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ABSTRACT

An ever-increasing number of classrooms are being equipped with computers. This trend began in the early 1970s and the numbers continue to swell at a more rapid pace each year. All facets of the computer world continue to multiply. Issues involving technology in schools will receive more and more attention, if not from internal sources then from society. The irresistible force of the Information Age, technology has not been dealt with in a manner that satisfies any one particular group. Technology should not be judged in isolation. This study was conducted in two fifth grade classrooms during the 1996-1997 school year. Subjects in the study were randomly selected by a computer and the students making up this study came from diverse backgrounds. The purpose of this study was to determine if Computer Assisted Instruction (CAI) makes a significant difference in test scores. Results indicate that no significant difference existed between the two groups. (Contains 27 references.) (Author/NB)

Computer Assisted Instruction

versus

Classroom Instruction

(Mathematics)

A Thesis

Presented to

The Faculty of the Master of Arts Degree Program

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by

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ABSTRACT

An ever-increasing number of classrooms are being equipped with computers. This trend began in the early 1970's and the numbers continue to swell at a more rapid pace each year. All facets of the computer world continue to multiply. Issues involving technology in schools will receive more and more attention, if not from internal sources, then from society. The irresistible force of the Information Age technology has not been dealt with in a manner that satisfies any one particular group. Technology should not be judged in isolation.

This study was conducted in two fifth grade classrooms during the school year 1996-1997. Subjects in this study were randomly selected by a computer. The students making up this study came from a diverse background.

The purpose of this study was to determine if Computer Assisted Instruction does make a significant difference in test scores. The results of this study show that no significant difference exists between the two groups.

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Chapter 1

Introduction

During the school year 1988-89 Gaston Caperton was sworn in as the thirty-first Governor of West Virginia. He immediately addressed the mounting problems confronting the public schools with respect to technology and education. Regarding student computer literacy, the status quo would no longer be acceptable, and in most areas of the state a complete overhaul was imminent. Wetzel County, immediately initiated an attempt to prepare for the Information Age. The Superintendent, recognizing the importance of preparation, scheduled unprecedented inservice sessions, including summer academies in an attempt to bring the teachers into this new era. It became an exciting time for most, and a threatening time for others, with no one being a bystander.

Within twelve months a computer lab was established in each elementary school. Kindergarten and first grade were to be the first exposed to "Computer Assisted Instruction." The naysayers grudgingly accepted this new technology. The life of the teacher would change; the life of the student would be impacted forever.

The installation of computer labs would progress up the ladder, eventually including all grade levels through the elementary schools, with the high schools to receive computer labs as expediently as possible. The Jostens Learning System was installed. Within four years all grades would be provided a minimum of 45 minutes each week for math instruction and an equal amount of time for reading.

The purpose of this study was, therefore, to determine the significance of Computer Assisted Instruction on academic gains, comparing students receiving CAI and students receiving an equal amount of classroom practice and instruction.

Research Questions

1. What is the opinion of educators on the use of computers as part of the curriculum?
2. How has Computer Assisted Instruction influenced test scores in the a computer lab setting?
3. Does the use of computers improve student understanding of mathematics?

Hypothesis

Ho: There will be no significant difference in academic achievement between students receiving Computer Assisted Instruction and those receiving an equal amount of classroom practice and instruction.

Assumptions

It is assumed that each group of students will receive an equal amount of time concerning the given lessons.

It is assumed that the testing instrument independently prepared at the New Martinsville School and Jostens provides a score that measures the intended goal.

It is assumed that the sample groups adequately reflect the entire New Martinsville School and also adequately represent a sample group in both size and composition.

Importance of the Study

The Wetzel County Board of Education, in compliance with the standards established by the State Department of Education of West Virginia, has decreed that every student in the elementary/middle school setting will receive a minimum of 45 minutes per week of math instruction in a computer lab. This represents between 12.5% and 20% of the time allocated for mathematics in the schedule for the New Martinsville School. Because of this dedication of time, a study to evaluate the effectiveness of this program will be conducted.

The Schools-to-Job (Career) program is being promoted as the wave of the future. Concerned citizens are concerned with the direction this trend is taking education. They want to be fully informed about the objectives of this and other programs, especially with respect to the outcome versus the expense. In every aspect of education, funding will be watched more closely.

