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THE EFFECT OF COMPUTER SIMULATIONS AND EXPERIMENTS ON SIXTH-GRADE STUDENTS' LEARNING IN SCIENCE

A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF MASTER OF SCIENCE IN SCIENCE TEACHING

IN THE GRADUATE SCHOOL OF THE

TEXAS WOMAN'S UNIVERSITY

COLLEGE OF ARTS AND SCIENCES

BY

VIOLETTE J. TAYLOR, B.S.

DENTON, TEXAS

DECEMBER 1996

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TEXAS WOMAN'S UNIVERSITY
DENTON, TEXAS

September 11, 1996

To the Associate Vice President for Research and Dean of the Graduate School:

I am submitting herewith a thesis written by Violette J. Taylor entitled "The Effect of Computer Simulations and Experiments on Sixth Grade Students' Learning in Science." I have examined this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirement for the degree of Master of Science in Science Teaching.

Ruth M. Caswell, Major Professor

I have read this thesis and recommend its acceptance:

Accepted

Associate Vice President for Research and Dean of the Graduate School

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THE EFFECT OF COMPUTER SIMULATIONS AND EXPERIMENTATION ON SIXTH-GRADE STUDENTS' LEARNING IN SCIENCE

VIOLETTE J. TAYLOR, B.S.
DECEMBER, 1996

ABSTRACT

The purpose of the study was to examine the effects of computer-assisted experiments and simulations of selected topics in sixth-grade science classrooms. The students participated in four weeks of hands-on science instruction coordinated with computer laboratory experiences. The science concepts covered include electricity, circuits, magnetism, and electromagnets.

The results revealed that the students scored higher on a post-test than a pre-test after participating in the experiment. Further test results indicate that the students increased their understanding of scientific concepts due to hands-on instruction and computer-assisted instruction. The reactions of the teacher and the students toward the computer software being used were positive.

The results of this study suggest that computer-assisted instruction complemented with hands-on instruction would be helpful in the elementary science classroom.

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CHAPTER I

INTRODUCTION

"The presence of the computer in the classroom is no longer considered an oddity. It [has] become an ordinary resource for teachers to use to enhance instruction" (Sia, 1992, p. 2). Computers are used in math for problem solving and drill-and-practice. In social studies they are being used to develop decision making skills and "...simulations [which] help students learn how history occurs" (Solomon, 1990, p. 18). Computers are used with at-risk students to encourage them to "...become critical thinkers and problem solvers and [to] motivate them to learn" (Poirot & Canales, 1993-94, p. 25). In other settings some computers are used for telecomputing experiences with students from different parts of the world. In secondary science classrooms they are being used for "simulations, tutorials, ...experiment analysis, laboratory instrumentation, data pools, computation, and problem solving" (Doyle & Lunetta, 1982, p. 26). If computer-assisted instruction (CAI) is being used successfully across the curriculum for elementary and secondary classrooms, how effectively can CAI instruction be integrated into the elementary science classroom?

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Conceptual Framework

In 1994 a survey was conducted in a rural community of Western Pennsylvania to determine how often elementary teachers use technology to teach math and science. Principals reported that "microcomputers were being used in at least some elementary grade levels for mathematics or science instruction in 84% of the schools. Teachers used microcomputers more frequently in mathematics (82.5%) than in science instruction (55%)" (Lehman, 1994a), p. 194). Perry (1990) says that "...most educators have come to believe that computers can utterly transform the way children are taught. Computer-based learning is active, not passive, and promotes the skills business says it values most--problem solving, teamwork, and familiarity with technology" (Perry, 1990, p. 72). If educators do agree that computers can enhance instructional methodologies being used today, then why are they not being used more systematically in elementary science classrooms? Some classroom teachers are learning to use computers in math and language, and have not been exposed to any new technology for teaching science. Magnusson and Palinscar (1995) suggest that teachers have specific reasons why they are reluctant to make changes in their instructional strategies. A teacher with 25 years of experience said that she had a strong desire to integrate science into the

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curriculum but did not know how. "This is a common sentiment expressed by other elementary teachers..." (Magnusson & Palinscar, 1995, p. 43). CAI can help elementary teachers fit science into existing educational programs. The computer-aided learning would not replace regular instruction, but could be used to augment what is already being done.

Computer-assisted instruction has been a part of secondary science classrooms since the 1980's. A survey conducted by Lehman (1994b) with 179 secondary science department chairs, examined the nature and extent of microcomputer use in science instruction in their schools. The results revealed that,

> ...47% of the secondary science teachers did not use microcomputers during instruction, 40% used them occasionally, and 13% used them in one or more lessons each week. The most frequent applications were simulations (70%), graphing packages (63%), and probes for collecting laboratory data (56%). In addition, 76% of the respondents indicated that microcomputers have had an impact on science laboratory activities in their schools (p. 413).

