The Effects of the Delaware Challenge Grant Program on the Standardized Reading and Mathematics Test Scores of Second and Third Grade Students in the Caesar Rodney School District

by

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Chapter I

Introduction

> "We're going to work together to help our schools use technology to revolutionize American education so that all children will be able to learn better and teachers will be able to be more effective" (President Bill Clinton, 1995).

With these words, President Clinton announced that The Lightspan Partnership, the Capital School District in Dover, Delaware and the Delaware State Department of Education were awarded a Technology Learning Challenge grant. This grant, which became known as the Delaware Challenge Grant, was designed to connect schools and homes with interactive curriculum programming and technology.

Technology has come to dominate every aspect of our lives: at work, home and school. You see it, hear it and read about it in almost every form of existing media (Blanchard, 1997). Digital telecommunications has made it possible for people throughout the world to share information in ways never before possible (Bridging Homes and Schools: An Education Summit, 1997).

There has been a major thrust to integrate science, mathematics and technology in the schools. Coupled with this is the national trend to make all citizens "computer literate" and the rationale being that we our in an information age (Hamilton, 1995). According to Hamilton (1995), those unable to access and process data in a meaningful way will find themselves unemployable. Entire curricula are being developed, funded, and mandated by the federal government to reach this goal

(Hamilton, 1995). School districts have begun to develop technology plans designed to ensure that each school is committed to making all children computer literate.

According to Hirschbuhl (1994), the educational media or instructional systems and technology field have expanded rapidly. It has spread far beyond the use of videos, films, and slides to encompass such innovations as programmed learning through teaching machines, computer based or computer-assisted instruction, CD ROM, interactive video, and closed circuit television.

Since their introduction in schools in the 1980s, computers and computer software have been increasingly accessible to students and teachers in classrooms, computer labs, school libraries, and in homes. By the mid 1990s there were about 4.5 million computers in elementary and secondary schools throughout the United States (Hirschbuhl, 1994).

Currently, computers are being used for teaching and learning in school in at least four ways. First, CD-ROMS, videodisks, electronic encyclopedia, and video libraries allow students to browse through and acquire a variety of information. Second, software called computer-assisted instruction, or CAI, poses questions to students and leads them through a progression of developmental skills like reading and mathematics. Third, computers aid students in the development of analytic competencies and understandings. Students attain these goals through word processors, graphing and "construction" tools, simulations of social environments, electronic painting and computer assisted drafting programs, and programs that aid in collecting data for analysis. Finally, several types of computer software can be used for communication: desktop publishing, computer programming for creating interactive computer exercises, and telecommunications software for exchanging ideas at electronic speeds with students in other classrooms all over the world (Hirschbuhl, 1994).

Enthusiasm for computer use in educational school settings has increased (Anderson, 1993). In 1992, research conducted by the International Association for the Evaluation of Educational Achievement found that U.S. schools had an inventory of about 3.5 million computers in the classroom (Anderson, 1993; Pelgrum, 1993). A school survey, conducted in 1983, indicated that 250,000 computers were found in schools for instructional purposes, although this had risen to one million by 1985 (Anderson, 1993; Becker, 1986; 1991). A more recent survey conducted in 1998 showed that the number of instructional computers grew to about 8.6 million (Anderson & Ronkvist, 1999).

However, according to Hirschbuhl (1994) in spite of the variety and power of education-related software, surveys indicated students are still using school computers mainly to practice basic language and mathematics skills and to learn about computers and computer software. In fact, according to the report Bridging Homes and Schools: An Education Summit (1997), the way American students learn has changed very little over the past 100 years. The textbook and other printed media are still the backbone of instructional practices in the classroom.

The Delaware Challenge Grant proposed to address key issues facing schools today by incorporating technology in the school and the home, thereby making a connection that would make it possible for many families in Delaware to:

- be connected to their schools via interactive technology
- access interactive educational media content in their homes any time
- significantly enhance the learning that takes place at school
- extend learning beyond the physical boundaries of the school building and the current time limits of the school day (Bridging Homes and Schools: An Education Summit, 1997).

Background

According to a 1995 Lightspan Partnership news release, President Bill Clinton announced the awarding of Technology Learning Challenge Grants to 19 communities nationwide. These challenge grants awarded over $9.5 million to school districts to develop partnerships with area businesses, which would foster technology within the community. The Lightspan Partnership and the Capital School District, in concert with The Delaware State Department of Education, were joint recipients of a federal “Challenge Grant” for a project to connect schools and homes with interactive curriculum programming and technology. The Capital School District, representing the state of Delaware as lead educational agency, received a $5.5 million federal matching grant. This grant proposed to bridge the family home/school connection through technology. The grant was to be used to bring new technology and Lightspan curriculum-based programming to schools and to thousands of students throughout the state.

The Challenge Grant Program proposed to establish instructional linkages between schools and student homes in over one-third of Delaware's elementary schools using the grant award. The Challenge Grant funding was also used to address student, parent, and staff needs relative to using technology in the classroom. By doing this, the Challenge Grant was to enhance teaching, learning, and parent involvement in the schools.

One of the first decisions of the Challenge Grant Program was to choose the instructional software that would be used to carry out its goals. The Lightspan Partnership was chosen to provide the interactive instructional programming to support Delaware's core curriculum standards in Reading/Language Arts, Mathematics, Science, and Social Studies. The Lightspan Curriculum was designed to be used with students in kindergarten through sixth grade. The curriculum contains sets of interactive reading and language arts games, which are united with exciting story lines and a variety of different characters. The software activities include riddles and puzzles, discovery games, databases, tool-based applications, strategy games, and arcade-style games. By playing the different games, students gain experience with many different ways of communicating information, ideas, and feelings.

Lightspan literature also states that the curriculum is designed so teachers, students, and parents have a variety of flexible navigation options that allow them access to any “world” or adventure. Each adventure has an established story that teachers may use to set the stage for a unit of study. Portions of the game play can be used to introduce new material.

Lightspan’s interactive instructional programming is designed to correlate with and extend the typical school’s curriculum in mathematics and reading. The programming can be used on computers, as well as on much less expensive “digital set-top” devices that connect to a normal family television set (Lightspan Partnership, 1996). Families receive these devices on loan from the school, allowing children and their parents to use powerful, interactive curriculum programs at home.

In terms of intended outcomes, the Delaware Challenge Grant through its design and activities is able to address needs in relation to improving student achievement, parental involvement, professional development and equity in a highly effective and cost-efficient manner.

The four main goals of the Delaware State Challenge Grant project are to:

- generate more time for learning
- increase parental involvement
- provide professional development for teachers and staff
- provide equitable access to technology and the information infrastructure. (Brown, 1997)

The goals were derived from a report commissioned by the U.S. Congress entitled Prisoners of Time, which identified four key problems that are hindering education in the United States. The first goal, to generate more time for learning, addresses the lack of time for learning. There is an abundance of research showing the link between academic learning time and achievement. Educators and researchers have long recognized time as an important factor in learning. The direct relationship between achievement and active learning time has become firmly established both for individuals and groups of students (Brookover, Beamer, Efthim, Hathaway,Layette, Miller, Passalacqua,& Tornatzky, 1986). Studies recording actual engaged time and time on task have consistently found that the greater the learning time, the greater the level of achievement (Anderson, 1982; Bloom, 1980). Studies done in Learning for Mastery (Bloom, 1976) showed that on average the difference between mastery and non-mastery for a student needing remediation is about an hour of extra instruction every two weeks. This is the equivalent of six minutes a day each school day. According to Bloom (1976), improving achievement by increasing academic learning time is a goal that teachers, parents, and students should strive to meet.

There is not much difference between schools in the amount of time in the total instructional day. Most schools schedule about five hours of classroom time a day (Prisoners of Time, 1994). However, only about three hours of the school day is spent learning core curriculum subjects such as mathematics, reading, science, and social studies (Prisoners of Time, 1994). This is about half of the time spent by Japanese and European students on similar subject matter. However large or small, variations in total instructional time are related to resulting levels of achievement (Wiley & Harneshfeger, 1974). As Bloom (1980) indicated, time on task is one of the variables that accounts for learning differences between students, between social classes and even between nations. Schools wanting to improve achievement should examine ways in which learning time can be increased.

Although it is well recognized that students need to spend more time on core academic subjects if they are to meet world class standards, lengthening the school day or school year may not be a feasible solution since the national cost of adding even a single day of school would exceed $1.1 billion (Prisoners of Time, 1994). Rather than lengthening the school day or school year, the Delaware Challenge Grant proposed to extend the school day by providing students technology that would enable them to continue to pursue curriculum objectives at home. This was accomplished by providing students with interactive television technology capable of running a comprehensive Kindergarten through sixth-grade curriculum with the motivational appeal of video games. Teachers used the interactive curriculum in their classroom during the day, and students interacted with it in their homes after school hours. Presenting curriculum in this entertaining fashion was designed to motivate students to use it, thereby extending the amount of time spent on the core subjects of Reading, Mathematics, Science and Social Studies.

Another goal of the Challenge Grant deals with the lack of family involvement. Promoting student achievement is the responsibility of all those involved in the learning process. This would include not only the principal and staff, but also the parents (Brookover, et al., 1986). The closer the parent is to the education of the child, the greater the impact on child development and educational achievement (Fullan, 1991). Studies have shown that the most accurate predictor of a student's achievement is not income or social status but the extent to which a family creates a home environment that encourages learning (Prisoners of Time, 1994; Epstein, 1988). A review of research conducted by Clark, Lotto, and MacCarthy (1980) identified studies that presented evidence on factors that accounted for educational achievement. Of the forty reports that were analyzed, thirteen showed a direct relationship between parental involvement and student achievement.

In light of the research indicating a direct relationship between parental involvement and student achievement, the concern was with those parents who do not become actively involved in their child's education. (Fullan, 1991; Ziegler, 1987). We are, in fact, seeing an emergence of single-parent homes (Prisoners of Time, 1994). A study conducted by Caldas and Bankston (1999) analyzed student, school, and district level effects on academic achievement. The study found that the percentage of single-parent families was the single most significant factor in predicting school effectiveness. The study stated that the influence of family structure on achievement was three times greater than race and two times greater than poverty.

It is widely recognized that some parents are reluctant to get involved in school activities (Vandergrift & Greene, 1992). According to Vandergrift and Greene (1992) there are more homes with both parents working. There has also been an emergence of single parent homes. Because of this, schools are challenged to find ways to involve parents in their children's education. Therefore, the school as a whole has to develop ways to work with parents to make them comfortable enough to get involved in the education process (Vandergrift & Greene, 1992).

Aspects of the Delaware Challenge Grant addressed this issue by providing the home with access to interactive educational television. This allowed parents to see exactly what their children were learning in school. Parents were able to interact with their children by actually experiencing the learning game format. They got to experience firsthand the concepts and objectives of their child's curriculum. If family and schools are connected, there can be positive effects for children (Booth & Dunn, 1996; Epstein, 1996; Lareau, 1989).

The third goal of the Delaware Challenge Grant was to provide professional development for teachers and staff. To educate students successfully, teachers need to be aware of changing educational paradigms while continuing to teach every day (Bridging School and Homes: An Educational Summit, 1997). Professional development of teachers enables them to expand knowledge and skills, contribute to growth, and enhance student learning (Fullan, 1991). According to Fullan (1991), professional development is one of the most successful and promising routes to growth on the job, school improvement, and job satisfaction.

With the implementation of technology in the school, teachers need to become technologically literate and competent. Even though recent trends show a new insistence that teachers become technologically literate, colleges of education are not adequately preparing teachers to use technology in the classroom (Gonzales & Hill, 1998). Research conducted by the Office of Technology Assessment (1995) indicated that teachers do not feel adequately prepared to integrate technology into their teaching. According to the study, most new teachers graduate with limited knowledge of how to integrate technology into their teaching. In another study, faculty members identified lack of knowledge about software, time constraints, and limited recognition of technology's potential as obstacles to effectively integrating technology into the curricula (Wentzel, 1993). In a study conducted by the National Center for Education Statistics (2000), only 23 percent of public school teachers felt well prepared to use computers in their teaching. The study further stated that teachers with more than 32 hours of professional development in the use of computers reported feeling much more prepared than teachers who had only 0-32 hours of training in computers. We have spent more than a decade studying new technology for the classroom and millions of dollars implementing it; however, there is some evidence that we have failed to integrate the use of technology throughout the regular classroom curriculum in ways that are meaningful, natural and powerful (Boersman, 1993).