With computer labs being an expensive purchase, they are being scrutinized (Dwterm 1994). Popularity is being judged against effectiveness, and no concrete results linking the computer labs in the elementary schools are forthcoming. Previously held opinions about computer training and computer instruction are presently under microscopic observation (Dwyer, 1994).

Definition of Terms

Computer Assisted Instruction (CAI) - Instruction derived from Programmed Instruction using a computer to steer the student through the particular program (Emerson, 1989).

Computer Managed Instruction (CMI) - Instruction that is adjusted by the teacher to reflect his/her standards (National Institute of Education, 1977).

Computer Skill - Anything that an individual has learned to do with ease and precision (Wood, 1968).

CRT - Criterion Referenced Test

Electronic Text (ET) - Exercises where the computer acts only as a page turner to advance the student through computerized lecture notes (Emerson, 1988).

Essentialism - This philosophical approach emphasizes a core of subject matter for mastery by all students (Ediger 1989).

Programmed Instruction (PI) - Instruction presented in a series of sequential questions (Cohen, 1962).

Socratic Dialogue (SD) - The part of Programmed Instruction which links the individual with the curriculum through questions (Cohen,1962).

Chapter 2

A LITERATURE REVIEW OF RELATED DATA

A Historical Perspective

Technology is not only a product of a given culture, it also shapes the culture that created it. Archimedes was a fan of the lever, a piece of technology that must have been state-of-the-art during his time. Learning to use the fulcrum and lever is one of the things that separates human beings from other animal species (Mehlinger, 1996). While not every student exhibits this enthusiasm for technology it has been used all over the earth to make life easier.

Society has been driven by technology throughout the ages, from the wheel to the computer (Emerson, 1988). It therefore stands to reason that schools should be driven to teach necessary technology. The computer is the definitive term at this point in history relative to technology in schools. The existing struggle with this technology has played out in several different methods.

The popularizing of Programmed Instruction (PI) by B. F. Skinner in the early 1950's continues to be a lasting component in today's educational system. Instruction presented in this manner offered a series of sequential questions that followed the Socratic Dialogue (SD) thus linking the individual with the curriculum. This method allowed the learner to select one of a series of answers and then advanced the learner when a "correct" answer was selected (Cohen, 1962). Choosing incorrectly sent the learner into a series of review/remedial lessons. Skinner's PI consisted of a box containing cards and lights, which were later replaced with workbooks, which were then replaced with Computer Assisted Instruction (CAI). Most CAI tutorials are direct computerized derivatives of the PI professed by Skinner using the computer to steer the student through the program (Emerson, 1988).

The Essentialist Manifesto stressed that all students must master a common set of mathematics goals (Bagley, 1938). This was necessary to prepare students of today to become responsible citizens of tomorrow (Ediger, 1989). Modern educational approaches are be driven by this essentialistic approach. An increase in state mandated objectives has forced school districts to be "basic" oriented. Essentialism fits like a glove with this belief that the core subject matter achieve a certain mastery level. The mathematics textbooks provide a scope and sequence for each lesson for all students (Computer Teacher, 1995). The established goals and objectives are identified both locally and state-wide, thus forcing an adherence to a common level regardless of the differences in student ability. As an outgrowth of these goals and objectives school boards select software based on its ability to offer sufficient drill and practice to accomplish the intended goals of mastery.

Only recently have schools begun to look at software that will provide materials for students of diverse abilities and interest levels. Ultimately, one or more philosophies may be incorporated to emphasize problem solving, idea centered curricula and decision making skills (Dwyer, 1994).

Trends

An ever-increasing number of classrooms are being equipped with computers. This trend began in the early 1970's and the numbers continue to swell at a more rapid pace each year, with its zenith occurring in 1994. All facets of the computer world continue to multiply. Every year there is a 50% to 100% increase in the number of people using the internet (Van Horn, 1996).

The following questions govern the present discussions about the future use of computers in the classroom (Caissy, 1984):

1. Which criteria need to be followed in selecting computers that harmonize with objectives of the school and class?

2. When selecting computer software, which set of standards should be utilized?

3. How might computers be utilized in problem solving activities in the curriculum?

4. How might programmed learning be utilized to provide for individual differences?

5. Which guidelines must be followed to assist learners to attain optimally while using computerized drill experiences?

6. How might simulations and games involving computer usage assist students to develop decision-making skills?

Questions such as these will be answered in different ways. Each district must mesh its general philosophical approach to education with its intended goals in the computer lab field. Research suggests that training be the essential ingredient once the decision is made to make computers an integral component of the curriculum (Tenth Planet, 1995).