The differences in computer usage in the secondary school was attributed to very simple reasons: (a) availability of

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computers and software, and (b) the lack of teacher training on the integration of the computer equipment into the science classroom. These are very common problems in both secondary and elementary schools which hinder the effective use of computers during instruction.

To incorporate more computer-assisted instruction into science classrooms, several changed would have to be made. First, teachers would have to become the science learners and "...there would have to be occasions for teachers to be the constructors of knowledge" (Magnusson & Palinscar, 1995, p. 48). Second, Greenwood (1996) suggests that teachers need the opportunity to "...design experiments to test their own ideas" and thoughts about scientific concepts (Greenwood, 1996, p. 32). Then they would be able to do the same kinds of science activities in their own classrooms. Computer-assisted instruction could be integrated into the instruction to provide experiments, simulations and enrichments. Third, it would also require the designing of a "...partnership to provide staff development support that is more than a single workshop... and one that utilizes technology that teachers currently have available to them. It would also provide experience with cutting edge technology (Lehnam, 1994, p. 201). Teachers need ongoing training with computers and new technology related to science in order to keep up with the

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rapid changes in instructional methodologies. Also "...prospective elementary [and] secondary teachers should acquire the knowledge of current innovations on science education in the context of teacher preparation" (Kyle, Abell, Shepardson, Seals, and Ruth, 1995, p. 170).

Many studies were conducted in the 1970's and 1980's on the effectiveness of computer-assisted instruction. The results showed "...that supplementary instruction with CAI leads to high achievement [and]... computer based education can be an improvement over conventional methods" (Texas Education Agency, 1991, p. 9-10). CAI has also been used successfully with adult educational programs to improve achievement. Can this type of instruction have a positive effect on student achievement in elementary science classrooms?

Statement of Purpose

The purpose of this study was to examine the effect that computer-assisted programs that use simulations and experiments had on student learning in elementary science classrooms.

Research Question

Three questions were explored in this study:

1. What understandings of specific science concepts will the students achieve when using simulations and experiments in computer-assisted instruction?

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2. What understandings of science concepts in an instructional unit will the students achieve when CAI simulations and experiments are integrated into instruction?

3. What response do the students have toward CAI simulations and experiments in their classes?

Definitions

Computer-assisted instruction (CAI) is the delivery of an instructional program assisted by computers (Texas Education Agency, 1991).

Hands-on science is defined as any science lab activity that allows students to handle, manipulate or observe a scientific process (Lumpe & Oliver, 1991).

Limitations

This study was limited to one homeroom class at a suburban elementary school in North Texas.

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CHAPTER II

REVIEW OF THE LITERATURE

A review of the literature describing a brief history of computer-assisted instruction, hands-on science, and science education reform will be discussed in this chapter. These topics were chosen because of their relevance to this particular study.

Computer Instruction

Using computers in science classrooms is not a new trend to some educators. They have been a part of the educational process since the 1970's (Doyle & Lunetta, 1982). With the passage of time the hardware and software have changed, and so have the functions of computers. In the past they were used for "mastery of facts using and practice type programs" (Graef, 1984, p. 430). This was fine if you wanted students to learn vocabulary or classify information; however, if teachers wanted students to be able to use computers as vehicles of more sophisticated instruction, a few changes needed to be made. "Visionaries [already using computers urged that] ...computers [be used] to improve problem solving and logical thinking" (p. 430).

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> In the 1980's a progressive use of computers was gaining recognition, it was called computer-assisted instruction. It was not limited to just remediation, but could be used for simulation, tutorial,... experiment analysis, laboratory instrumentation, laboratory data pools, computation, and problem solving. For the teacher it could provide information storage, course management, hand out preparation, and evaluation" (Doyle & Lunetta, 1982, p. 26).

The major hindrances to using this new technology were: (a) the small percentage of teachers trained to use the equipment; and (b) the fact that "computers [were] a novelty in schools since they were available to only small percentages of faculty and students" (p. 30). During the late 1980's computer usage had caught on in the educational arena; school districts were putting computer-assisted instruction to the test. A high school in North Carolina used CAI to teach biology. "They arranged to use computers to expand, enrich, reconstruct, and supplement the laboratory and lecture components of the traditional biology course for students in grades 10 to 12" (Hounshell & Hill, 1989, p. 543). Their goal was to influence the students' attitude toward science and science instruction. The significant difference between the experimental classes and

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the traditional classes was due to the use of the computer simulations. After the study was completed the authors concluded that, "computer [use] for selected laboratory demonstration, and classroom activity can make a difference in improving both attitude and achievement for students enrolled in biology" (p. 544).