The Delaware Challenge Grant is providing professional development for staff members at each of its participating schools. The Challenge Grant in cooperation with the Lightspan Partnership has provided over 60 hours of professional development for participating schools. The Challenge Grant contracts with the Lightspan partnership to provide approximately twelve visits to each school during the year. The grant employs two full time teacher-trainers to provide staff development for teachers.

The fourth Challenge Grant goal was to provide equitable access to technology. Equity among students is necessary in order to promote the positive self-esteem needed to enable students to make productive contributions in his or her school community, country, and world (Becker, & Sterling 1987). According to a joint policy statement on equity in education put out by the federal government, educators must identify and remove physical and programmatic barriers that produce inequities in academic achievement. Special emphasis should be placed on identifying and removing barriers for students of color, students with disabilities, students in poverty and female students (Equity in Education: Policy and Recommendations, 1996).

The computer is fast becoming a prerequisite for a high quality education, yet less than five percent of students from low income homes have computers, compared to over fifty percent of students from high income homes (Bridging Schools and Homes, 1997; Trotter, 1996). According to the Pew Research Center study, Technology in the American Household (1995) computer ownership also varies by race. The study states that only 9.5 percent of black families own computers, and 12 percent of Hispanic households own them.

Inequity regarding females and computer usage has also been researched. Empirical evidence suggests that female students, in comparison with males, are disenfranchised with respect to access and usage of computers, less likely to acquire computer competence and confidence, and do not assume leadership roles in this area (Becker & Sterling, 1987; Brepan & de Costell 1996; Comber, 1997).

Schools enlarge their sphere of computer technology when they include a home-school connection (Trotter, 1996: Blanchard & Oliver, 1999). When schools take steps to bridge the technology gap between the haves and have nots, there becomes one less barrier preventing all students equal access to a basic education (Trotter, 1996).

The Delaware Challenge Grant, with the Lightspan Partnership, proposed to address this disparity by using pre existing technology found in over 99 percent of homes in the United States, the television. By combining the ordinary television and computer technologies of today, the Lightspan Partnership are able to deliver high-quality interactive educational curriculum programming into the home. According to Lightspan Partnership literature, this is accomplished by attaching a digital video multi-player to the television set, which acts as a monitor. This device gives the family television the functionality of a computer. By using the television set and the interactive digital multi-player, the Delaware Challenge Grant hoped to address the disparity of the computer have and have-nots in an economical way.

The project consisted of placing 20 to 25 computers in selected elementary schools throughout the state. These computers ran CD-ROM software that correlated with the national standards. Teachers used the CDs to teach whole group instruction or assign students individual lessons to work on in class.

In addition, the grant provided 150 SONY Playstations, which were distributed to the students' homes. These Playstations are capable of running the same instructional software in the home that is available in the classroom. This allows all students, regardless of economic background, access to the same technology, both in school and at home.

Purpose and Need for the Study

The purpose of this study was to evaluate the impact the Challenge Grant program had on student achievement. Specifically, the intent was to evaluate the effects that participation in the Challenge Grant program had on the reading and mathematics achievement levels of students in second and third grade over a two-year period. In the spring of 1997, W.B. Simpson Elementary School was selected to participate in the Delaware Challenge Grant Project. The second grade and the fifth grade were the grade levels chosen to participate. In 1999, the program included third grade students. To date, a total of 16 computers have been placed in eight classrooms. Over 150 SONY Playstations have been placed in students' homes. Many hours have been devoted to teacher training and student training. Staff members have been used to coordinate the challenge project within the school. Building budget monies have been used to buy necessary hookups, computer tables, and other accessories. Eventually, the challenge grant monies will cease. At that point a decision will need to be made as to the "worthiness" of this program and whether it should be continued and supported at the school level. According to Ascher (1984), research studying the effectiveness of using computers to teach elementary reading and mathematics has shown positive, although varying, and "ungeneralizable" results. Other studies have found little proof of educational improvement.

This study examined the effects of computers and the use of video game formatted instructional software on student achievement. This study is important because it investigated technologies that allow families and schools to have equivalent technology and how that family-school connection affects student achievement.

Research Question

The question that this study sought to answer was, "What effect did the Delaware Challenge Grant based software program that is available to second and third grade students both in school and at home have on the reading and mathematics skill levels of those students on a standardized test?" Three specific questions were answered by this investigation.

1. In comparison to other students, did participation in the Delaware Challenge Grant Project have a positive effect on the vocabulary achievement of students in grades two or three?
2. In comparison to other students, did participation in the Delaware Challenge Grant Project have a positive effect on the reading achievement of students in grades two or three?

3. In comparison to other students, did participation in the Delaware Challenge Grant Project have a positive effect on the mathematics achievement of students in grades two or three?

Null and Alternative Hypotheses

Ho1: There will be no significant difference between the vocabulary comprehension scores on the Stanford Achievement Test (SAT 9) vocabulary survey subtest of second and third grade students who received computer instruction using the Lightspan Partnership software, along with traditional vocabulary instruction, and second and third grade students who received only the traditional classroom vocabulary instruction.

H_a1: Ho1 is false.

Ho2: There will be no significant difference between reading comprehension scores on the Stanford Achievement Test 9 (SAT 9) reading survey subtest of second grade and third grade students who received computer instruction using the Lightspan Partnership software, along with traditional reading instruction, and second and third grade students who received only the traditional classroom reading instruction.

H_a2: Ho2 is false.

Ho3: There will be no significant difference between mathematics scores on the Stanford Achievement Test (SAT 9) mathematics survey subtest of second and third grade students who received computer instruction using the Lightspan Partnership software, along with traditional mathematics instruction and second and third grade students who received only traditional classroom mathematics instruction.

H_a3: Ho3 is false

Definition of Terms

CAI- Computer assisted instruction- instructional software, which aids teachers and students in obtaining skill development in reading, math and other subjects.

SONY Playstation- a 32-bit CD-ROM video game computer.

Lightspan Partnership: Software Company that developed CD programs that features K-8 instructional content.

Chapter II

Review of the Literature

When researching technology and its effect on academics, one finds a plethora of information in articles, journals and books on the successful use of computers in the classroom. Advocates cite cases and examples of effective programs, while critics question whether technology will ever fulfill its expectation and promise of providing a better learning tool for students (Thompson & Montgomery, 1994). Many of the studies are based on global comparisons between computer- assisted instruction (CAI) and traditional forms of instruction (Woodward & Ruth, 1997). The research will be presented as it evolved historically from the reform movements that facilitated the introduction of computers in the schools to broad comparisons between CAI and traditional instruction.

This review focuses on literature that deals specifically with technology and instructional software supplementing the learning process within the classroom, and the impact it had on student achievement. Specific literature studying the impact instructional software had on the reading and math scores of students is given a priority. Although this study deals specifically with elementary grade students, any literature studying the effects of computer software on student achievement was considered for this review.

Computers and Reform

Educational reform and the quality of schools have been at the top of the list of national reform for decades (Coley, Cradler, Engel, 1999). Political leaders, employers and the general public have expressed grave concern about the educational process in America (Means, Blanco, Middleton, 1993). For more than a decade now, reformers at the state and local levels have attempted to revolutionize the way schools operate and students learn with a variety of top- to- bottom and bottom- to- top changes in administration, curricula and instructional process (Carvin, 2000). While a number of different approaches have been suggested for the improvement of K-12 education in the United States, one common element of many such plans has been the extensive and effective use of computers (President’s Committee of Advisors on Science and Technology, Panel on Educational Technology, 1997). The successful introduction of computers in the schools is due partly to the association between education, technology and school reform (Carvin, 2000).

In 1983, the landmark report A Nation at Risk was published. The report demonstrated that, from kindergarten through twelfth grade, basic comprehension rates were low compared to other nations, and high school drop out rates were high. It was made clear that the nation was indeed at- risk, and something had to be done (Carvin, 2000).

That something became the “First Wave of Reform,” and it consisted of standardization of schools. By the mid-1980s, 45 states had expanded their standardized testing, required more regular testing, required greater preparation for standardized tests, and instituted more exacting graduation requirements. On top of all that, 46 states instituted various types of merit pay for teachers (Carvin, 2000).

However, by the 1990s, research indicated that all the emphasis on standardization had resulted in little improvement in student learning and comprehension. Teaching guidelines had become "more complex and less coherent" (Carvin, 2000 p.48). Critics claimed these early attempts at reform were merely more of the same with little change in the nature of instruction (Means et al., 1993).

According to Andy Carvin's (2000) book, The Developmental Years: First Wave Reform, it was suggested that bureaucracy and the administrative structure also had to be reformed. Consequently, since about 1995, "Systemic Reform" was instituted. Systemic reform refers to two, rather broad, areas. The first is sweeping changes in education. These changes are usually found in state and federal omnibus bills, such as the Federal Government's "Goals 2000" plan. The second reform involved grassroots reorganization. This included states taking back power from the Federal government; school districts taking power back from the state; schools taking power back from the district; all the way down to parents taking power back from their local school boards. The purpose was to decentralize educational mandates, allowing individual schools to reach goals and mandates in their own ways through local initiatives and independent decisions (Carvin, 2000).

The Federal Government passed legislation – Goals 2000 – to encourage schools throughout the country to set and reach distinct goals, such as the Ready to Learn program, which would encourage the preparation of pre-schoolers to be "ready to learn" when they enter regular school, and to increase the national graduation rates to 90% (President's Committee of Advisors on Science and Technology, Panel on Educational Technology, 1997). The Goals 2000 Act also contained a number of provisions designed to foster the application of technology within the nation's schools

(President's Committee of Advisors on Science and Technology, Panel on Educational Technology, 1997).

This new wave of reformation also called for bottom-up control, and encouraged the development of alternatives, such as charter schools, the involvement of educational management organizations, school choice, and even home schooling (Carvin, 2000). There were increasing calls for accountability in reaching the goals of improved comprehension, testing, and graduation levels (Carvin, 2000).

Computers became important in reaching stated reform movements' goals. One of the earliest insights into the educational application of technology was that computer- based systems individualized the educational process to accommodate the needs, interests and learning styles of different students (President's Committee of Advisors on Science and Technology, Panel on Educational Technology, 1997). Earliest drill and practice based computer systems offered the advantages of self-paced instruction. It allowed students to be exposed to textual material at their own pace thereby individualizing the lesson for each student (Coley et al., 1999; Cotton, 1997; Cuban, 1985). With the addition of the Internet, computers have enabled teachers and administrators to form professional bonds to an extent never before seen in the history of education (Becker, 1998; Fletcher, 1996). The Internet and e-mail allow teachers to exchange lesson plans, ideas, opinions, and methodologies with colleagues all over the world (Becker, 1998; Fletcher, 1996). Thus, new methods can be employed without attendance at outside teachers' conferences. Rather, change can be immediate and localized.

Within the classroom, computers encourage active collaboration of students in learning and educational assessment (Boersma, 1992). According to Boersma (1992) a word processor may enable a child to become a publisher of his/her own ideas and opinions, and e-mail provides group editing and review. Various types of software enable "inquiry" type learning, where a student can pursue knowledge on his/her own with one question leading to another, and the computer/internet providing the answers (Mageau, 1992).

However, the use of computers in the classroom is still being debated (Archer, 1998; McNabb et al., 1999; Trotter, 1996). Some say the computer does not replace the teacher; rather, it frees him/her to focus all his/her efforts on individual students' needs, interacting and providing assistance as necessary, allowing each student to learn at his or her own pace (Carvin, 2000).