Issues involving technology in schools will receive more and more attention, if not from internal sources, then from society. The irresistible force of the Information Age technology has no comparable immovable object. "It is impossible both to participate fully in the culture and yet resist its defining features" (Mehlinger, 1996, p. 402).

Other Research and Studies

Although volumes of related research are not readily available, the research supports the installation of computer labs when possible (Tenth Planet, 1995). When discussing the CAI teachers point to surveys more often than research. Research does not absolutely prove or disprove the expected outcomes of teachers and/or administrators (Tenth Planet, 1995). Surveys such as those provided by the statistics from California Elementary School Teachers propose the type of information that is generally studied. In this particular study the following was obtained from the teachers surveyed (Tenth Plant, 1995):

92% believe computers are powerful motivators to improve learning
77% use PCs at school in a typical week
65 % use them for direct instruction
71% have at last one PC in their classroom
65% say they do not get enough training and support
43% say they do not have enough computers in the classroom
56% have 30 or more students in their class

However, even with this seemingly strong endorsement, Cheryl Vedoe, CEO and president of Tenth Planet Explorations, Inc. says, "Still, the survey identifies factors which are holding back the full integration of computers as a powerful teaching tool. California teachers want - and deserve - more training and greater numbers of up-to-date computers (Tenth Plant, 1995, p. 2)."

Two other intriguing studies with diverse results have illustrated reasons for students to have access to computers. These studies, among numerous others, examine the variety of philosophical approaches that can and will be observed in educational circles (Computing Teacher, 1995).

Increasing motivation is often cited as the principle reason for computerizing the schools. This, however, is difficult to measure, especially among the culturally disadvantaged (Mevarech, 1985). Motivation is not being measured in many studies.

A 1994 study commissioned by the Software Publishers Association concluded among other things that educational technology has positive effects on student attitudes (Computing Teacher, 1995). This study went on to endorse student use of a computer lab by stating that positive changes in the learning environment evolve over time and do not occur quickly. "While this study was commissioned by an organization that had a stake in the results, the conclusions seem consistent with other research findings, especially with those of the Apple Classrooms of Tomorrow (ACOT)" (Mehlinger, p. 405, 1996).

Secondly, research found that more than 90% of the students who had "high computer access" were planning to attend college (Dwyer, 1994). High schools are challenged to increase the number of students who graduate and attend college (Dwyer, 1994). As a means of justifying itself, the school must also be fluent in providing certain powerful software tools, as this will be crucial to many young job seekers (Van Horn, 1996). "The successful transformation of student learning and accomplishment in the next decade requires effectively bringing together three agendas - an emerging consensus about learning and teaching, well-integrated uses of technology, and restructuring the current system" (Sheingold, p. 4, 1996).

Compatible Research

Comparative educational studies are plagued by one burning question: Are the differences between groups due to the different instructional strategies or are they due to factors extraneous to the instructional strategies (Kulik & Kulik, 1986)? Careful identification and elimination of these extraneous variables are essential to the validity of these studies (Kulik & Kulik, 1986). So monumental is this task that few serious researchers continue to be involved in comparative studies. The need to have educational strategies weighed against one another should be a prime motivator in forcing new considerations of these problems (Gleason, 1981).

Most comparative studies involving computer based education have been between CAI, (such as drill and practice, simulation and tutorial) and traditional lecture methods and have generally shown the superiority of CAI (Kulik & Kulik, 1986). While computers labs furnish a wide variety of methods and groupings for research, studies in mathematics will in general provide the desired and necessary comparisons used in this section.

The first related study to be presented was conducted in Israel, at the Weizmann Institute of Science(Zehavi, 1988). It concluded that eighth-grade students (n=54) who used a standard classroom textbook were at a low state of readiness for examining graphs, whereas students (n=84) who used software designed by a curriculum project exhibited high readiness (Zehavi, 1988). The software designed for this experiment attempted to focus on the intuitive understanding of graphs with verbal descriptions. Instruction was informal and concentrated on changing linear equations into graphic solutions. Transferring of such data requires a certain amount of intuitiveness as well as prior preparation (Zehavi, 1988). This would be comparable to requiring a fifth grader to make up a bar graph from a series of number sentences (Zehavi, 1988).

Research was also conducted with seventh-graders (n=78, experimental; n=77, control). The software remained unchanged. The seventh-graders likewise showed higher intuitive understanding. Retention was measured eight months later. A significant retention of what had been learned was found among both experimental groups.