A similar study was conducted at the University of Windsor, Windsor, Ontario. The science department was currently using an "audio-directed multimedia laboratory for students to work through the laboratory portion of a biology course" (Habowsky, et al., 1990, p. 233). In 1985 the university added computer-assisted instruction tot heir existing audio directed lab. "To test the effectiveness of CAI, [they] converted an audio-tutorial mini-course on plant structure into a CAI program without adding a supplementary audio component" (p. 233). The results of the experiment were both positive and negative. Habowsky (1990) concluded that "computerized simulations of biological processes and phenomena are excellent... Although microcomputers [did] have unique and superior features, computer-assisted instruction programs could not satisfactorily replace [our] audio tutorial units" (p. 233).

About two years after the Habowsky study, another study was completed in San Antonio, Texas.

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Computer-assisted instruction, which incorporated tutorials with laboratory simulations, was being studied in a biology course for non-biology majors. On the first day of lab the students used selected programs for a two and one-half hour period. They also received a study guide, lab report, and an assignment based on the lesson. The experiment proved to be beneficial for those participating in the biology course. First, "experimental simulations [used] as an introduction to the laboratory exercises and for teaching the scientific method, proved to be an effective addition to the overall course" (Buttles, 1992, p. 493). Second, "student experimental techniques, mathematical performance, and attitude towards the class [had] improved" (p. 493).

It is interesting to note that two universities conducted studies using computer-assisted instruction with biology classes, but they gathered different results. Both schools agreed the CAI material was superior, but they noted different effects from the instruction. The existing audio tutorial program and lack of audio support may have affected their results and may have handicapped the students at Windsor, Ontario; however, the students in San Antonio received study materials and tutorials built into the CAI instructional program. These differences could account for weaknesses in certain types of CAI instructional programs.

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Kracjik, Simmons & Lunetta (1986) critiqued papers submitted to help build a research base for the effective use of computer-assisted instruction in science learning. They collectively "concluded that large group presentation of computer simulations were at least as effective as were experiences in which two students worked together at a microcomputer" (p. 466). Another study examined an experimental group using CAI to learn volume displacement and a control group using a parallel laboratory activity. The control group spent twice as much time as did the experimental group interacting with the actual materials in a laboratory setting. Both groups reported to have performed similarly. These two studies add credibility to the idea that computer-assisted instruction could enhance science learning in many classes.

The Texas Department of Criminal Justice and the Windham School System (1991) presented a paper describing how adults benefit from computer-assisted instruction. First, they discussed the fact that college students using CAI "found that instructional activities delivered by a computer required less time for students to complete than similar [assignments] by other means" (p. 1). Second, they discussed how CAI was used in adult education programs. "Evidence indicates that providing adult learners with as little as three or four weeks of intense access to CAI can

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yield close to three-fourths of a year of master-achievement gains in basic skills" (p. 2)

From the early 1970's through the early 1990's computers have gradually become a permanent part of the classrooms. Techniques like drill-and-practice activities are still in use, but advanced technology will allow students to use experimentation and simulation to understand scientific concepts.

Many of the discussions and studies cited in this paper emphasize the benefit of computers and modern technology in science classrooms of the future. It is clear that simulations, demonstrations, and experiments can enhance student learning across the curriculum.

Science instruction appears to be incorporating new trends to meet the demands of the 21st century. This review has looked at the present, the past, and possibly the future of science, technology, and computers. The methodologies of the 1970's, 1980's, and early 1990's have been modified to accommodate present and projected needs of computers of the future. Will today's elementary students be ready for the challenges of business and industry tomorrow? If educators incorporate modern technology, computers, student-focused instruction, as well as real world experiences and good instruction, they may be ready.

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Hands-on Science

Educational reform is bombarding elementary and secondary school teachers across the curriculum. One of the major areas of concern is science instruction. Educators are required to find ways to integrate science and math, and also teach hands-on science. Many teachers recognize that "...letting children do hands-on science is beneficial" (Greenwood, 1996, p. 32). However,they "relegate science to the end of [the day] or avoid it all together" (p. 32). Often the teachers are afraid to try something new, and they do not want to give up absolute control of the classroom. Krueger (1994) introduced his science class to independent learning through constructivism in a series of lessons that allowed for inquiry and discovery. "Students actively constructed their own knowledge about electrical concepts" (p. 31). Some students felt they had learned very little, but others felt they had learned more by discussing and interacting with other students. The actual results revealed that "the quality of learning improved because it started with knowledge that the students possessed" (p. 34).