Historical Overview of Computer Assisted Instruction

Computers first began appearing in schools during the mid -1960s (Culp et al., 1999). These earliest forms of educational technology were systems designed to automate tutorial learning in the classroom (President's Committee of Advisors on Science and Technology, Panel on Educational Technology, 1997). The interest in computers accelerated in the 1970s with the introduction of the microcomputer (Culp et.al, 1999; Sinkis, 1993; Standish, 1995). According to Kinnaman (1990), the use of microcomputers expanded rapidly during the 1980s. Between 1981 and the end of that decade:

- American schools acquired over 2 million microcomputers

- The number of schools owning computers increased from approximately 25 percent to virtually 100 percent.
- More than half of the states began requiring or at least recommending pre-service technology programs for all prospective teachers (Kinnaman, 1990, p.29).

By the- mid 1980s, more innovative and electronic material became available, and technical innovation and more powerful technology were being brought into the schools (Culp et al, 1999). The most prevalent type of program being used in the schools at this time basically individualized student learning through the use of computers (Boersma, 1993; Kosakowski, 1998). These systems were generally referred to as computer assisted instruction (CAI) (Bangert-Drowns Kulik, Kulik, 1985). According to Grimes (1977), CAI presented blocks of educational information to individual students. Students were usually required to answer questions designed to assess comprehension of specific elements of the material. Questions were usually multiple choice or true/false and usually elicited a simple, concrete answer that could be interpreted by the computer in a straightforward manner. The student was able to receive instantaneous feedback to their responses and track mastery of the material. Grimes (1997) further noted that conventional CAI systems have historically been employed primarily for individual instruction, most often in a drill-and-skill practice mode.

Another type of CAI incorporated computer and networking hardware, software, tutorial content, and student record management programs all under one vendor (Bangert-Downs et al., 1985). This network-based system was known as integrated learning system or ILS. This type of computer managed instruction allowed staff to organize student data, make instructional decisions, plan activities in which the computer evaluates students' test performances, guides them to appropriate instructional resources, and keeps records of their progress (Mageau, 1992; McFarlane, 1999). According to Bangert-Downs et al. (1985), these programs provide a skills-based model of learning, in which students are presented a question, record their response, give instantaneous feedback and make an automatic selection of the next question. Some integrated learning systems were structured to deal with only the content provided, but others could be linked with additional software resources or the internet, or cross referenced to books and videos (McFarlane, 1999).

These systems became very popular among educators because of their built-in assessment measures, ability to demonstrate student progress over time and their efficiency (Becker, 1994). As of 1990, over 10,000 ILS systems had been installed in the United States in over 40 percent of the schools (President's Committee of Advisors a Science and Technology: Panel on Educational Technology, 1997).

The problem with these types of models is they are restricted to student performance based solely within the context of the integrated learning system (Becker, 1994). Students learned isolated skills and tools, but they lacked an understanding of how these skills fit together to solve problems or complete tasks (Eisenberg & Johnson, 1996). The limitations of CAI and ILS led to an approach designed to use computers to facilitate open-ended exercises that would stimulate and motivate students (Bangert-Drowns, 1985). This approach is known as computer enriched instruction (CEI). According to the definition offered by Bangert-Drowns (1985):

> computer enriched instruction provides learning activities in which computers generate data at the students' request to illustrate relationships in models of social or physical reality, to execute programs developed by students, and to provide general enrichment in relatively unstructured exercises to stimulate and motivate students. (p. 36).

According to Kirkpatrick and Cuban (1998), CEI differs from both CAI and ILS in that CEI programs provide less structure and more open-ended opportunities to support a learning concept. Some examples of CEI include having students use the Internet, word processing, graphing and drawing programs to complete a project or task. Educators using the CEI approach provide collaborative learning in the classroom (Carvin, 2000). Students using word-processing become independent publishers of ideas and opinions, and e-mail provides opportunities for peer review and group editing (Carvin, 2000). Other CEI programs offer true inquiry-based learning, where students construct and demonstrate solutions to a variety of in-class projects (Carvin, 2000).

Using computers to facilitate discovery is based on the learning theory of constructivism (Means et al., 1993; President's Committee of Advisors on Science and Technology, 1997). Constructivist learning is based on students' active participation in problem solving and critical thinking regarding learning activities (Lambert, Walker, Cooper, Lambert, Gardner, Ford-Slack, 1995; Strommen, 1992). They "construct" their own knowledge by testing ideas and approaches based on prior knowledge and experience, applying these to a new situation, and integrating the new knowledge gained with pre-existing views to construct a new level of understanding (Lambert et al., 1995; Strommen, 1992). The educational research community has, in part, agreed that advanced skills of comprehension, reasoning, composition, and experimentation are acquired not through the transmission of facts, but through the learners' interaction with context (Means et al., 1993; Steffe & Gales, 1995; Strommen, 1992). This constructivist view of learning allows students to pursue a problem or activity by applying approaches they already know, and integrating those approaches with alternatives presented by other students, research sources, or current experience. This approach allows students to attain their own intellectual identities (Brooks & Brooks, 1993).

Computers are an invaluable tool for providing students a chance to engage in active collaborative learning and assessment (Carvin, 2000). This contructivist/computer relationship exists because computers provide students with unlimited access to information that they need in order to do research and test their ideas (Becker, 1998). According to Becker's (1998) Teaching Learning anComputing study, the computers facilitate communication, which allow students to present their beliefs and products to broader audiences and expose them to opinions of a more diverse population beyond the classroom walls. According to Becker (1998), these are optimum conditions for constructivist learning.

Research on Computer Assisted Instruction

A great deal of research has been conducted on the effects of computer use and achievement, attitudes, and other variables such as learning rate (Cotton, 1997; Mergendoller, 1997). The research covers a wide range of topics from computerized tutorial instruction, which supplement conventional instruction, to computer programming, to integrated learning systems, to writing using databases, to computer enriched instruction and other applications (Cotton, 1997; Mergendoller, 1997).

The main focus of this research will report on the most commonly used and most frequently researched kind of educational computer use, which is computer-assisted instruction (Cotton, 1997). This type of computer use can be found in almost every classroom today (Mergendoller, 1997).

Kulik (1994) conducted a meta-analysis to aggregate the data from more than 500 individual research studies dealing with computer-based instruction. His findings indicated that on average, students who used computer based instruction scored at the 64th percentile on tests of achievement compared to students in the control group without computers who scored in the 50th percentile. The study also indicated that students learn more in less time when they receive computer-based instruction.

A review conducted by Sivin-Kachala (1998), investigated 219 research studies from 1990-1997 that assessed the effect of technology on learning and achievement across all learning domains and all ages of learners. From his analysis of these studies, he found that students in a technology rich environment experienced positive effects of achievement in all major subject areas. Students in a technology rich environment also showed an increase in achievement in preschool through higher education for both regular and special needs children. In addition, students' attitudes toward learning and their self-concept improved consistently when computers were used for instruction

Baker, Gearheart and Herman (1994) conducted a five-year evaluation of The Apple Classrooms of Tomorrow (ACOT). This study assessed the impact of interactive technologies on teaching and learning in five school sites across the nation. The purpose of ACOT was to encourage instructional innovation. It also emphasized for teachers the potential of computers to support student initiative, access multiple resources, and cooperative learning. Over the course of the five-year initiative, comparisons were made of students' basic skills performance to nationally reported norms, student progress and achievement over time, and ACOT teachers' instructional practices. Baker, Gearhart and Herman (1994) found that the ACOT experience resulted in new learning experiences that required higher-level reasoning and problem solving. ACOT also had a positive impact on student attitudes and resulted in teachers using more cooperative teaching and less lecturing in the classroom.

A study of the state of West Virginia's Basic Skills/Computer Education (BS/CE) program was conducted by Mann (1999). This study collected data from 290 teachers whose fifth grade students had participated in the program since 1991-92. The study examined the influence West Virginia's Integrated Learning System technology had on student achievement. The Integrated Learning System focused on spelling, vocabulary, reading and mathematics. The study found that students' using BS/CE showed an increase in test scores on the Stanford 9 achievement test. The at-risk or lower achieving students had the greatest increase in test scores. Mann (1999) also found that the more the students participated in BS/CE, the more their test scores rose on the Stanford 9. Consistent student access to the technology, positive attitudes towards the technology and teacher training led to the greatest student achievement gains (Mann, 1999).

There have been several studies researching computer-enriched instruction. One such study conducted by Wenglinsky (1998) assessed the effects of simulation and higher order thinking technologies on a national sample of 6,227 fourth graders and 7,146 eighth graders in mathematics achievement on the National Assessment of Educational Progress (NAEP). Wenglinsky controlled for socioeconomic status, class size, and teacher characteristics. His findings indicated that eighth grade students who used simulations and higher order thinking software showed gains in mathematics scores of up to 15 weeks above grade level as measured by the NAEP. Eighth grade students whose teachers received professional development on computers showed gains of up to 13 weeks above grade level. However, Wenglinsky (1998) also reported that fourth grade students who used technology to play learning games and develop higher order thinking, performed only three to five weeks ahead of students who did not use technology. Both fourth and eighth grade students who used drill and practice technologies performed worse on NAEP than students who did not use the drill and practice technology.

Recent advances in networked technologies with computers are making a social and collaborative enterprise (Scardamalia & Bereiter, 1996). One of the most widely studied collaborative computer applications in schools today is the Computer Supported Intentional Learning Environment (CSILE) Scardamalia, Bereiter and, 1996). Computer Supported Intentional Learning Environment had entire classrooms of children conceive, respond to, and reframe what was said and written using computers. CSILE students asked questions, searched for other students' answers to their questions, commented on and reviewed each other's work and then restructured and formulated answers to their original inquiries. Eight years of research conducted by Scardamalia and Bereiter, (1996) demonstrated that CSILE students surpassed students in control classrooms on measures of depth of understanding and reflection. They also surpassed the control group on gains using a standardized test of reading, language and vocabulary. The researchers found that using CSILE maximized student reflection, encouraged: progressive thought, and encouraged taking multiple perspectives and independent thinking.

A group of researchers at the Massachusetts Institute of Technology employed learning by design principles to educational technology by having students become creators and designers of educational software (Harel, 1990). The children learned through design activities by programming computers to create applications that other children use and learn from. Research by Harel (1990) studied the effects of introducing Logo programming to design software to teach fractions to younger students. Students had to structure their computer program, maintain connections between content and functionality, and design the user interface and activities. In addition, students had to consider different ideas about how to teach fractions to younger students. Harel's research (1990) indicated that students who designed fraction software using Logo learned fractions better than students taught fractions the traditional way. Also, students who used Logo to design software learned Logo better than students who received Logo programming instruction only.

Since the mid -1980s, computers in elementary and middle grade schools have functioned to a large extent as a medium for student practice in the skills and concepts of basic mathematics and reading (Becker, 1990). Many studies have been done showing the positive effects of computer-assisted instruction on the mathematics and reading scores of remedial students (Wenglinsky, 1999).

A study by Zollman, Oldham, and Wyrick (1989) involving Chapter I remedial students was conducted in Lexington, Kentucky to determine if computer-assisted instruction had an effect on the achievement levels of those students. A total of 561 Chapter I students (grades two through six for reading and grades four through six for mathematics) participated in the study. These students were exposed to the use of Education Systems Software (ESS) twice a week for a period of one school year. The students received the instruction through the school's computer lab. The control group had no access to the computer lab anytime during the one-year study. Since the students were homogeneous because of Chapter I selection criteria, a one-way analysis of variance (ANOVA) test was used to determine statistical difference. A pre/post test using the Metropolitan Achievement Test (MAT) was given to the experimental and control groups. An analysis of research (Zollman, Oldham, &Wyrick, 1989) found students who worked with the ESS software demonstrated significantly greater increases in achievement both in reading and mathematics than those in the control group. Students who worked with the ESS reading software gained an average of 14.77 Normal Curve Equivalents (NCE) on the MAT Reading Survey, a significant increase above the average of 11.87 NCE of those students who did not work with the software (Zollman, Oldham, & Wyrick, 1989). The difference on the mathematics part was even greater. The experimental group gained an average of 16.68 NCE on the MAT Mathematics Survey, which was well above the control group (12.23).

A study conducted by Lang et al., (1987) did an analysis of the effects of the computer-enhanced classroom on the achievement of remedial high school mathematics students. The study, which included 4,293 ninth through twelfth graders, compared computer-based instruction with traditional classroom instruction.