Another study completed at the Weizmann Institute tested seventh- and eighth-graders (Zehavi, 1988). Information gained enabled the researchers to suggest that teachers use the newly created software in Grade 7 and again in Grade 8 to increase the likelihood of success. This project proved to be useful in its long range importance. Recommendations were made that students should enjoy a related activity in a timely manner upon completion of the initial activity. Software offers activities which teach the two-way transfer skill between point and rule. Advantages such as multiple linked representation, dynamic interaction and constructive feedback were noted. From t-test analysis the control group showed a significant ($p < 0.05$) decrease on all sections from the post treatment test to the retention test (Zehavi, 1988).

The Medgar Evers College conducted research using CAI and Computer Managed Instruction (CMI) (Wood, 1968). A logical hierarchy of objectives was used to form the evaluation process. A skill was defined as anything that an individual has learned to do with ease and precision (Wood, 1968). Students formed a heterogeneous mix of ages, background and preparation - the average age of 29, 70 percent women, 98 percent minority and 85 percent requiring mathematics remediation.

The work was divided up into four specific areas: CAI + NONCAI, CAI + TUTORS, CAI ONLY, AND NO CAI. These four categories were rotated over selected periods of time. During the first three semesters students received approximately equal amount of CAI and classroom instruction. The next set of three semesters provided CAI with tutoring, although tutoring was optional. During the next three semesters the students received only CAI, and lastly, no CAI instruction was provided for the fourth set, however this set represented seven semesters of study.

Passing rates of CAI and Non-CAI were comparable but attrition rates were lower in CAI. Other findings included:

1. Computers play an important role in individualization.

2. The passing rates improve when use of computers, tutoring and instruction are integrated.

3. Released time for faculty working on these activities is also an important factor.

Other important research information was forcoming from this study. Evaluating effectiveness of a program must include other criteria such as students' attitudinal changes and students' relative improvement. These should be analyzed easily using a computerized management system. Even though the observations in this article are very specific, the problem of remediation is long standing and difficult to solve (Nagarkatte, 1989).

Few studies have attempted to compare the CAI tutorial with its non-computerized pedagogical roots: SD & PI (Emerson, 1988). The Electronic

Text (ET) and Printed Reading Assignment (PRA) groups were also included in this study. They were compared to each other in some areas of this experiment. Each of these three possesses a strong interaction between the individual and the curriculum. The CAI tutorial in this study is not the highly interactive mode nor is it the electronic text exercise in which the computer acts only as a page turner to advance the student through computerized lecture notes (Nagarkatte, 1989).

This study was specifically designed to test the effectiveness of a CAI tutorial against four other interactive and non-interactive instructional strategies (Nagarkatte, 1989). Parallels between the SD, PI, and CAI tutorial have been drawn, although the latter two strategies are thought to be more structured because they must rely on predetermined multiple choice questions (Hildebrandt, 1985).

Two regular classes totaling 122 students were divided by alphabet into five groups, three groups from one class, two from the other. Each instructional strategy used a standardized approach consisting of a series of increasingly complex illustrated examples, each followed by a periodic review. Comparing the instructional groups by means of Duncan's multiple range test showed that the students who learned by CAI performed significantly better than the students who learned by ET, SD and PI. However, the PRA students did not significantly perform differently than CAI students.

The fact that the greatest difference in achievement existed between the most individualized interactive strategy, CAI, and the least individualized one, SD, causes one to conclude that the interactive strategy must be individualized in order to significantly improve student performance. The author, in conclusion, states that computer based instructional strategies were shown to be superior to their non-computer based counterparts only when they increased the degree of interaction (Emerson, 1988).

Technology and the Standards

History provides education with valuable lessons about instituting change. Any successful change must come with the integral ingredients. Should the schools attempt to provide computer education without the proper materials? Unfunded or underfunded mandates, national and state standards, and the myriad of requirements that confronts individual schools needs to be addressed. Business and industry are using computers to improve efficiency and save money. The question then becomes, "Why can't schools strive for both?" (Dvorak, p.24, 1994).

The technocrats and the standards writers are locked in a dynamic attempt to produce a product that will satisfy the education community. Neither group is pleased with the other's history. Technologists heretofore have not been involved in the writing of standards, and the standards people, who are not technology users, do not know how to incorporate technology. For all their objections to the standards, technology advocates must take some responsibility for these shortcomings. Until recently, no major technology group made a public effort to ensure that technology is included in standards discussions (Bardige, 1994).