Making changes in the way science instruction takes place is not a new process. According to Stohr-Hunt (1996) curriculum reform in science began a long time ago. "The

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successful flight of the A Soviet Sputnik in 1957 gave renewed impetus to the curriculum reform movement toward the end of World War II" (Klopfer & Champagne, 1990, p. 101). After that major event the emphasis of science and math instruction shifted to include more student involvement in the learning process.

> Many new programs, referred to as "alphabet" science programs, thrived through financing by federal agencies, such as the National Science Foundation, and private foundations. Although these programs differed in their origination and style, each placed a great deal of stress on, and value in, hands-on activities that were oriented toward discovery learning" (Kyle, Shymansky & Alport, 1982, p. 101).

Programs like Science-A Process Approach (SAPA), Elementary Science Study (ESS), and Intermediate Science Curriculum Study (ISCS), [surfaced] and were known to "focus on ways to develop basic skills in the process of science. these processes include observing, classifying, measuring, predicting, and other important skills needed to conduct science investigations" (p. 101).

A weakness that was identified in the hands-on science programs was a de-emphasis on content. Program developers

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assumed that basic facts and principles would develop through the student experiences; however, this rarely occurred in the learning process. Today the early hands-on science programs are no longer used. New discovery science programs are gaining favor in the educational arena. Will these new programs be discarded as the others have been because of poor performance? This question will be answered as educational reform in science classrooms is documented and studied at length.

Hands-on science is defined as "any science lab activity that allows the student to handle, manipulate or observe a scientific process" (Lumpe & Oliver, 1991, p. 345). This approach is gaining favor among educators in the elementary and secondary grades. "A distinguished panel of biology educators iterated the fact that current modes of biology laboratory instructional strategies have failed to meet the goals of laboratory instruction..." This panel recommended that hands-on science lab activities should be capable of producing "conceptual changes necessary for intellectual development and understanding" (p. 345). The resurgence of hands-on science could be based on the emphasis on higher thinking skill development and problem solving opportunities.

Hands-on science activities are divided into three different dimensions that work systematically together.

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"The first dimension is inquiry. In this type of activity students are seeking information through experimentation, questioning, and working through a process to discover specific principals and concepts. The second dimension is called structure. This dimension centers around involvement of students in making decisions concerning the design and planning of an activity's procedure" (Lumpe & Oliver, 1991, p. 346). This dimension is divided further to include three subgroups to explain the process. They are descriptive, correctional, and experimental. Each of these areas allow for a different type of student involvement and critical thinking during the hands-on activity. It is very clear to see why the secondary biology educators would want to incorporate hands-on science activities into the existing curriculum. "Certain types of activities can be powerful tools for shaping and reshaping students' cognitive conceptions of the natural world" (p. 347). Elementary and secondary science teachers want their students to be free to analyze and create new ways of thinking about scientific concepts, also to discover new learning through manipulation of materials and information. Hands-on science activities can be designed to meet the needs and demands of science instruction for the present and future classrooms.

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Science Education Reform

> Not so long ago, educators prided themselves on the stability of their programs and the traditions of their institutions. Formal educators' principal goals were to foster an appreciation for learning and to develop citizens for sound moral character and judgment... Today's fast-paced world is forcing educators and educational institutions to refocus their goals to accommodate or even anticipate change (Thomas, 1995, p. 1).

This is the philosophy of many professional educators throughout the United States. Several progressive states have anticipated the need to change their current educational framework; they have designed new criteria for instruction and content to be implemented across the entire curriculum. Their hope is that the contemporary teaching strategies, methodologies, and technological innovations will be enough to prepare students for the fast approaching 21st century and beyond. What are some of the changing trends in the field of science education in regard to instruction and the use of computers?

The North Carolina State Department of Public Education [NCSDPE] (1994) has taken steps to prepare for the future by initiating "school reform efforts... to strive to reflect the understanding that changes in the

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ways young children and their families are served must be systematic and sustained (p. 3). In order to fulfill this commitment, the State Superintendent suggested that science instruction should be "student centered, activity based, constructivist... [actively using] cooperative groups to solve problems [to] develop independent thinking skills... [and] connections for science curriculum with math, technology, and other content areas" (NCSDPE, 1994, p. 15). Similar changes and guidelines for the entire early childhood and elementary programs have been written. These reforms are based on national and state trends. It is their desire to have schools in their state examine the new standards, "...evaluate their current programs and set goals for continued improvement" (p. 5).