Using an analysis of variance on selected variables, Lang, Branch, and Thigpen, (1987) found that the computer based instruction was found to be effective and showed superiority to traditional classroom instruction for remedial students in the program. All comparisons showed significant gains on the CTBS with the exception of tenth-grade gain for subtest concepts and applications.

In addition to research on the effects of computer-assisted learning on remedial studies and low achieving students, research using regular student population has also been done. One such study conducted by Nancy Van Prooyen and Wilburn Clouse (1994) looked at the effects of incorporating components of language experience, and computer assisted instruction into the traditional basal reading program. Research indicated that students in classes which incorporate computer assisted instruction approaches into the basal reader programs scored much higher in achievement than students using only the basal reader (VanProoyen & Clouse, 1994). Student use of computers in elementary schools can incorporate drill and practice, tutorial computer-assisted learning and word processing. The authors state that the most important values the computer can add are immediate feedback, attentional focus, diagnoses, and a wide variety of discovery environments. Children learn to read and write with computer assistance, and results compare favorably and sometimes above average with other reading methods (Van Prooyen, & Clouse, 1994).

Becker (1990) did an extensive two-year nationwide field experiment designed to prove credible evidence about the effects of using computers in mathematics instruction in grades five through eight. Ninety-six classes (48 pairs of computers and "traditional" classes) taught by 56 teachers in 31 schools from 25 districts participated in the first year of the study. Eleven teachers from nine school districts employed the same "teacher-control" design through the second year of the experiment (Becker, 1990). On the average, students spent about 36 hours on the computer during the school year.

Results from analysis of pre and post test results indicate that the overall effects found in the first year on five measures of mathematics achievement were not substantially significant for the study populations as a whole, except for the estimation subtest (Becker, 1990). Even though the sample was more representative than most studies it still was not a national probability sample of teachers and classrooms.

A 1995 take home computer project in Las Cruces, New Mexico studied the effect computer usage, both in school and at home, had on student achievement. This study focused on the Partners in Learning Project that launched the Take Home Computer Program that put 200 computers in students' homes. The computers were rotated among the families on a ten-week basis. Consultants from Jostens Learning and the district provided software, hardware, teacher workshops, and parent training. The program has been successful. Test results on reading comprehension scores have risen an average of 7.10 NCE points. Total reading scores have risen an average 7.47 NCE points and total mathematics scores have gone up by an average 8.63 NCE points (Fullerton, 1995). Not only did the test scores increase, but parental involvement increased as well (Fullerton, 1995).

Another study involving computers in the home was the Buddy System Project. This study investigated a home/school computer project and its effects on reading, language, and mathematics achievement for students after one year and two years in the project (Miller& McInerney, 1994). The treatment groups consisted of 142 fourth and fifth graders, each of whom received a computer and software in their homes. The primary purpose of the study was to examine the effectiveness of the Buddy System project in terms of its effect on the academic achievement of the experimental group compared to the control group. The first set of hypotheses tested for a statistically significant difference between the achievement scores of the treatment and comparison groups in the areas of reading, language, and mathematics after one year and two years. There was found to be significance ($F=5.23$ $p < .05$) in mathematics with relation to treatment after one year. Significance ($F=8.68$, $p < .05$) was also found in language with relation to treatment after two years. Likewise, there was significance ($F=11.85$, $p < .05$) in mathematics with relation to treatment after two years (Miller & McInerney, 1994).

A study was conducted in Northern Ireland researching the effect that "laptop" or portable computers had on pupils' learning. The project involved nine schools: one special education school, one primary school, six secondary schools and one grammar school. Five experimental and five control class groups were matched for age, gender and ability. The experimental group was given portable laptop computers for use at home and in the schools. Each matched group was given a pretest in mathematics, English and science before the experiment and a posttest upon the completion of the project. In each school, one whole class was supplied with the laptops. There were 235 pupils in the experimental group and 191 pupils in the control group (Gardner, Morrison, & Jarmon, (1993). While the subjects were encouraged to use the computers throughout their curriculum, their participation was specifically monitored in a focus subject: English, mathematics or science (Gardner et al., 1993).

The research hypotheses proposed that posttest scores of the experimental group in each of the three disciplines (mathematics, science, and English) would be superior at the $p < .05$ level to those of the control group when the scores were adjusted for differences in pretest scores (Gardner et al., 1993). The method used for the comparison of the pre and posttest scores was the analysis of covariance (ANCOVA).

In mathematics, no statistically significant difference between the performances of the experimental and control groups was found. In fact the results indicate a slight non-significant effect in favor of the control group overall (Gardner et al., 1993).

Although the test results in science showed a positive non-significant effect in favor of the experimental group, only one matched pair showed a statistically significant result ($p < 0.05$) in favor of the experimental group.

In English, no significant difference in gains at the .05 level, in the large majority of the secondary school comparisons, were shown between the experimental and control groups. There were significant differences in the primary school comparisons but it should be remembered that they referred to just one matched pair in English, a subject where the reliability of the measurements cannot be guaranteed (Gardner et al., 1993).

It is the opinion of the authors that the impact of personal access to laptop computers on pupil performance was not significant and at best was marginal over the course of one school year (Gardner et al., 1993).

Critical Reviews

When researching literature regarding technology, one has to keep in mind that there are researchers and field experts who question the validity of using computer software to increase student achievement (Fahnoe, 2000). More so, criticism regarding problems that researchers have determining if computer software use has an effect on student achievement seems to be an issue with critics (Fahnoe, 2000). Decision makers responsible for deciding the implementation of computer technology plans at the district and building level need to give careful consideration to research reports that are critical of its use (Kimble, 1999). Only then will the stockholders be able to balance all issues before making decisions affecting technology implementation (Kimble 1999).

One outspoken critic of computer technology use is Oppenheimer (1997). He states:

> There is no good evidence that most uses of computers significantly improve teaching and learning, yet school districts are cutting programs-music, art, physical education-that enrich children's lives to make room for this dubious nostrum, and the Clinton administration has embraced the goal of 'computers in every classroom' with credulous and costly enthusiasm (p.17).

Oppenheimer (1997) goes on to say that the research studies that have been done are flawed and show benefits that are not really there. The giant often cited meta-analyses "lack the necessary scientific controls to make solid conclusions possible" (p.17). He states that the studies are artificial, not easily repeated, not statistically reliable, and do not control for other factors such as differences between teachers and their methods.

Means et al., (1993) state that hundreds of studies have been conducted comparing computer-assisted instruction with more traditional modes, and that most of these studies find that use of computer technology is either equivalent or superior to conventional instruction. However, Means et al., (1993) contend that it is almost impossible to separate the technology medium or software from the variables that will naturally interact within the context to which the intervention is used and with the characteristics of the particular students involved in the study. According to Means et.al. (1998) “There is no defensible logic to attributing them to a technology medium rather than to instructional content or method, instruction or student characteristics, or some interaction among those variables” (p.43).

Wenglensky (1998) asserts that there are problems with claims that are made by advocates and critics alike. He claims that most CAI evaluations of drill and practice software applications, higher order applications and the data from exemplary programs contain methodological problems that raise questions regarding their results. According to Wenglinsky (1998) no distinction is made between different types of programs such as drill and skill, higher order thinking programs or those programs that involve intensive professional development. Other methodological problems include focusing on a small geographical area, not using control groups and not randomly assigning students to different environments (Wenglensky, 1998).

A report released by the Alliance for Childhood (2000), and endorsed by 82 experts in various fields of education, called for a nationwide halt to the introduction of computers in elementary and early childhood programs. The study called for offering children a curriculum that is based on the natural and physical world, and a halt to commercial hyping of harmful or useless technology for children. The study also called for research to be conducted on the full physical, emotional and developmental effects of computers on children.

Jane Healy also voiced concerns regarding computer usage in elementary schools. In her book, Failure to Connect: How Computers Affect Our Children's Minds- for Better or Worse (1999), Healy questioned whether exposing children to unlimited access to computers at the expense of more concrete learning experiences was helping or harming the development of children. Healy would like to see the decision-makers downplay using technology for skill and drill mathematics and language activities, in favor of interactive problem solving and open-ended learning.

Conversely, Coley et al. (1997) contended that research conducted for the Educational Testing Service showed that the most common use of computer technology in school (drill and practice software and integrated learning systems) had proven to be effective and efficient. However, according to Coley et al. (1997) using the computer for more complex and sophisticated instructional design, such as collaborative research and CEI, have only shown inconclusive results.

Summary

Computer-assisted instruction has existed in our schools for over two decades. Substantial research has been done on the effects CAI has had on achievement levels of students with mixed results. Some studies reviewed have shown substantial gains in achievement when students are exposed to computer instructional software, while others have been inconclusive regarding significant differences in test scores of those students exposed to computer-assisted instruction. Among the possible explanations for these contradictory results is difficulty in assessing student exposure to computer-assisted instruction since most classrooms have a limited number of computers available.

Recently there has been a trend toward home/school computer projects. Research regarding increased achievement has again been favorable in certain cases, but not all. Research is limited on home/school computer projects. More research must be done to justify cost factors in relation to the benefits of continuing expensive computer technology in the home.

From these studies it can be said that computer-assisted instruction has been shown to have positive effects on student achievement under certain conditions. Findings from the literature review in regard to the effectiveness of computer-assisted instruction on student achievement have been decidedly mixed. Therefore, justification for further studies exists.

Chapter III

Methodology

Parameters of the Study

The purpose of this evaluation was to determine the academic effects on students participating in the Delaware Challenge Grant initiative, as the students progressed through second and third grade. This two-year study examined the reading and mathematics scores of the students using materials received from the Challenge Grant during a two-year period from 1998-2000. Students in both the experimental group and the control group were given pre and post tests for each of the two years of the study.

The null hypotheses were researched by comparing the second- and third-grade students from W.B. Simpson Elementary School with the second and third grade students from Nellie Hughes Stokes Elementary School. Both of these schools are located in the Caesar Rodney School District. The two schools are similar in many respects. These schools implement the same district-wide curriculum, have access to comparable resources and financial assistance, and have similar demographics.

The nature of this study necessitated the division of students into two separate groups. Group 1 consisted of students enrolled in W.B. Simpson Elementary School who participated in the Delaware Challenge Grant Project in either second or third grade. Group 2 consisted of students enrolled in Nellie Hughes Stokes Elementary School and who did not participate in the Delaware Challenge Grant in either of the two years.

The evaluation of the Delaware Challenge Grant focused on answering three essential questions:

1. In comparison to other students, did participation in the Delaware Challenge Grant Project have a positive effect on the reading comprehension of students in grades two or three?
2. In comparison to other students, did participation in the Delaware Challenge Grant Project have a positive effect on the vocabulary achievement of students in grades two or three?
3. In comparison to other students, did participation in the Delaware Challenge Grant Project have a positive effect on the mathematics achievement of students in grades two or three?

Participants

For the 1999-2000 school year, the Caesar Rodney School District reported a district-wide population of 6,688 students to the Delaware Department of Education. The school district is comprised of seven elementary schools, six that house grades kindergarten through five and one that serves kindergarten through three. There are three middle schools that house grades six through eight and one high school.

According to the September 30th count (1999) filed with the Department of Education, W.B. Simpson Elementary School reported a total of 518 students for the 1999-2000-enrollment count. Of those students, 53 percent were male and 47 percent were female. The school reports a minority population of 25.2 percent. The socio-economic status of the school as determined by the number of free-reduced lunch students is 37.76 percent (Caesar Rodney School District Food/Nutrition Services, 1999).

According to the Nellie Hughes Elementary School enrollment report (1999), a total of 525 students were enrolled for the 1999-2000 school year. Of those students 51 percent were male and 49 percent were female. The minority population for Stokes Elementary is 25.4 percent. (Delaware Department of Education, 1999). Based on the number of students receiving free/reduced lunch, the socio-economic status is 37.29 percent for the school (Caesar Rodney School District Food/Nutrition Services, 1999).

Sample

The subjects considered for this study consisted of those students who attended W.B. Simpson Elementary and Nellie Hughes Stokes Elementary as second graders during the 1998-1999 school year and third graders during the 1999-2000 school year. W.B. Simpson students served as the treatment group, and Nellie Hughes Stokes students served as the non-treatment group.

