with one computer for each two students.

Results were analyzed in two ways. First, the difference between third and fourth grade scores were analyzed by a t-test. Second, with the third grade scores as a covariate, an analysis of covariance was performed. Results are contained in Table 24 and Table 25 below.

Table 2-B contains the results of the analysis of covariance for differences between the means of the posttest when scores are corrected for differeinces in the pretest results of the two groups.

When mean scores are adjusted to compensate for differences in the covariate (3rd grade achievement test scores) the differences between reading means and the difference between composite means were both significant.

This confirms the results found in the t-test (Table 2-A).

The gains in reading and composite scores were significant and favored the experiental groups. The gains in mathematics favored the experimental group, but were not statistically significant.

Table 2-A

Results of t-test for Experimental and Control Groups

	Mean Scores		
Group A (Control)	Reading 11.55	Math 10.2	Composite 10.4
Group B (Experimental)	13.13	11.7	12.1
T Value =	2.61	1.9	2.14
Significance =	.006	.03	.02

From the results of Table A, it can be seen that the gains on the reading (PL .006) and composite (PL .02) subtests were significant. The gains on the mathematics subtest were almost significant (PL .03) at the

When gain scores are used as a dependent variable, the results for two variables were significant and favored the experimental group.

Table 2-B

Analysis of Covariance Results for Class Assignments

Group Means

	Reading			Math			Composite		
Group	Gr. 3 (Co. Var)	Gr. 4 (Dep)	Gr. 4 (Adjust)	Gr. 3 (Co. Var)	Gr. 4 (Dep)	Gr. 4 (Adjust)	Gr. 3 (Co. Var)	Gr. 4 (Dep)	Gr. 4 (Adjust)
AA	41.70	51.75	51.26	35.[illegible]	51.55	51.[illegible]	[illegible]	[illegible].30	51.56
AB	49.73	54.91	57.34	54.[illegible]	57.[illegible]	57.12	[illegible]	54.39	54.73

	Ratio	Significance
Reading	7.91	.01
Math	1.64	.20
Composite	4.32	.03