Changes being considered in the state of Georgia came from a study compiled in that state. It utilizes national and state standards to design a framework that involved "...community-based partners and professional educators to produce a vision of mathematics and science that will prepare all George students for the 21st century" (Georgia Initiative In Mathematics and Science [GIIMS], 1994, p. 1). Their science program would include four higher level thinking skills: "...problem solving, reasoning, communication, and making connections" (p. 37). These major processes are applied to real world problems in science

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classrooms. To find solutions to the situations, advanced technology, [like CAI] will be used to experiment with data, simulations will be used to work through difficult scenarios, and data interpretation will be used to draw parallels with actual life experiences. Research suggests that computer-assisted instruction helps develop problem solving skills, logical reasoning, and data analysis through experimentation and simulations. Integration of specific process skills and CAI instruction would accomplish some portions of the GIIMS for their students.

Stringfield (1994), a high school biology teacher, believes microcomputers are effective instructional tools that help students master concepts and motivates them to learn. He also states that it is time to broaden the type of experience that students can acquire while using microcomputers.

> Microcomputer-based labs offer several advantages over other forms of computer-assisted instruction. Although simulations can be an excellent means of performing activities that would otherwise be too time consuming, dangerous, expensive or otherwise impractical, microcomputer-based labs allow students to develop hands-on experience with actual experiments... They also involve inquiry,

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> the use of higher level thinking skills, [and the opportunity to] see data graphed as it is being collected..." (p. 106).

Stringfield (1994) suggests microcomputer-based labs can promise more for the biology student than other forms of computer simulations and experimentation.

A new trend being used in science classrooms is the integration of computers and technology. Wiburg (1994) research the subject and found "...more than twice as many articles on using telecommunications and interactive multimedia in science education than other applications, with secondary emphasis on the use of computer-based simulations and laboratory tools" (Wiburg, 1994, p. 6). She also discussed three studies that used different telecomputing projects and their similarities.

> Several commonalities between the three projects suggest what is needed for successful telecomputing in science classrooms. [They] include: (a) hands-on, project-oriented activities that require student cooperation, problem solving, and data analysis; (b) investigation into real world and important world problems such as water quality and population growth; (c) the sharing of data and collaborating with other schools using

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> telecommunications; and (d) the involvement of scientists with student investigators over the network (p. 6).

Advanced technology combined with computer instruction integrated with science concepts will provide unique learning possibilities for the students of today and the future.

In Iowa a study was conducted that integrated "...hypermedia with science learning, which [allows] several students in [different] schools to work as programmers and instructional designers" (Wiburg, 1994, p. 6). This is another trend in computer usage that started in the 1980's. Hale (1986) said "that there is a strong intuitive belief that programming increases logical thinking skills" (Hale, 1986, p. 471).

Another study that involved a method for researching computers supported collaborative learning. Telecomputing is being used in science classrooms and can promote student independence, cooperation between groups, encourage the development of higher thinking skills through hands-on activities, and involve real world experiences by networking with working scientists through computers.

Other new trends that relate to science education in schools include a variety of CD-ROM software for early childhood through upper. These science programs allow

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young users to discover and utilize process skills. "Users can observe, classify, construct, compare and experiment with..." many different subjects (Rosegrant, 1995, p. 116). For high school students, computers are being used to help explore many different uses such as science research (Buldyrev, et al., 19914, p. 411), instruction, laboratory graphing and simulations, (Lehman, 1994, p. 413). Many other uses for the computer in the science classroom are being developed by creative educators who recognize the educational demands of the future, and who are not afraid to explore untraveled territory in the exploration of computer capability.

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CHAPTER III

METHODOLOGY

Subjects

The subjects were 26 sixth-grade students in a homeroom at a suburban elementary school in North Texas. There were 15 boys and 11 girls in the class. The students were all Caucasian with the exception of one Hispanic student. The socioeconomic levels of the parents varied from middle to upper class.

Procedures

The students participated in a 4-week study that involved science instruction coordinated with computer laboratory experience. The lessons focused on electricity and magnetism. Each week the students had one hands-on lab activity and a discussion time to learn the concepts. A pre- and post-test were administered to measure the content knowledge of the students. They also participated in an authentic assessment at the end of each classroom session and after each computer session. They kept a journal to record their interactions and reactions to the software. The teacher also kept a journal of personal observations and reactions to student involvement with the computer simulations and experiments.

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Science Lessons and Computer Simulations

The lessons focused on electricity and magnetism. The topic of each lesson and related computer software is presented in Table 1.

Table 1.

Lesson Topics, Lab Activities, and Computer Software

Topic	Lab Activity	Computer Software
What is Electricity	Open/Closed Circuits	Electric Charges with Wiring in Parallel/Series Circuits
Electromagnets and How They Work	Making Electromagnets	Magnetism from Electricity

During the first session of each week, the class was involved in hands-on activities and discussion of the selected topic. The second session of each week focused on computer simulations or experiments. The software for the computer simulations and experiments was Josten's Explorations in Science (Jostens, 1992, p. 103-107).