Students eligible for the treatment group were those students who were second graders at W.B. Simpson during the 1998-99 school year and third graders during the 1999-2000 school year. The selection of subjects from this group was based on two criteria: 1) The student had to participate in a grade level appropriate curriculum for language arts and mathematics, and 2) The student had to participate in the Delaware Challenge Grant Project at W.B. Simpson Elementary School.

Students for the non-treatment group were selected from Stokes Elementary students who attended second grade from 1998-99 school year and attended third grade during the 1999-2000 school year. The selection of subjects for the non-treatment group was based on the following criteria: 1) The student had to participate in a grade level appropriate curriculum for language arts and mathematics, and 2) The student did not participate in the Delaware Challenge Grant Project.

Demographic Information

Demographic information for the subjects studied was gathered from Caesar Rodney School District's September 30th enrollment report to the Delaware Department of Education and the Caesar Rodney School District Food/Nutrition Services. The demographic information for both groups was reported in terms of ethnicity, gender, socio-economic status, and Title I eligibility. This information was used to describe students comprising the groups involved in the evaluation, and to determine the comparability of the groups. This is important to know because when using non-random assignment the treatment and non-treatment groups should be similar so fair comparison between the groups can be made. The description will help decide whether the observed group differences on the posttest were caused by the treatment or by pre-existing group differences on some variable (Borg & Gall, 1989).

The demographic information contained in Table 1 shows any student that participated in the study. This means that the students listed could have participated in the first year of the study, just the second year or both years of the study. A determination was made to eliminate students that did not participate in both years of the study. Any student with partial scores was eliminated prior to any statistical analysis being performed. This lead to some students being dropped from the study (see Appendix I).

Table 1

Demographic Information for Each Group by Year

Variable	Treatment	Non-Treatment	Treatment	Non-Treatment
	1998		1999	
Gender				
Male	29	29	34	31
Female	30	34	36	29
Socio-Economic				
Free/Reduced	24	22	21	17
Paid Lunch	35	41	49	45
Ethnicity				
Majority	45	50	53	49
Minority	14	13	17	13
Type				
Regular	45	45	55	48
Title I	14	18	15	14

Design of the Study

The design of the study is a nonequivalent group, pretest/posttest design. A quasi-experimental design is similar to a true experimental design except for a key difference; they lack random assignment of the participants (Gibbons & Herman, 1997). In true experimental design, the subjects are randomly assigned to program and comparison groups (Gibbons & Herman, 1997). It is only through random assignment that evaluators can be assured that the groups are truly comparable and that observed differences in outcomes are not the result of extraneous factors or pre-existing differences (Gibbons & Herman, 1997). In a quasi-experimental design, the researcher does not control the assignment to groups through the mechanism of random assignment (Campbell & Stanley, 1967; Trochim, 2000). Quasi-experimental designs are commonly employed when random assignment is not possible or practical (Gibbons & Herman, 1997).

The type of quasi-experimental design used for this study was a nonequivalent group, pretest/posttest design. The non-equivalent group design is one of the most commonly used designs in educational research (Borg & Gall, 1989; Trochim, 2000). It is structured like a pretest/posttest-randomized experiment, but it lacks random assignment (Borg & Gall, 1989; Campbell & Stanley, 1967; Trochim, 2000). In the non-equivalent groups design, researchers often use intact groups that they believe are similar, as the treatment and non-treatment groups (Trochim, 2000). In educational settings this might consist of two comparable classrooms or schools (Campbell & Stanley, 1967). Researchers try to select groups that are as similar as possible so a fair comparison can be made between the treatment and non-treatment groups (Gibbons & Herman, 1997; Trochim, 2000). However, because of non random assignment, it is not possible to ensure the groups are comparable, and it is unlikely that they would be as similar as they would if they were assigned through a random process (Trochim, 2000). This is important to note because the use of non-equivalent group design is susceptible to the internal threat of validity, and any prior differences between the groups may affect the outcome of the study (Borg & Gall, 1989; Campbell & Stanley, 1967; Trochin, 2000).

Since the groups studied were in different schools, random assignment was not logistically possible. Since random assignment was not used, any pretreatment differences between the groups were adjusted for by using the pretest as the covariate. The dependent variable studied was the posttest score the student received on a standardized achievement test. The independent variable was the treatment, which had two levels: 1) the first level was computer-assisted software instruction combined with instruction from the district's curriculum, and 2) the other level was instruction using the district's current curriculum without the use of computer assisted software instruction.

Procedures

This study focused on the implementation of the Delaware Challenge Grant project from 1998 through 2000. The program incorporated $26,000 worth of computer hardware in the classroom and approximately $96,000 worth of software. In addition to the computer hardware and software, the school received 150 Sony Playstations, which were to be distributed to students for home-use.

The Lightspan Corporation, a leading publisher of instructional software, designed the software and Internet services for schools (Coburn, 2000). The content scopes were correlated to the scopes and sequences articulated by the national curriculum associations and covered by leading standardized tests and textbooks publishers (Lightspan Partnership, 1996). According to Lightspan, Inc. (1996) Lightspan's scope and sequence is directly on-target and correlates at .90 or higher relative to the various state curriculum reforms adopted in the mid-1990s. Each treatment classroom was equipped with three computer stations capable of running the Lightspan instructional software. Each student in those classrooms received a Sony Playstation to facilitate the use of the Lightspan software at home.

Professional development was provided for each teacher involved in the project. This consisted of training on the use of the hardware and software. Teachers met with Lightspan personnel regularly throughout the school year. In addition to hardware/software training, teachers and trainers also matched the Lightspan software with the district's grade level curriculum. Ideas and suggestions of where to incorporate the software within their daily instruction were discussed as well as the development of lesson plans (see Appendix A).

A parent-training component of the project was also implemented (see Appendix B). Project personnel and Lightspan representatives trained parents on how to operate the Playstation and use the software appropriately. Parents were provided with a "hot line" that enabled them to speak with Lightspan personnel regarding problems or questions about hardware or software. Teachers and Lightspan personnel conducted student training.

The students had access to the software in several ways. One way was through teacher directed instruction using the software to teach instructional objectives. Another way was student independent use of the software during the students' assigned class time. Each student was assigned a minimum of one hour per week, usually in twenty-minute blocks, to work with the software (see Appendix C). Software was assigned by the teacher or self-selected by the students. The student logged information each time the software was used. Information in the log included the software selected, when the student worked on it, and the amount of time spent using the software. These logs were checked and recorded by the teacher (see Appendix D).

The home use component consisted of students taking home a Sony Playstation and using the assigned instructional software in their homes. Each student had access to the Playstation for the entire school year. During that time, students self-selected instructional CDs or CDs were assigned to them by their teacher. Each week a new CD was given to the student for home use. Again, each student maintained a daily home use log noting the software used and the time spent using the software each day (see Appendix E). Teachers also used activity checks that assessed student knowledge of the software they were using for the week (see Appendix F).

The non-treatment group and their teachers followed the district curriculum for all subjects. They took a pretest at the beginning of the year and a posttest at the end of the year. Any exposure to computers or technology was done within the regular classroom routine, and consisted of materials and software that are normally available to all the district's second- and third-grade students.

Instrumentation

All students participating in the study were given a pretest and a posttest. Three subtests of the Stanford were used: reading vocabulary, reading comprehension, and mathematics procedures. The teachers were administered the tests in their classrooms. Clerical staff, unfamiliar with the study, scored tests and recorded results. Student test scores were reported as raw scores.

The Stanford Achievement Test, 9th Edition, Form S, Primary 2, and Primary 3 (Harcourt Brace, 1996) was the instrument of measurement used for study. Primary 2 was used for the first year of the study and Primary 3 was used for the second year of the study. The Stanford Achievement Test is a norm-referenced standardized test that is designed to measure important learning outcomes of school curriculum (Harcourt Brace, 1996). According to its publisher (Harcourt Brace, 1996), the Stanford Achievement test concentrates on important concepts and learning processes across the content areas. There is curriculum alignment with state curriculum and frameworks, national standards, and instructional methods (Harcourt Brace, 1996). The Stanford Achievement tests were judged to be one of the best achievement batteries for assessing basic skills taught in grades one through nine (Airasian, 1995). Statistical analyses, as well as a review by a panel of prominent minority group of educators, are used as a precaution to avoid possible bias (Harcourt Brace, 1996; Salvia & Ysseldyke, 1985).

There are three aspects to a test's validity: content validity, criterion-related validity, and construct validity (Borg & Gall, 1996). The most critical aspect of validity for an achievement test is best defined as the extent to which the test content represents an appropriate sample of the skills, knowledge, and understanding that are the goals of instruction (Borg & Gall, 1996). Validity can be evaluated through careful examination of the test content and how that content compares with the instructional objectives of the school's curriculum (Borg & Gall, 1996; Rogers 1997). An examination of the Stanford 9 Compendium of Instructional Objectives indicates a match between the school's curriculum and the SAT9 Test. In fact, the Delaware State Testing Program uses the SAT9 as part of its statewide testing program.

Reliability addresses the extent to which an assessment tool is free of measurement error (Bartz, Anderson-Robinson & Hillman, 1994; Rogers, 1997). Generally speaking, the more consistent and accurate the assessment measure, the higher its reliability as determined through the use of coefficients, which range from 0.00 to 1.00. From a traditional and technical perspective, assessments with coefficients of .90 and above are considered highly reliable (Elliott, 1995). The Stanford Achievement Test is measured for reliability using the Kudor-Richardson (KR-20) measures of reliability. In general, the KR-20s are excellent for this test.

For the Stanford 9 Achievement Test the subscale coefficients are in excess of .85 or .90 and total scores and composite scores are in excess of .95 (Elliott, 1995).

The Stanford Achievement Tests used in this study are norm-referenced tests designed to measure achievement in grades kindergarten through twelve. Standardization, reliability, and validity are exceptionally good (Salvia & Ysseldyke, 1985).

Data Analysis

Students in two separate schools were the subjects for this study. Students in one school received the experimental treatment and students in the second school did not. It was important that the schools be closely related so the demographic variables did not play a factor in influencing test results. The demographics of the two treatment groups were compared using cross-tabulations and chi square tests. This made it possible to determine if there were any significant differences between the two treatment groups with respect to gender, socio-economics, type (regular student versus remedial student) or ethnicity.

Descriptive statistics were used to measure the averages of the sub-tests of each test that was given to the two groups. This allowed an examination of the scores to determine a mean score for each group on every sub-test. This allowed the researcher to determine the typical or average performance of each group.

Inferential statistics were computed for the three sub-tests for the pretest, and three sub-tests for the posttest. This was done for each treatment group, separately and again for the total sample. This determined if there were any significant differences with regard to performance between the two treatment groups.

An analysis of covariance was performed to compare means of the two groups on the posttests. The pretests scores were used as the covariates. The independent variable was the treatment, which had two levels: the normal day-to-day instruction and the use of the Lightspan software, compared to the normal day-to-day instruction without the use of Lightspan software. The dependent variables were the posttest scores. Table 2 shows the ANCOVA quantitative research matrix for this study.

Table 2

ANCOVA: Quantitative Research Matrix

Variables	*Measure*	*Level*	*Coding*
Dependent			
SAT 9 Performance	SAT 9 (Vocabulary)	Interval	0-30
	SAT 9 (Mathematics)	Interval	0-46
	SAT 9 (Comprehension)	Interval	0-54
Independent			
Group Type	Non-treatment	Nominal	1=Non-treatment
	Treatment	Nominal	2=Treatment

Validity Issues

A multiple-group design using two groups with before and after measurement was used for this research project. In this case, one group received the treatment while the other group did not, thereby constituting the control or comparison group. The two programs were compared for their relative outcomes. In such designs, there exists an internal threat to validity. This refers to the extent to which extraneous variables are controlled (Parker, 1993). In other words, to what degree are the groups comparable before the study. Failure to control these extraneous variables prevents the researcher from concluding that observed outcomes are due to the independent variable (Borg & Gall, 1989; Parker, 1993).