Recently, groups of technologists and writers of the standards have begun to recognize this dilemma and have joined forces to insure that past problems will not stand in the way of progress. "Our publishers need to deeply understand what the standards people are thinking about and trying to accomplish so we can create materials that meet their vision. At the same time, standards people need to understand the power technology has, which we now can bring to teaching and learning" (Bardige, p. 39, 1994).

Perhaps the most compelling argument against mandating technology in standards is one that centers on issues of equity. How can one advocate including technology into standards when not every child has equal access to technology? The other side of the argument is that if the schools are not forced to join the modern era, they never will. "We cannot allow the equity issue to define our education system because we don't yet know how to put a computer into every home or classroom" (Bardige, p. 39, 1994). The argument goes on - Do we mandate quickly and force schools to reallocate funds, gradually mandate and fall behind further, find funding on the state and/or national level, etc.?

Jostens

The following information pertains to the Jostens Learning System (BLS- Mathematics) presently in use at the New Martinsville School. This system is installed in three different labs. The philosophy of the Wetzel County Board of Education concerning computer labs was to install computers in the lower grades first. The K-1 building is in its seventh year with a lab. The 2-4 building is in its fourth year. The 5-6 building is in its third year. The subjects of this study have therefore been exposed to a computer lab throughout each of their school years, with the exception of those entering after kindergarten. Students in this study should be categorized as "High Computer Use" students. Each student is required to spend 45 minutes per week in the lab for math and 45 minutes per week for reading. Every classroom has at least one computer for students to do make-up computer work or to extend previous lessons. They have experienced a minimum of four different keyboarding modules during their six years. Mathematics and reading labs have almost become an indigenous part of their curriculum.

The designers of the present mathematics curriculum looked at all the traditional methods of mathematics education. Many believed that learning mathematics is a highly individual experience. Therefore, the curriculum should fit the background of the students. The Jostens System and its year-to-year carryover met the desires of the curriculum designers.

Studies provided by Jostens
(Year 1 Study - Elementary Grades 2-5, with Mainstream Student Courseware: BLS Mathematics)

District Profile/Student Population - Prince George's County, located in southeast Maryland adjacent to Washington, D.C., has a population of over 56,000 elementary students, attending over 100 public elementary schools. Approximately 65 percent of the students are African-American, with 26 percent being Caucasian and the balance being from many diverse cultures. Prince George's County has a high socioeconomic population, and generally, the students score above the national average in standardized achievement tests, regardless of racial or socioeconomic background.

Implementation Strategy - In September, 1988, the Prince George's County Public Schools introduced a CAI system to supplement their elementary math program. Four computers were installed in every second- and third-grade classroom in 68 of the system's comprehensive elementary schools. Teachers were informed of ways to integrate the computers into their daily teaching plans. By April, 1989, 1,416 computers were operating and serving approximately 11,000 students.

Evaluation Design - The following goals for the CAI system formed the basis for the evaluation study:

*to improve student achievement in basic skills,

*to improve students' problem-solving abilities, and

*to allow teachers the flexibility to use time more effectively for instruction.

To assess the impact of the CAI on attaining these goals, the researchers:

*administered a survey to a sample of 300 second- and third-grade teachers and principals,

*observed a stratified random sample of 26 second- and third-grade classrooms, and

*measured performance of 2500 randomly selected students on criterion-referenced tests in math.

To assess math performance, students were pre- and post-tested using the school system's criterion-referenced tests. Differences in scores were related to time spent on the computer to determine the relationship between level of computer use and performance gains.

Student Performance Results - The effect of the use of CAI was tested by examining the relationship between the number of minutes students were engaged in computerized math lessons and their pre-test, post-test gains on math CRT.

Students in the "high computer use" group (minimum of 38 minutes per week), gained 30 percentage points between their September and May testings. The percentage gain for "low computer use" group (maximum of 37 minutes per week) was 27 percentage points between tests. This three percentage point difference was highly significant ($p<.001$) when corrections were made for differences in the students' initial achievement levels. In sub-tests of the CRT, a correlational analysis shows that the effect was especially strong for Problem-Solving and Fractions/Decimals. The analysis provides evidence that when students engage in CAI on a consistent basis they are likely to show significant performance gains (Office of Research and Evaluation - Prince George's County, 1990).