Evaluation

The content knowledge test consisted of 75 items that were scored by the number correct. The pre- and post-mean scores were compared to demonstrate students' learning of

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concepts presented. A scoring rubric with zero to four range was used to score the authentic activity assessments. The class mean scores were used as indicators of student learning. The student responses to the computer sessions were analyzed for common threads occurring in the comments. These common threads, along with student and teacher journals, provided data for describing the students' responses to the computer simulations and experiments.

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CHAPTER IV

RESULTS AND DISCUSSION

The purpose of this study was to examine the effects of computer-assisted programs that use simulations and experiments on student learning in the elementary classrooms. Three questions were asked that examined student learning and reactions to exposure to CAI simulations and experiments along with classroom instruction.

Results

Question 1

What understandings of specific science concepts will the students achieve when using simulations and experiments in computer-assisted instruction? To answer this question, one instrument was used to measure student learning before and after the instructional period. A 75-item multiple choice test was given prior to and following the study to demonstrate student learning. The pre- and post-test means were 43.12 and 55.19. The results were $\underline{t}$ = 2.767, $p < .01$. All data are shown in Table 2. This indicates that there was a significant increase in learning as a result of classroom instruction integrated with CAI experiments and simulations.

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Table 2.

Group Means and Standard Deviation for the Pre- and Post-Test.

Test	Means	Standard Deviation
Pre-test	42.12	9.95
Post-test	55.19	7.24

Question 2

The second question was: What understanding of science concepts in an instructional unit will the students achieve when CAI simulations and experiments are integrated into instruction? A computer generated test given systematically at the end of each computer session was used to answer this question. Each test had a score range of zero to five based on the same number of questions. the results of the tests are listed in Table 3.

Table 3.

Group Means for Computer Test.

Test	Means	Percent Score
Electricity from Magnetism	3.15	63.00
Wiring in Parallel & Series	3.85	77.00

The first test covered electricity from magnetism. The group mean score was 3.15 which was equivalent to 63%. The

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second test covered wiring in parallel; the students' mean raw score was 3.85 which was equal to 77%. Based on the data collected, students comprehended 70% of the information presented through the CAI experiences. The data shows that computer interactions assisted the student learning of concepts related to electricity from magnetism and wiring in parallel circuits.

Question 3

The third and final question was: What responses did the students have toward CAI simulations and experiments in their science class? To answer this question, three types of assessments were used: questionnaires, small group discussions with students, and reactions from the classroom teacher. The student questionnaire asked specific questions that were covered during the computer lessons and their reactions and opinions about Josten's Physical Science Software. The results of the reactions are found in Table 4.

The first set of questions came from the Electric Charges lesson. Questions were scored on a zero to four scale with a low score indicating agreement and a high score indicating disagreement. The group mean score was 1.43 which was a positive response to the use of computer simulations and experiments. The second set of questions came from the Electricity from Magnetism lesson, and the

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Table 4.

Group Means for Student Reactions

Topic	Questions 1	2	3	4	5	6	Means
Electric Charges	1.00	1.10	1.00	1.30	1.20	3.00	1.43
Electricity from Magnetism	1.65	2.47	1.85	3.27	0	0	2.31
Electricity and Magnetism	2.80	1.63	1.50	2.61	0	0	2.13

group mean score was 2.30. This was also a positive response to the CAI. The last set of questions came from the Electricity and Magnetism lesson. The group mean score was 2.13, which was also a positive reaction to the CAI activities.

An analysis of student reactions to the computer-assisted instruction ranged from agree to strongly agree. This indicated that they understood the concepts being presented and liked using the computer lessons.

The second instrument used to determine student responses to the CAI simulations and experiments was six small group discussion sessions with the researcher. The students were asked to answer four questions about their experiences throughout the study. Common threads of student response were used the summarize the data.

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Question 1 asked them how they felt about the science experiments and simulations they had used. Each group seemed to like the science programs, however, they thought the material was very difficult to read and understand. A few suggested that computer software be changed so that the computer would read the information to the student; also they wanted the opportunity to stop one session and come back later and not have to start from the beginning. Several students felt the programs were fun but they would never replace hands-on science activities. A large number of students wanted free access to the computer programs throughout the school day.

The second question asked the students how they would improve the CAI activities they used on the computer. One student wanted to add virtual reality type features to make the computer simulations and experiments more interactive. Others wanted to add a touch screen in order to have more control over the activities; they wanted to have the flexibility to watch a simulation more than once or redo an experiment. Several students wanted to take out some of the reading and add more pictures or diagrams to simplify the material. Also, others wanted to change the program so that the explanations of the concepts and skills were systematically read to them. Many of the changes that the students suggested related to changing the way the CAI

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simulations and experiments were demonstrated or explained in Josten's Physical Science Software. They wanted to make it more user-friendly.