The most important threat, when using multiple group selection, to internal validity is selection bias or selection threat (Borg & Gall, 1989; Trochim, 2000). A selection threat is any factor, other than the treatment, that leads to posttest differences between groups (Trochim, 2000). Whenever it is suspected that outcomes differ between groups, not because of our treatment, but because of prior differences, a selection bias is likely (Parker, 1993; Trochim, 2000). According to Campbell and Stanley (1967) there are eight variables that if not properly controlled could have an effect on the outcomes of an experimental design. The most common threats to internal validity are history, maturation, testing, instrumentation, regression, selection, mortality, and interaction of selection and maturation (Campbell and Stanley, 1967). The following threats to validity are addressed by this study:

<u>History</u>: A selection history threat is any other event that occurs between the pretest and posttest that the group experiences differently (Trochim, 2000). Because experimental treatments occur over a period of time, there is an opportunity for events to occur that could influence the outcome of the study. This study extended over a two-year period. The treatment and non-treatment group was composed of students from two different schools. It was important that the two schools were kept similar in all respects and that they remained constant over the two year study. The only difference between the schools should be the treatment (Borg & Gall, 1989). There were no dramatic changes within the course of the study between the two schools. Since this study spanned two school years, participants moved from one grade level to another. This meant that they had different teachers during the course of this study. Teacher expectation may have had an effect on the results of the study. Teachers participating in the study varied in experience, age, and degrees earned (see Appendix J). The expectations teachers have for their students and the assumptions they make about their potential have a tangible effect on student achievement (Bamburg, 1994). Research clearly shows what teachers do in the classroom effects how well and how much students learn (Bamburg, 1994). However, the teachers participating were all certified by the state of Delaware, were given professional development in teaching the district curriculum and had access to the same resources afforded all teachers within the district. Otherwise, there were no dramatic changes within the timeframe of the study

Maturation: This threat refers to the "uncontrolled naturally occurring, developmental changes in research participants that affect their performance on the outcome variable" (Parker, 1993, p. 133). For example, the research group may become stronger, more cognitively able, more self-confident, and more independent over the years. Since we compared achievement scores between groups of students, maturation may have been a threat to the internal validity. Research has shown that girls mature both physically and cognitively faster than boys (Childs, 1990). A higher percentage of girls in one group might have an effect on the performance differential between the two groups. The background characteristics of the two groups must be assessed to rule out whether these characteristics had an affect on the performance levels of the groups.

Testing: In this study, a pretest was administered followed by a posttest. The same test was used for both the pretest and posttest. A testing threat occurs when there is a differential effect between groups on the posttest and the pretest (Borg & Gall, 1989; Trochim, 2000). For example, students may remember their pretest responses and answer more items correctly at posttest. Students might show improvement simply as an effort of their experience with the pretest (Borg & Gall, 1989). The opposite result could occur if the participants reacted negatively to taking the same test twice. They could answer questions haphazardly and obtain a spuriously low score (Parker, 1993). Students in this study were tested in September and May of each year the study was in progress. No scores or answers were shared with the students during the study.

Statistical Regression: When researchers use a pretest/posttest procedure to determine whether a treatment has had an effect on participants, the possibility exists that statistical regression could account for any observed changes in performance (Borg & Gall, 1989; Campbell & Stanley, 1967). This occurs when there are different rates of regression to the mean score of the two groups (Campbell & Stanley, 1967; Trochim, 2000). This might occur if one group is extremely higher or lower on the pretest, since extreme scores tend to regress toward the group mean on repeated testing (Parker, 1993; Trochim, 2000). This probable regression was estimated and considered in performance results.

Differential Selection: According to Borg and Gall (1989) “In experimental designs in which a control group is used, the effect of the treatment sometimes can be confounded because of differential selection of the subject for the experimental and control groups” (p. 645). This assignment could result in the groups being different on many variables. Random assignment is usually the best safeguard against differential selection (Borg & Gall, 1989, p. 645). Since this study used nonrandom assignment, information about the characteristics of the group was noted for consideration during the statistical data analysis.

Mortality: This threat refers to the loss of subjects and their data during the course of the study due to illness, absenteeism or some other event (Parker, 1993). This can be a threat to validity if students do not complete the posttest phase after completing the pretest. For example, if a great number of low-achieving students were to dropout of the control group, this would have an effect on the overall results. Posttest differences might then be due to the different types of dropouts and not to the program. It is important to keep records for each treatment of subjects' failure to complete the study. During the course of the study nine students from the treatment group and twelve students from the non-treatment group failed to complete the study. This was a naturally occurring process usually resulting from students transferring in or out of the school. Students who had partial test scores were removed prior to doing the statistical analyses (see appendix I).

Other Considerations

Since the design is quasi-experimental, there are other variables that must be taken into consideration. Different variables such as ethnicity, gender, socioeconomic status and classification (i.e. Title I, Special Education) could have an impact on the results of the study. These variables must be measured and reported.

Ethnicity: Minority students are underrepresented among students who do well on academic achievement tests (Lomax et al., 1992). As of 1992, minority students made up over 30 percent of school- age youth (5 through 17 years) (Lomax, West & Harmon, 1992). Research has indicated that race and cultural differences impact student achievement (Standish, 1995). Therefore, to note variations among race, students were coded for ethnicity. All non-white students were coded 1. This included African-American, Asian, American Indian, and Hispanic ethnicity. All white students were coded 2.

Socio-economic: Children living in poverty levels have generally not performed as well on achievement tests and other measures of achievement than have children from affluent families (Children's Defense Fund, 1992). Studies have shown that there is a clear relationship between student achievement and a student's socio-economic status (Standish, 1995). For purposes of this study, socio-economic status (SES) was identified as those students eligible for federally funded free or reduced school lunch. Students with a SES status were coded as 2 and all other students were coded as 1.

Gender: Research indicating the impact of gender on achievement scores indicate that females have a tendency to score lower on achievement tests (Childs, 1990). There are studies that indicate males may feel more comfortable using computers than females (Sinkis, 1993; Standish, 1995). Females were coded as 1 and males were coded as 2.

Title I: Students who are at-risk for reading are eligible for reading remediation provided by federally funded Title I money. These students, although assigned to regular classrooms, have been diagnosed with weak reading skills. Students who are classified as Title I students were coded as 2 and those students not receiving services were coded as 1.

Ethical Issues

This study was carried out between the researcher's school and a similar school within the district. There are a number of ethical issues to be considered when working with large groups of school age subjects. The first issue is the principle of voluntary participation. Parents of all subjects were informed of the study and the role their particular child would play in the process (see Appendixes G, and H). Parents who requested that their child not participate in the study were honored. No parent formally requested that his or her child not participate in the study.

There are two standards that are applied in order to help protect the privacy of research participants, one is confidentiality and the other is anonymity (Trochim, 2000). The participants in this study were assured confidentiality of all test scores. Names of participants were not used in the analysis of data; a number identified each participant.

Chapter IV

Results

The purpose of this study was to determine if the Delaware Challenge Grant Program and the Lightspan Partnership computer software had a positive educational impact on student achievement. The study lasted approximately two school years. The study examined the test scores of second- and third-grade students in the areas of reading vocabulary, reading comprehension, and mathematics.

Scores, demographics, and student variables were recorded over a two-year period. Because of this, great care had to be taken in preparing and logging information for statistical analysis. Student information and test scores were organized for entry using a spreadsheet matrix. This information was entered into a spreadsheet in the computer. Information from the spreadsheet was loaded into a statistical analysis program known as Minitab Version 13.

Since the study took place over a two-year period, some subjects participated in only a portion of the study. This resulted in missing or incomplete information with regards to test scores. Since ample data were available, it was decided that students with partial or missing information would be removed prior to the completion of the statistical analysis (see Appendix I). Only those students that participated in both years of the study were included in the statistical analysis.

Statistical Analysis

When conducting this study, two separate schools were used for the treatment and non-treatment groups. It was important that the schools be closely related so the demographic and other student variables did not play a factor in influencing the test results. In order to determine if using samples from two different schools had an influence on the test results, the demographics of the two schools were analyzed. Students who had partial scores were removed prior to any statistical analysis being performed (see Appendix I). The demographics of the two treatment groups were compared using cross tabulators and chi-square tests to compare frequencies. The results are displayed in Table 3

Table 3

Description of Sample

Variable	*Non-treatment*	*Treatment*	*Chi Square*	*p*
Gender				
Females	24	27		
Males	26	24	0.25	0.62
Socioeconomic				
Free/Reduced Lunch	14	19		
Paid Lunch	36	32	0.98	0.32
Type				
Regular	38	39		
Title I	12	12	0.00	0.96
Ethnicity				
Majority	41	41		
Minority	9	10	0.04	0.84

The results displayed in Table 3 indicate that there were no statistically significant differences between the two treatment groups with respect to gender. The number of males and females in each school was very similar (p= 0.62). The table also indicated the socioeconomic status of each school was similar (p= 0.32), Title I students versus regular students (p= 0.96) showed no significant differences between the two schools. In examining any differences between the ethnicity of the schools the table indicates no significant differences (p= 0.84). None of the Chi square values were large enough to be statistically significant. In other words, the two groups were equivalent on the demographic variables that were measured, thereby indicating that the two groups were similar in those areas.

Descriptive Statistics

Next, descriptive statistics were computed, using raw scores from each of the groups that were tested. This was done to compute the mean scores for each group on each of the sub-tests that were given. Descriptive statistics were computed for the three pretests and the three posttests for each treatment group separately for the two-year period. In other words each year of the study was statistically analyzed separately. Descriptive statistics on each treatment group included in the study for the two treatment groups are displayed in Table 4 and Table 5. Table 4 shows descriptive statistics for both the groups during the first year of the study.

Table 4

Descriptive Statistics-Pre-Posttests First Year

Variable	*Non-Treatment*			*Treatment*			**ΔM**
	N	M	SD	N	M	SD	
Vocabulary							
Pretest	50	13.96	6.33	51	13.41	6.64	+ 0.55
Posttest	50	19.30	6.20	51	21.72	5.40	- 2.42
Reading Comprehension							
Pretest	50	23.34	6.13	51	23.43	6.19	- 0.09
Posttest	50	30.98	7.36	51	31.72	6.34	- 0.74
Mathematics							
Pretest	50	13.86	4.80	51	15.09	5.88	- 1.23
Posttest	50	20.20	5.00	51	24.11	3.47	- 3.91

The results in Table 4 show the pretest and the posttest scores for the treatment and the non-treatment groups for the first year. The pretest scores on the vocabulary test suggest that there was very little difference between the non-treatment group (m=13.96) and the treatment group (m=13.41). On the reading comprehension pretest, there was again very little difference between the treatment group (m=23.43) and the non-treatment group (m=23.34). However, in examining the pretest scores of the mathematics section, the treatment group (m=15.09), appeared to outperform the non-treatment group (m=13.86).

In examining the results for the posttest scores, the treatment group (m=21.72) appeared to outperform the non-treatment group (m=19.30) in the area of vocabulary. The reading comprehension posttest scores indicate that the treatment group (m=31.72) scored slightly higher than the non-treatment group (m=30.98). In analyzing the mathematics posttest, the treatment group (m=24.11) far outscored the non-treatment group (m=20.20).

Table 5

Descriptive Statistics-Pre-Posttests Second Year

Variable	*Non-Treatment*			*Treatment*			ΔM
	N	M	SD	N	M	SD	
Vocabulary							
Pretest	50	18.58	6.21	51	18.58	5.37	0.00
Posttest	50	21.46	6.12	51	24.51	4.29	-3.05
Reading Comprehension							
Pretest	50	32.70	10.62	51	32.14	10.77	+ 0.56
Posttest	50	36.90	10.25	51	39.61	9.10	- 2.71
Mathematics							
Pretest	50	27.56	7.89	51	30.04	7.21	- 2.48
Posttest	50	32.40	8.69	51	37.07	6.02	- 4.67

In the second year of the study the same students were used for the treatment and non-treatment groups. Students were pretested before exposure to the treatment at the beginning of the school year and then posttested at the end of the year. The results of the two groups for the second year of the study are shown in Table 5.

The pretest scores between the treatment group and the non-treatment group indicate that the scores on the vocabulary pretest were identical for both groups (m=18.58). Reading comprehension pretest scores indicate very little difference between the treatment (m=32.70) and the non-treatment group (m=32.14). However, with regard to mathematics pretest scores, the treatment group (m=30.04) appeared to score higher than those in the non-treatment group (m=27.56).