(Year 2 Study)

In an evaluation of the second year of implementation of mathematics, third-grade students and their teachers were studied to determine the effects of computer use in the classroom. The study confirms that students in the high use math group will score higher on the math CRT than classmates who do not take regular advantage of computer lessons. The "effect threshold" for computer use appears to be approximately 40-minutes per week. The monthly average computer use for the full sample of students in mathematics was 83-minutes, or approximately half of the time needed to reach the "effects threshold" at which students begin to show achievement gain. Only about one fourth of the classrooms were found to have a majority of students over the 40-minutes per week average needed for academic achievement gains. Students in the highest use quartile for math used computers an average of 50-minutes per week.

Evaluation design -The Year 2 study was designed to retest several of the empirical claims from the Year 1 report, as well as adding several new components to the study plan. The Year 2 study addressed the following additional questions:

*do the preliminary gains detected in the first year study hold for Year 2 cohorts,

*do students of all ethnic, gender and achievement groups enjoy equal access to the classroom computers, and

*is there evidence that teachers in Year 2 used the computers more consistently than during the first year?

Other goals were to assess the impact of the CAI on attaining these goals and to answer the additional concerns of the researchers. They expected to:

*examine the association between achievement gains and computer use for the entire third-grade cohort (4,107 students), the same grade studied in Year 1, using actual log-on time to estimate levels of computer use, and

*compare teacher attitudes toward computer usage in the classroom as indicated on a questionnaire with the extent to which teachers use the computers in their classroom program.

Student Performance Results - The effect of the use of CAI was tested by examining the relationship between the number of minutes students were engaged in computerized math lessons and their pre-test, post-test gains on math CRTs. The computer use of students skewed toward the lower end of the use range. Classroom computer experiences of students were highly variable. The average student worked on math lessons for approximately 83 minutes per month. No significant imbalances were evident between boys and girls or black and non-black students in computer usage. The nucleus of the study was to determine if students made any significant academic gains based on systematic, consistent use of their classroom computers. For analysis purposes, students were grouped by computer usage in "High," "Moderate," "Low-Moderate" and "Low" categories, based on computer-generated usage records. A significant, positive correlation was found between computer math use and math gains for the full sample. Researchers determined precisely what is the net effect of using CAI in math on the student's end-of-year CRT performance. The table below demonstrates:

	Low Use	Low-Mod	Moderate	High Use
CAT Math Use	<5 min/wk	5-14 min/wk	15-28 min/wk	>28min/w
CRT Math Effect	-.10	-.09	+.01	+.17

(Office of Research & Evaluation - Prince George's County)

One further study presented was conducted for second-through fifth-grade students in an attempt to compare CAI use and its effects on the differences in numbers and percentages of students scoring in the four quartiles on the Stanford 7 Plus Test. The parameters for this study mirrored the previously mentioned studies for Jostens. The results were fairly dramatic. The percentage of students scoring above the 50th percentile increased by 30 percent in Total Mathematics. Gains in student achievement for the year were significant and unprecedented. The median student achievement score went from the 44th percentile to 70th percentile in Total Mathematics. The percentage of students scoring in the third and fourth quartiles (above 50th percentile) increased by 30 percent in mathematics. The percentage of students scoring in the fourth quartile (above the 75th percentile) was more noteworthy, from 15 percent to 45 percent. This study was conducted at the Hardin Elementary in Burkburnett, Texas (Jostens 1989-90).

Conclusions

Can a system based on measured outcomes be measured? Can it go beyond test scores? Some researchers believe that the question should not be whether students learn more, purely because they are using technology, but whether technology is facilitating other innovations to change the nature of the school, and the work of teachers and students in it (Van Horn, 1996 & Mehlinger, 1996). Real advances in student learning depend on changing what teachers expect their students to know and do, how they organize their classrooms and how they revise their curriculum (Computing Teacher, 1995). Technology can be used to support all kinds of learning, from memorization exercises using drill and practice software, to collaborative research projects done with multimedia authoring tools (Dwyer, 1994). One cannot merely look at technology in isolation when assessing true understanding or the development of high level cognitive skills. It is but a tool to be incorporated into the entire fabric of education (Sheingold, 1996).

Chapter 3

METHODS

Hypothesis

There will be no significant difference in academic achievement between students receiving Computer Assisted Instruction and those who receive an equal amount of classroom practice and instruction.