Question 3 asked the students to describe the format of an ideal elementary science class. Their choices were: classroom instruction and discussion only, classroom instruction with hands-on lab activities or classroom instruction, hands-on activities and computer-assisted instruction with simulations and experiments. Overwhelmingly they chose option three. They felt that classroom instruction combined with hands-on lab activities prepared them to complete the CAI lessons independently.

As a group, the students said they enjoyed the CAI simulations and experiments, but would really like to do the experiments themselves. If the material for a particular activity were not available, then they would use CAI.

The last instrument used to assess the student reactions to using CAI simulations and experiments was the evaluations and observations of the classroom teacher. The teacher observed the student reaction to computer interaction and the other forms of instruction. She said, "that students were actively involved with the computer lessons and appeared to enjoy using the program". She also pointed out two limitations of the computer lessons that were hindrances to student involvement. The limitations were

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the difficult reading level, and the inability to return to a specific activity once a student logged out. Both of these factors were frustrating to the students and they lost interest in the entire computer lesson. Suggestions for improving the CAI activities included increased computer usage time, adding more cartoon-like characters and more current graphics to the activities, integrating some virtual reality capability to programs along with joysticks and touch screens.

The classroom teacher evaluations and observations of student involvement with CAI activities were positive. She felt that computer-assisted simulations and experiments were motivating to the students and encouraged them to remain involved every time the students used the computer lessons. She also said the computer lessons would never be able to replace the normal science classroom with hands-on activities and instruction.

Discussion

Within the study presented in this paper students did score higher on a 75-item multiple choice test after having science instruction integrated with CAI experiments and simulations. Research during the last two decades suggests that computer-assisted instruction can and does have a positive effect on student education and achievement. Johnson and Jangejan (1981), in Texas Education Agency

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(1991), assert that supplementary instruction with CAI leads to higher achievement. The data gathered from the study outlined in this paper is in agreement with current research. The 26 sixth-grade students tested before and after receiving science instruction integrated with CAI simulations and experiments did score significantly better on the post-test.

Another concern of this study was student understanding of science concepts in an instructional unit when CAI simulations and experiments are integrated into instruction. Two sets of computer-generated tests were used to answer this question. In both sets of tests the students answered three out of five questions correctly. The group mean scores were 63% and 77%; the overall group mean score was 70%. After receiving CAI instruction, the students scored average on computer-generated tests. Combining instruction and CAI simulations and experiments did enhance student achievement. Earlier researchers felt that a combination of the strengths of classroom instruction and computers provided a powerful tool to enhance instruction. "Burns and Calp (1980) and Johnson and Jangejan (1981) support the idea that supplementary instruction with CAI leads to higher achievement" (Texas Education Agency, 1991, p. 6). This was true for the study outlined in this paper.

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The last question to be answered by this study involved student and teacher reactions to the CAI instruction. The results were gathered and organized by common threads found within the data. On of the first set of questions the answers ranged from zero through two, which indicated a positive response to the content and the computer usage. However, one question had a group mean score of three. This was a negative response by the group. The question asked the students if the CAI lesson had helped them to comprehend the specific concept. This could be one of the areas of the computer lessons the students thought was too difficult to understand with only one exposure. It could also correspond to changes that the students suggested to make the activities more user friendly.

Electricity from Magnetism was the title of the second set of questions to address the student reactions to the Josten's Physical Science Software. The group mean score was 2.31, which was a positive score. The overall scores for this section varied from 1.64 through 3.27; they reacted positively and negatively to these questions. Three out of four of the questions asked students about likes or dislikes of the computer sessions or changes that needed to be made. They responded negatively to changing the specific lesson in its current form and the other three

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were answered positively. As a group, the students did not want to change this particular lesson nor did they think that it was too difficult.

In the last set of questions to determine student reactions to the CAI computer activities, the responses ranged from 1.50 through 2.80. Those responses were positive but were very close to becoming negative. The questions dealt with Electricity and Magnetism. Once again they were opinion-type questions which were asking the students if they comprehended the content or wanted to change the overall lesson. their responses were positive and the students did not want to make any changes to the computer lesson.

The classroom teacher evaluations agree with the student reactions to the computer experiences and other forms of instruction. Minor changes like freedom to move in and out of the computer program at will, more computer time throughout the day, and current graphics were cited as possible improvements.