The posttest scores of the two groups were analyzed for the second year. The results are also shown in Table 5. The results of the vocabulary posttest indicate that there appeared to be an appreciable difference between the treatment group (m=24.51) and the non-treatment group (m=21.46). The treatment group also scored higher than the non-treatment group in the area of reading comprehension (m=39.61 and 36.90 respectively). On the mathematics posttest scores the treatment group (m=37.07) also scored higher than the non-treatment group (m=32.40).

The results in Table 5 suggest very little difference with regard to performance between the two groups on the vocabulary pretest for the second year of the study. However, the treatment group performed better on the posttest in this area. On the reading comprehension tests there was no significant difference with regard to the pretest scores between the two groups. However, the group that received the treatment did perform better on the reading comprehension posttest. In the area of mathematics the treatment group appears to perform better on both the pretest and posttests.

The differences between the scores on the pretest and posttest could be attributed to several factors. Prior exposure to content tested may have played a role in differences of the mean scores. Extraneous variables such as teacher experience, learning style, or other external variables that were not controlled could account for mean score differences. Since these students were not randomly assigned to the two study groups, the effect of the treatment could be the result of inequities within the assigned groups prior to the treatment.

Two-Sample t-tests: Posttests

Since there appears to be differences between the sample means of the posttests results, a two-sample t-test was performed to determine the level of significance between the sample means. Table 6 shows the results of the two-sample t-test comparing the averages of the treatment and non-treatment groups in each tested area for the first year of the study.

Table 6

Two-sample t-test Posttests: First Year

Variable	*difference in m*	*t*	*df*	*p*
Vocabulary	-2.42	-2.08	99	0.04
Reading Comprehension	-0.74	-0.54	99	0.58
Mathematics	-3.91	-4.55	99	<0.01

In the area of vocabulary, the t-test shows that there was a significant difference between the posttest mean scores of the two groups (*p*=0.04). For reading comprehension the calculated p value (0.58) was higher than the predetermined alpha level (0.05). This indicates there was no significant difference between the groups. When examining the t-tests of the mathematics posttests there is a significant difference between the two groups (*p*<0.01).

The t-test analysis shows that in the first year of the study there was a statistically significant difference between the posttests scores on two variables: vocabulary and mathematics. However there were no significant differences in the area of reading comprehension.

A t-test analysis was also completed for the second year of the study, again, using the same subjects. The results of the two sample t-tests are presented in Table 7.

Table 7

Two-sample t-test Posttests: Second Year

Variable	*difference in m*	*t*	*df*	*p*
Vocabulary	-3.05	-2.86	99	<0.01
Reading Comprehension	-2.71	-1.40	99	0.16
Mathematics	-4.67	-3.14	99	<0.01

Table7 shows that there was a statistically significant difference between the two groups in the area of vocabulary (*p*<0.01). It also indicates that again there was no significant difference between the two groups on the reading comprehension results for the second year of the study. However, in the area of mathematics, there was a statistically significant difference between the two groups ($p<0.01$).

The second year of the study produced similar results as the first year. In each case there was a significant difference between the groups in the areas of vocabulary and mathematics. However, there was no significant difference with regard to reading comprehension in either year.

One could assume that based on the results of the t-test that the null hypothesis could be rejected for the vocabulary (Ho1) and mathematics (Ho3). It might also be assumed based on the results that the null hypotheses for reading comprehension (Ho2) could be accepted.

However, the students in this study were not randomly assigned. Therefore, students of the treatment group may have had previous knowledge prior to the treatment. In other words, their pretest scores may have been higher to begin with. Another statistical procedure known as an analysis of covariance (ANCOVA) can be used to control for any difference in prior knowledge between the two groups (Borg & Gall, 1996).

Analysis of Covariance-Discussion and Results: First Year

An analysis of covariance allows us to make a statistical adjustment of one variable based on its covariance with another variable. (Trochim, 2000). These statistical adjustments attempt to control for important factors in our study.

In order to compare the apparent posttest differences in the treatment and non-treatment groups while controlling for any pretest differences between the treatment and non-treatment groups, three analyses of covariance were performed for each year. The posttest scores on the three subtests were used as the dependent variables in those respective analyses. The treatment served as the dependent variable and the appropriate pretest was used as the covariate in each analysis. The alpha level to reject the null hypotheses was set at .05, since this is a customary level of significance in quasi-experimental studies. The results for year one of the study are displayed in Tables, 8,9,10.

Table 8

Analysis of Covariance-Vocabulary Posttest: First Year

Dependent Variable= Vocabulary Posttest N=101

Analysis of Variance Post-Vocabulary using adjusted SS for Tests

Source	*dF*	*Seq SS*	*Adj SS*	*Adj MS*	*F*	*p*
Pretest	1	1084.19	1120.69	1120.69	48.38	<0.01
Treatment	1	185.03	185.03	185.03	7.99	<0.01
Error	98	2269.97	2269.97	23.16		
Total	100	3539.19				

The analysis of variance for the vocabulary posttests using the adjusted sum of squares is shown in the table. The treatment group had an adjusted mean score of 21.87

as compared to the non-treatment group who had an adjusted mean score of 19.16. The results indicate a statistically significant difference between the two groups on the vocabulary posttests (F=7.99, *p*<0.01). The treatment group outperformed the non-treatment group at a statistical significant level.

Table 9 compares the results between the treatment and non-treatment group in the area of reading comprehension. These results shown are for the first year of the study.

Results in Table 9 indicate that there was no statistically significant difference in the performance between the treatment group (adjusted m=31.69) and the non-treatment group (adjusted m=31.01) on the reading comprehension test (F=0.41, *p*=0.52).

Table 9

Analysis of Covariance-Reading Comprehension Posttest: First Year

Dependent Variable= Reading Comprehension Posttest N=101

Analysis of Variance Post-Reading Comprehension using adjusted SS for Tests

Source	*dF*	*Seq SS*	*Adj SS*	*Adj MS*	*F*	*p*
Pretest	1	1903.67	1901.33	1901.33	67.43	0.00
Treatment	1	11.69	11.69	11.69	0.41	0.52
Error	98	2761.80	2761.80	28.18		
Total	100	4677.17				

Table 10 compares the results between the treatment group and the non-treatment group in the area of mathematics. The results are for the first year of the study.

Table 10

Analysis of Covariance-Mathematics Posttest: First Year

Dependent Variable= Mathematics Posttest N=101

Analysis of Variance Post-Mathematics using adjusted SS for Tests

Source	*dF*	*Seq SS*	*Adj SS*	*Adj MS*	*F*	*p*
Pretest	1	447.44	361.51	361.51	23.97	<0.01
Treatment	1	301.57	301.57	301.57	20.00	<0.01
Error	98	1477.79	1477.79	15.08		
Total	100	2226.79				

The results of Table 10 indicate that there was a statistically significant difference between the treatment group (adjusted m=23.90) and the non-treatment group (adjusted m=20.42) on the mathematics posttests. The treatment group outperformed the non-treatment group in this area (F=20.00, $p<0.01$).

The results of the first year of the study show that those students who participated in the Delaware Challenge Grant Project outperformed the comparison group in two areas. In the area of vocabulary, the experimental group out performed the control group. In the area of mathematics, the experimental group once again out performed the control group. However, there was no statistical significance in the area of reading comprehension.

Analysis of Covariance-Discussion and Results: Second Year

The second year of the study measured the test scores of the same students from W.B. Simpson Elementary School and Nellie Hughes Stokes Elementary School. The students tested were third-grade students. The treatment group had now been exposed to the treatment for a two-year period. The non-treatment group served as the control group for the second year. The program that the experimental group had participated in remained the same except for the grade level of the software, which increased one grade level. The only other significant change was each group now had a new teacher. As mentioned previously, students who had partial information were removed before any statistical analysis was completed. These students were participants that did not have complete pretest/posttests scores for both years of the study. Removing these students ensured that the study examined the same groups of students over the two-year period.

An analysis of covariance was completed for the treatment and non-treatment groups in the areas of vocabulary, reading comprehension, and mathematics. The results are presented in Tables 11, 12, and 13.

Table 11 compares the results between the treatment group and the non-treatment group in the area of mathematics. The results are for the first year of the study.

Table 11

Analysis of Covariance-Vocabulary Posttest: Second Year

Dependent Variable= Vocabulary Posttest N=101

Analysis of Variance Post-Vocabulary using adjusted SS for Tests

Source	*dF*	*Seq SS*	*Adj SS*	*Adj MS*	*F*	*p*
Pretest	1	1380.27	1379.45	1379.45	94.03	<0.01
Treatment	1	234.02	234.02	234.02	15.95	<0.01
Error	98	1437.71	1437.71	14.67		
Total	100	3052.00				

The results of Table 11indicate a statistically significant difference between the treatment group (adjusted m=24.51) and the non-treatment group (adjusted m=21.46) on the vocabulary posttest for the second year. The treatment group outperformed the non-treatment group (F=15.95, $p<0.01$) for the second year of the study.

Table 12 compares the results between the treatment group and the non-treatment group in the area of mathematics. The results are for the first year of the study.

Table 12

Analysis of Covariance-Reading Comprehension Posttest: Second Year

Dependent Variable= Reading Comprehension Posttest N=101

Analysis of Variance Post-Reading Comprehension using adjusted SS for Tests

Source	*dF*	*Seq SS*	*Adj SS*	*Adj MS*	*F*	*p*
Pretest	1	6369.90	6432.20	6432.20	220.22	<0.01
Treatment	1	247.50	247.50	247.50	8.47	<0.01
Error	98	2862.40	2862.40	29.20		
Total	100	9479.80				

The results of Table 12 indicate there was a statistically significant difference between the treatment group (m=39.82) and the non-treatment group (m=36.69) on the reading comprehension posttests for the second year of the study. The treatment group outperformed the non-treatment group in this area (F=8.47, $p<0.01$)

Table 13 compares the results between the treatment group and the non-treatment group in the area of mathematics. The results are for the first year of the study.

Table 13

Analysis of Covariance-Mathematics Posttest: Second Year

Dependent Variable= Mathematics Posttest N=101

Analysis of variance Post-Mathematics using adjusted SS for Tests

Source	*dF*	*Seq SS*	*Adj SS*	*Adj MS*	*F*	*p*
Pretest	1	3794.80	3427.70	3427.70	161.04	<0.01
Treatment	1	185.50	185.50	185.50	8.72	<0.01
Error	98	2085.90	2085.90	21.30		
Total	100	6066.30				

The results of Table 13 indicate that the treatment group (adjusted m=36.12) outperformed the non-treatment group (adjusted m=33.37) at a statistically significant level (F=8.72, $p<0.01$) in the area of mathematics for the second year of the study.

Summary

Demographic variables were analyzed using Chi square values. The results of the analyses indicated that the groups studied were equivalent on the demographic variables collected.

Students’ growth in the areas of vocabulary, reading comprehension and mathematics was measured by the Stanford 9 test of basic skills. The performance assessment provided a measure of these areas immediately before and after the program was administered. The scores were subjected to various statistical analyses.

The results of the descriptive statistics for the first year indicated there were few differences with regard to most areas of the pretest/posttests between the two study groups. In the area of mathematics, the treatment group performed better than the non-treatment group on both the pretest and posttest. In the second year of the study there was no significant difference between the two groups on the pretests in vocabulary and reading comprehension. However, the treatment group appeared to perform better on the posttests in these two areas. In the area of mathematics the treatment group appears to have performed better on both the pretest and posttests

A two-sample t-test conducted on the posttests scores indicated significant differences in several areas. In the first year of the study there was a significant difference between the two groups in the area of vocabulary and mathematics. However there was no difference between the two groups with regard to reading comprehension. When the t-test was applied to the scores of the second year the same trend appeared. Again, the t-test indicated a significant difference between the two groups with regard to vocabulary and mathematics. However, like the first year, there was again, no significant difference between the groups in the area of reading comprehension.

Of course as stated previously, these students were not randomly assigned to groups. Because of that an analysis of covariance was done to take in account any exposure or prior knowledge that the subjects may have possessed.