Introduction

The relevance of computer labs is a constant question among educators. A study collecting pertinent statistical data could be of assistance in planning for the future scheduling, expendures, and training for the New Martinsville School. Up to 20% of the time allocated for mathematics will be spent on Computer Assisted Instruction. Money has been and will be invested in purchasing and updating computers for the express purpose of meeting the current standards established by the state of West Virginia. Staff development, through inservice training, is necessary to meet the goals of computer literacy. With these and other concerns in mind, applicable research should be completed and considered.

Group Selection

The two groups selected for this study consisted of fifty-one students at the New Martinsville School. This represents forty percent of the students enrolled in the fifth grade. All students had the same math teacher and were rotated on a half day schedule between two teachers for other subjects. Of the students selected for this study, forty had been exposed to the computer lab throughout their school years. The remaining eleven had from one to five years exposure, and seven of the eleven were members of the CAI group. All students had forty-five minutes per week scheduled in the computer lab for math, and an additional forty-five minutes in the lab for reading.

Procedures

The Experimental Group had math class one hour per day five times a week and attended the computer lab forty-five minutes one day a week for a period of six weeks. The students received computer assisted instruction each time they attended the computer lab. The teacher provided beginning instruction and became an active participant, asking and answering questions, making suggestions, clarifying computer provided instructions and generally being of help when needed. All lessons in the computer lab were pre-programmed to correlate as nearly as possible with the text.

The Control Group also had math class one hour per day five times a week in the classroom with one additional forty-five minute period of review and practice. Their computer lab work consisted of work that was not related to the math concept taught in the classroom. They did work that was unrelated to math, i.e. accelerated reader.

The lessons in the classroom consisted of all phases of fractions from the fifth grade text. This entailed a beginning lesson that explained what a fraction is and further lessons dealt with addition and subtraction of complex fractions. All students received basically the same instruction in class during their five hours per week. Neither group was aware of their participation in this study.

Instrumentation

Pretests were given prior to the first lesson. This consisted of a total of 20 problems covering seven areas. The students were tested and a score was recorded for each pretest. A percentage score was recorded for every student on every test. Using the .05 level, a t-test was performed on the raw data.

At the conclusion of the study the same test was used as a posttest with different numbers in each problem. The testing instruments reflected the objectives of the textbook currently in use and the State Instructional Goals and Objectives.

Limitation

This study was limited to 51 fifth grade students in a rural area. The students in the Computer Assisted Instruction group received 45 additional minutes in the computer lab each week, or six times over the course of this study, concerning the given lesson.

The remaining students continued to attend the computer lab but were not exposed to the related lessons. They received 45 additional minutes of instruction and practice within the traditional classroom session.

Chapter 4

RESULTS

Data Analysis

The purpose of this study was to investigate two methods of instruction that are available to students in mathematics. The methods investigated were classroom instruction combined with Computer Assisted Instruction and traditional classroom instruction.

The Subjects

This study was conducted among two randomly selected groups of fifth grade students. Each year the students are divided among six teachers. The Principal then presents a list to each teacher. Teachers have very little, if any, input into the class lists. The list for each grade level is generally apportioned equally by gender. These computer generated lists have few parameters.

The students making up this study came from a diverse background. A wide variety of socio-economic backgrounds was represented in this extremely large school.

The students were completely unaware of the study. Classes met at varying times as the computer lab schedule was established with no particular pattern. One class met in the morning and the other class met both mornings and afternoons. Each student had been conditioned to taking a pretest and posttest in the computer lab during the past four years.

Hypothesis

There is no significant difference in academic performance between students receiving Computer Assisted Instruction and those receiving an equal amount of classroom practice and instruction.

Data

Fourteen tests were given to the two groups over a six-week period. They were administered during the second semester of the 1996-1997 school year. Prior to each of seven separate lessons, the subjects were given a pretest. When the two groups were established the pretest was given. A t-test was then conducted on the raw data. The results are presented and labeled as Table 1, page 29. At the completion of each of these lessons the subjects were given a posttest that was representative of the respective pretest. A t-test was administered on the raw data from the posttest. The results are presented and labeled Table 2, page 30. These testing instruments were developed to reflect the objectives of the textbooks presently in use. The seven lessons were:

1. Value
2. Simple/Complex
3. Reducing/Greatest Common Factors

4. Least Common Multiples
5. Comparing
6. Addition/Subtraction
7. Multiplication/Division

The mean and critical t was calculated and presented in the following tables:

Table 1

T-Score

Pretest

The Pretest consisted of 20 problems. Each of the seven lessons listed above were represented. This instrument was developed to test the students on state and school objectives. The Instructional Goals and Objectives (IGO) required by the state are covered completely.