In conclusion, based on the results of this study, the students did score higher on a post-test after receiving classroom instruction integrated with CAI simulations and experiments. On content-related tests, the students scored a mean of 70%. They also enjoyed using the Josten's Physical Science Software and would like to make minor

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changes to make the computer lessons more user-friendly. The results of this study suggest that computer-assisted instruction for science would be helpful in elementary classrooms. The students' achievement was noticeably higher and their attitudes were positive toward the use of CAI. The Texas Education Agency (1991) suggests that "the immediate feedback afforded by computerized instruction provides the learners reinforcement for success and a motivating, esteem building learning experience. With each success, the learner is encouraged to continue" (Texas Education Agency, 1991, p. 9).

Summary

The purpose of the study was to examine the effects of computer-assisted experiments and simulations on student learning in elementary classrooms. Students did score higher on a post-test after receiving classroom instruction and computer experience on specific topics. Students increased their understanding of science concepts based on classroom instruction and CAI. The reactions of the teacher and the students were positive toward using simulations and experiments; however, changes were suggested from both groups to improve the software.

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REFERENCES

Buttles, S. (1992). A model for incorporating and evaluating use of a computer laboratory simulation in the nonmajors biology course. The American Biology Teacher, 54, 492-494.

Couch, D. J. & others. (1993). Interdisciplinary study with computer-based multimedia. Pittsburgh, PA: Conference of the International Visual Literacy Association.

Doyle, J. J., & Lunetta, V. N. (1982). Class, open your microcomputers. The Science Teacher, 49, 26-30.

Etheridge, B. (1994). A guide to quality childhood and elementary school programs. North Carolina Department of Public Instruction.

Georgia Framework for Learning Mathematics and Science. (1994). Washington, D.C.: National Science Foundation.

Graef, J. (1984). Teaching science with computers. The Physics Teacher, 22, 430-436.

Greenwood, A. (1996). Science is part of the big picture. Science and Children, 32, 32-34.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Habowsky, J. J., Sands, T. W., Hogue, C. W., Stager, R. A., & Postlethwait, S. N. (1990). An audio-directed multimedia lab. Journal of Computer Science Teachers, 19, 232-234.

Hale, E. M. (1986). Improving research on computers in science learning: A reaction. Journal of Research in Science Teaching, 23, 471-473.

Hounsell, P. B., & Hill, S. R. (1989). The microcomputer and achievement and attitudes in high school biology. Journal of Research in Science Teaching, 26, 543-549.

Jostens Learning Corporation. (1992). Exploration in science curriculum guide. San Diego, CA: Author.

Krueger, B. (1994). Theory in practice: The importance of constructivist learning in a science unit. Australian Science Teacher Journal, 40, 31-34.

Kyle, W. C., Jr., Abel, S. K., Shepardson, D. P., Seals, M. A., & Ruth, D. J. (1995). Using NGS kids network as an instructional tool in science methods courses. Journal of Computers in Mathematics and Science Teaching, 14, 169-186.

Lehman, J. R. (1994a). Technology use in the teaching of mathematics and science in elementary school. School Science and Mathematics, 94, 194-201.

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Lehman, J. R. (1994b). Secondary science teachers' use of microcomputers during instruction. School Science and Mathematics, 94, 413-420.

Lumpe, A. T., & Oliver, J. S. (1991). Dimensions of hands-on science. The American Biology Teacher, 53, 413.

Magnusson, S. J., & Palinscar, A. S. (1995). The learning environment as a site of science education reform. Theory Into Practice, 34, 43-48.

Poirot, J. L. , & Canales, J. (1993). Technology and the at-risk--an overview. The Computing Teacher, 38, 25-55.

Perry, N. J. (1990). Computers come of age in class. Fortune, 72-78.

Richards, J., Barowy, W., & Levin, D. (1992). Computer simulations in the science classroom. Journal of Science Education and Technology, 1, 67-78.

Rosegrant, T. (1995). Technology in the classroom. Childhood Education, 32, 116-117.

Sia, A. P. (1992). Enhancing instruction through software infusion. Orlando, FL: A.T.E. Conference.

Solomon, G. (1990). Learning social studies in a one-computer classroom. Electronic Learning, 36, 18-20.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Stohr-Hunt, P. (1996). An analysis of frequency of hands-on experience and science. Journal of Research in Science Teaching, 33, 101-109.

Stringfield, J. K. (1994). Using commercially available, microcomputer-based labs in the biology classroom. The American Biology Teacher, 56, 106-108.

Texas Education Agency. (1991). Learning with computers: Implementation of an integrated learning system for computer assisted instruction (CAI). Huntsville, TX.

Thomas, D. A. (1994). Scientific visualization in mathematics and science teaching. Charlotteville, VA: Association for the Advancement of Computing in Education.

Wiburg, K. (1994). Teaching science with technology: Telecommunications and multimedia. The Computing Teacher, 21, 6-8.

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