An analysis of covariance was completed on the mean scores to compare the two groups taking into consideration any apparent differences in the pretest scores between the treatment and non-treatment group.

In the first year of the study there was a significant difference between the two groups on the vocabulary and mathematics test. The treatment group outperformed the non-treatment group in these areas. There was no significant difference between the scores on the reading comprehension test.

An analysis of covariance was completed for the second year of the study. Again there was a statistically significant difference between the two groups in the areas of vocabulary and mathematics. The treatment group outperformed the non-treatment group at a significant level. In addition for the second year of the study, there was a significant difference between the groups with regard to reading comprehension, even though there appeared to be no significant difference with the t-test. This is because the t-test did not take into considerations the differences between the pretest scores. Students were not chosen randomly for the groups. Therefore, the treatment group may have had higher or lower pretest scores. In second year of the study, the treatment group outperformed the non-treatment group in reading comprehension.

Chapter V

Conclusions and Recommendations

Review of the Evaluation

This evaluation examined the effect that the Delaware challenge Grant had on the academic achievement of those students who participated in the grant program. The study used a quasi-experimental posttest design to study the effects of the Delaware Challenge Grant Project on the reading and mathematics achievement of second and third grade students. This study was completed over a two-year period. Students included in the study were enrolled in W.B. Simpson Elementary School and Nellie Hughes Stokes Elementary School during the 1998-00 and 1999-2000 school year. This evaluation involved a sample of 101 students who were divided into two groups. The treatment group included students who were exposed to the regular district's curriculum in reading and mathematics and given the treatment, which included all components of the Delaware Challenge Grant Program. This essentially consisted of an interactive computer program designed to extend the learning activities both in the classroom and at home. The non-treatment group consisted of those students who were exposed only to the districts' curriculum in reading and mathematics.

Data were collected to evaluate three dependent variables: vocabulary achievement, reading comprehension achievement, and mathematics achievement.

Chi-square tests were utilized to evaluate the demographic variables: gender, ethnicity, socioeconomics and Title I to see whether there was any differences in the frequency distributions. Descriptive statistics were performed on the pretests and posttests of the treatment and non-treatment groups separately, and again for the total sample. A t-test was computed to evaluate the posttest measures on each of the subtests: vocabulary, reading comprehension, and mathematics. Analysis of covariance was utilized to further enhance the t-test results and to adjust posttest scores for variability on the covariate.

Results

The purpose of this study was to answer three evaluation questions:

1. In comparison to other students, will participation in the Delaware Challenge Grant Project have a positive effect on the vocabulary comprehension achievement of students in grades two or three?

2. In comparison to other students, will participation in the Delaware Challenge Grant Project have a positive effect on the reading comprehension achievement of students in grades two or three?

3. In comparison to other students, will participation in the Delaware Challenge Grant Project have a positive effect on the mathematics comprehension achievement of students in grades two or three?

The achievement of W.B. Simpson students in grades two and three was compared to the achievement of Nellie Hughes Stokes students in the same grades. The study was conducted over a two-year period and the results were analyzed separately for each year. It should be noted that the students were not randomly assigned for the study. However, analyses of student demographic variables did indicate that the two groups were not statistically different on those characteristics analyzed.

Evaluation Questions

Question 1

In comparison to other students, will participation in the Delaware Challenge Grant Project have a positive effect on the vocabulary achievement of students in grades or three?

An evaluation of student variables was compiled using the vocabulary test scores of the students over a two-year period.

Participation in the Delaware Challenge Grant appeared to have a significant impact on the vocabulary achievement of students in both years of the study. The overall treatment group (adjusted m=21.87) outperformed the non-treatment group (adjusted m=19.16) at a statistically significant level (F=7.99, $p<0.01$) in second grade. These same students were tested in third grade and again the treatment group (adjusted m=24.51) outperformed the non-treatment group (adjusted m=21.46) at a statistically significant level (F=15.95, *p*<0.01). Based on these findings the null hypothesis was rejected.

<u>Evaluation Question 2</u>

<u>In comparison to other students, will participation in the Delaware Challenge Grant Project have a positive effect on the reading comprehension achievement of students in grades two or three?</u>

Participation in the Delaware Challenge Grant Project had a positive effect on the reading comprehension test scores of those students in grade three.

In the first year of the study there was no significant difference (F=0.41, *p*=0.52) between those students who in the treatment group (adjusted m=31.69) and those that were in the non- treatment group (adjusted m=31.01). However, in the second year of the study the students in the treatment group (adjusted m=39.82) showed a statistically significant improvement (F=8.47, *p*<0.01) in comprehension scores than did students (adjusted m=36.69) receiving no treatment. Based on these findings the null hypothesis must be rejected.

<u>Evaluation Question 3.</u>

<u>In comparison to other students, will participation in the Delaware Challenge Grant Project have a positive effect on the mathematics achievement of students in grades two or three?</u>

Participation in the Delaware Challenge Grant Project had a positive effect on the mathematics test scores of those students in grades two and three. Perhaps the most significant impact of the Delaware Challenge Grant could be seen in measures associated with mathematics achievement. Those students participating in the Challenge Grant outperformed the non-treatment groups in both the first and second year of the study at a statistically significant level. In the first year of the study the treatment group (adjusted m=23.90) out performed the non-treatment group (adjusted m=20.42)(F=20.00, $p<0.01$). The second year of the study indicates the treatment group (adjusted m=36.12) outperformed the non-treatment group (adjusted m=33.37) at a statistically significant level (F=8.72, $p<0.01$). Based on these findings the null hypothesis must be rejected.

In summary, the students who participated in the Delaware Challenge Grant Project outperformed the comparison group with regard to vocabulary, reading comprehension and mathematics achievement. The overall treatment group performed better than the non-treatment group in five of the six subtests over the two-year period.

More significant is the comparison of the two overall sample groups over a two-year period. The students that received the treatment for two years showed a statistically significant improvement in test scores in two of the three subtests in the first year, and a statistically significant improvement on all subtests in the second year of the study. One could make the assumption that that the longer the students participated in the Delaware Challenge Grant Project the better they performed with regard to their comparison group.

The Delaware Challenge Grant Project set four goals for its program: generate more time for learning, increase parental involvement, provide professional development for staff, and provide equitable access to technology at home and school. By providing these four conditions for students, it was felt that student achievement would be increased. This study has shown that participation in the Delaware Challenge Grant increased the academic achievement of its participants.

Limitations

The study was a quasi-experimental design, which lends itself to limitations that must be addressed. Perhaps the most important limitation was the nonrandom assignment of students into the treatment and non-treatment groups used in this study. By not using random assignment there may have been differences among the groups prior to the treatment being administered.

Administratively, it would have been difficult for me to offer this program to a select group of students from individual classrooms. The non-treatment group was located in another school within the district. Again it would have been difficult to have teachers test only some of their students. Since students were not randomly assigned, there is a risk that the two groups differ on some variable at the onset of the study. Variables had to be measured and compared between the two groups. As indicated in Table 1, the two groups were not statistically different on the demographic measures.

Another limitation of the study was the effect that teacher/student contact had on the results of the study. Over the two-year period, the treatment groups were exposed to six different teachers. Likewise, the non-treatment group was also exposed to six different teachers. The teacher’s personal style, experience, knowledge and enthusiasm may have had an effect on students that was not measured (see Appendix J). However, all of the teachers participating in the study were Caesar Rodney School district employees, had State of Delaware teacher certification, were trained in the delivery of the district’s curriculum, and were afforded the same professional opportunities and materials.

Mortality, or the loss of subjects and their data during the course of the study, is another limitation of the study. Over the course of this study up to 153 students participated in some part of the study during the two-year period. It was decided to remove those students that had missing or partial information prior to any statistical analyses being performed. The students removed from each group were similar in composition to the students in the final sample (see Appendix I). This resulted in 101 students completing the two-year study. The size of the cohort of each group provided a sufficient sample size to perform the needed statistical analyses.

Generalizations

Evaluating the population and the sample used in the study is necessary to determine the degree to which you can apply your research findings to other groups and samples. This study took place in an area, which is surrounded by a combination of rural areas, middle class suburbs, and small to medium size towns. The results of this study should not be generalized beyond groups that would have similar conditions, i.e. same rural areas, middle class suburbs, and small to medium size towns or cities. In order to make this study more valid it should be replicated in other types of settings, i.e. large cities or urban areas. Replication of this study, which produced similar findings, could provide greater confidence in the findings.

Discussion

Each year billions of dollars are being spent on computer technology in schools (Bronner, 1997). School systems nationwide are continuing to invest in computers and software (Bronner, 1997). With the emphasis of implementing computer technology seemingly shared by the educational community, the focus now seems to be shifting to evaluating the effectiveness of its use in the schools (McNabb, et al., 1999). Now the “powers that be,” parents, teachers, school boards, legislators, want to know if all this investment in computers is raising test scores (McNabb, et al., 1999). If we expect to continue to expand computer technology in the schools we need to explain the enormous commitment to technologies in terms most people understand-student achievement.

There are many researchers who believe that evaluation of computer technology goes far beyond student achievement (Viadero, 2000). However, state policymakers continue to be faced with questions from their constituents regarding educational technology. They want to know how much it will cost, and will it improve achievement, as measured by standardized tests. (Trotter, 1996). Technology advocates complain that improving standardized test scores is just a small part of student achievement, and do not accurately reflect the benefits students derive from using technology (Trotter, 1996). With so much pressure from outside groups to show increased test scores as a result of computer technology investments, many administrators admit that if technology does not lead to increase test scores they will have to reevaluate their technology expenditures (Trotter, 1996).

The Delaware Challenge Grant sought to improve student achievement by focusing on four goals: improve students' mastery of basic skills, increase parental involvement, extend the academic learning time beyond school, and provide inservice for teachers to use computer technology. Research has shown that these factors are significant in improving achievement. A study of the Delaware Challenge Grant, conducted by the University of Delaware, found that over a two-year period second graders participating in the study had an average test score gain of more than 15 percentile points in reading and mathematics as measured by the Stanford 9 Achievement Test (Giancola et al., 1998).

W.B. Simpson Elementary School has participated in the Challenge Grant project since 1997. This study evaluated the effect of second and third grade achievement scores over a two-year period. On the three subtests, of the Stanford 9, those students participating in the Delaware Challenge Grant scored better than the non-treatment group. There was a statistically significant difference in vocabulary and mathematics in both years of the study. And in reading comprehension those same students showed a dramatic improvement in the second year of the study. Participation in the Delaware Challenge Grant project had a significant impact on the test scores of W.B. Simpson students.

The Delaware Challenge Grant was awarded to Delaware schools for a five-year period. Once the grant ends, continued funding will be the responsibility of each individual school district. Maintenance and an expansion of the project will be expensive. Decisions at both the district and building level will have to be made regarding the feasibility of investing local funds for this project. Many questions will be asked regarding cost issues, overall benefits, and effects on student achievement. This study affirms that participation in the Challenge Grant had a positive effect on the achievement scores of W. B. Simpson students.

General Recommendations

This study strongly indicates that the Delaware Challenge Grant Project had a positive effect on student achievement. Because of this positive effect the following recommendations are suggested:

- W.B. Simpson Elementary School continue to participate in and allocate funding for participation in the program.
- Caesar Rodney School District considers expanding the program to other schools in the district. Particularly to the school that served as the non-treatment site. The demographics of these schools are similar and therefore similar results could be expected.
- Continue to collect data on future students who participate in the program to determine if results from this evaluation can be duplicated.

- Continued study of the data to examine effects that individual challenge grant goals had on student achievement.
- Analyze the relationship between the amount of time spent using the software and the increase in student achievement.
- Randomization of students for similar studies may increase generalizability across larger populations.
- Continue professional development opportunities for both parents and teachers to ensure implementation of the program is optimized in the classroom and at home.

Future Recommendations

- Study the home component versus classroom component portion of the project and the effect it might have had on test scores.
- Examine extraneous teacher variables such as; teacher experience, learning style,

  teacher expectation, and the effect they may have had on achievement results.
- Analyze the results and their relationship to the student demographics of the study.

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