Test Group	N	Mean	Critical t
CAI	26	28.34	0.416
Non-CAI	25	27.31	

With the t-score below the critical t of 1.645, the homeogeneity of the Experimental Group (Computer Assisted Instruction) and the Control Group (Non-Computer Assisted Instruction) was established at the .05 level.

Table 2

T-Score

Posttest

The Posttest consisted of 20 problems. These problems were nearly identical to the 20 problems on the Pretest. The only difference was the fractions used, i.e. two-thirds on the pretest might be three-fourths on the posttest.

Test Group	N	Mean	Critical t
CAI	26	79.76	0.877
Non-CAI	25	77.62	

With the t-score being below the critical t of 1.645, the null hypothesis is accepted indicating no significant difference, at the .05 level.

Learning mathematics is a highly individual experience. Computer Assisted Instruction alone does not produce success. The effective integration of computers with classroom instruction needs to be evaluated in many different formats. The simple observations of this study are easily analyzed because of the specific parameters.

A t-test was administered on each of the seven posttests. With the t-scores ranging between 0.037 and 1.008, the null hypothesis is accepted indicating no significant difference, at the .05 level, for each of these test.

Chapter 5

Conclusion

Learning mathematics is a highly individual experience. Computer Assisted Instruction is quite likely "the wave of the future." Methods to optimize the effectiveness of meshing CAI and classroom instruction should receive top priority. This study demonstrated that when little or no time is spent uniting these two areas, study results are insignificant. Other cited studies presented in this work reveal similar results.

Discussion

This study was conducted with 51 students during a period of six weeks. It was limited to two chapters of work within the fifth grade text. The area studied was fractions. Learning fractions is very representative of learning most other areas of math, therefore these results should apply to other areas as well. The State Instructional Goals and Objectives formed a concise set of parameters in such areas as specific content, learner preparedness, instructional expectations, and teacher evaluations.

Throughout the course of this study, students were unaware of their participation in the study. To maintain this confidentiality, the instructor tended to display a neutral attitude which was in contrast to the normal classroom presentation. A more uniform method during the entire year needs to be developed. Enthusiasm is something that can be included without divulging the nature of a particular study.

The computer offers great potential for interactively with its simulated environment. Computer programs are proving to be unlimited in their stimulating activities in all areas of the curriculum. Mathematics and the computer form a perfect marriage, and overlooking this is something that the school systems cannot afford.

Evaluating the effectiveness of CAI research must include criteria that will allow the researcher to measure attitudinal changes of the students. Many times it was noted that particular students shared a concept with other students and/or the instructor. For example, a student noticed that reducing fractions could be accomplished on many occasions by using the numerator as the greatest common factor. This is more apparent on the computer screen because several examples are presented in rapid succession for the self-paced students. With some previous experience, the students will notice this and share their new found "secret". Other examples present convincing evidence that merely using concrete examinations does not measure the full potential of the computer.

Although Josten's is presented as a system that is "as good as any out there", it leaves much to be desired. It does not coordinate well with the textbooks. All too often it appears that the presentation is more for the expedience of the computer programmer than for the learner. Examples of this are when colors are used to relate likeness of values rather than simply drawing arrows, as would be demonstrated in the classroom. Students do not seem to pick up the color/likeness concept. Many questions were asked during the lessons where concepts were presented in this manner.

Four other areas present interesting topics for future study:

1. learning styles
2. intellectual maturity
3. life experiences

4. remediation

In particular, remediation in math seems to be the most intriguing. Many times the students who have trouble in the classroom sorting out the material appear to move through a lesson much more smoothly in the lab. Some below average students suffer from many learning difficulties, i.e. attention span, distractibility, etc. These students do not really miss any instruction in the lab because it is there waiting for them "when they get back."

Recommendations

One prevailing theme of each study is the fact that the instructor is the defining ingredient of a math program. Not surprisingly, success is linked to the degree of involvement of the presenter. The degree of involvement has proven to be difficult to measure precisely, but researchers often refer to this involvement as the major determinant. However, accepting or rejecting this assumption does not alter the fact that CAI and classroom instruction must be successfully linked to produce a desired result. Blending of these two then becomes a personal matter for the instructor. This has proven to be a highly individualized area.

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