To the Graduate Council:

I am submitting herewith a dissertation written by Virginia P. Souders entitled "Technology and Test Scores: The Impact of Technology Funding on Student Achievement as Measured by Standardized Test Scores on the Georgia High School Graduation Tests." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Education, with a major in Leadership Studies in Education.

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TECHNOLOGY AND TEST SCORES: THE IMPACT OF TECHNOLOGY FUNDING ON STUDENT ACHIEVEMENT AS MEASURED BY STANDARDIZED TEST SCORES ON THE GEORGIA HIGH SCHOOL GRADUATION TESTS

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ABSTRACT

This study examined the impact of major technology funding, specifically the 1995 Georgia Innovative Technology Grants, on English and mathematics standardized achievement scores on the Georgia High School Graduation Tests. The study tracked, over three years, the scores of 11,083 eleventh-grade students, in four high schools that received innovative technology grants of more than $100,000 and in 12 similar high schools that did not receive such major technology funding, comparing one group with the other.

The study evaluated instructional technology funding based on objective, validated measures of academic achievement that are recognized and understood by policymakers who allocate educational funding to schools. The study made no attempt to evaluate grant program goals or software effectiveness. Study strengths included a large number of students, diverse student populations from 16 high schools in 15 systems across the state of Georgia, the use of a pre-test to compare experiment results, and the use of a control group to compare experiment results.

The study found no significant difference in test scores among schools in the year prior to funding through the innovative technology grants. The difference in the means of English test scores between the experimental group and the control group grew significantly in the first two years of technology funding, ending in the third year of the study with a significant t value of .003. There was no statistically significant finding that technology funding made a difference in the math scores in the experimental group after two years of technology funding.

The main conclusion of the study was that technology funding appears to make a significant positive difference in English achievement test scores after two years, but makes no significant difference in mathematics achievement test scores after two years of technology funding.

Recommendations included extending the study for another three years to determine if future results support this study's conclusions; conducting a study of instructional technology goals in the experimental schools; conducting a study in the same schools, looking at the type of technology used and the software application(s) applied to the experiment; conducting a study of cohort groups over a similar period of time, using both experimental and control schools in the study; looking at specific populations within these schools to see the differences in scores among special needs' groups such as gifted, English to Speakers of Other Languages, and special education; looking at ethnic groups within these schools to see the differences in scores by ethnicity; studying the effectiveness of state curriculum-based "exit" tests; conducting a similar study to look at technology funding in relation to SAT scores; conducting a longitudinal study of cohort groups using the Georgia-required, nationally normed Iowa Tests of Basic Skills (ITBS) in the third, fifth, and eighth grades; and, conducting a similar study including the science and social studies portions of the Georgia High School Graduation Tests, beginning in 1996-97, the first year individual student scores were available in both these areas.

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CHAPTER ONE

INTRODUCTION

With the 1969 landing of men on the moon and the expertise required for this achievement, the technological world came of age. The world's base of knowledge expanded in geometric proportions until, presently, those persons without solid grounding in technological skills are finding themselves rapidly being shunted aside by a global society whose jobs, recreations, economics, and day-to-day living habits are increasingly dominated and manipulated by electronic processes.

That technology in instruction is needed and necessary has been an undisputed concept for years (Astleitner, 1994). Now, many public-school classrooms are beginning to reflect the technological world in which students live. More teachers are learning to use technology in the classroom for core academic instruction as well as for enrichment, in order to meet the needs and interests of children who are being "light" or "picture-image" trained with video- and computer-based materials instead of "paper" trained with pencil, paper, and textbooks as the generations before them. Matching learning styles with delivery systems has become an urgent educational challenge of our times (Reif & Morse, 1992). Still another challenge presents itself as it is realized that children do not learn at the same rate and are not interested in the same subjects at the same time (Brooks & Perl, 1991). Classroom technology may be an answer to more effective instruction of twenty-first century children and all the growing diversity associated with them.

Background

Two of the major education initiatives in the State of Georgia in the 1990s have been the implementation of the Georgia High School Graduation Tests (GHSGT) that all students must pass before receiving a high school diploma, and the statewide lottery. Lottery proceeds fund instructional technology in the public schools, along with other educational initiatives. The GHSGT assess student knowledge of the Georgia Quality Core Curriculum (QCC) in English, math, science, social studies, and writing. Students must pass all five parts of the examination in order to receive a diploma. The test scores, reported through <u>The Georgia Education Report Cards</u>, are viewed by some as a means of measuring the effectiveness of schools in preparing Georgia youth for the world of work.

The second initiative, a statewide lottery, received support in the early 1990s when Governor Zell Miller, the Georgia Legislature, then State Superintendent of Schools Dr. Werner Rogers, and the Georgia Board of Education pledged all proceeds of a state lottery to public schools, if such a lottery were to be approved by the voters. Lottery funds, by state law, would supplement, not supplant, general education funds; primary areas identified for funding were HOPE college scholarships, prekindergarten programs, alternative schools for disruptive students, and instructional technology software and hardware. A further aim was to provide teachers in Georgia with the opportunity to gain knowledge of software applications and to learn how to effectively incorporate technology into classroom instruction.

After Georgia voters approved the lottery referendum, the 1994 Georgia General Assembly, in the FY 1995 Appropriations Act, provided $7.8 million from lottery revenues "to establish model technology grants" to public schools and higher education institutions for fiscal year 1995. Stated aims were (1) to hasten the integration of technology into the instructional program, (2) for the state to learn how to apply technology to the learning process most effectively, and (3) to have projects which might serve as a basis for widely influencing policymakers as to the benefits of funding technology (Manning, 1994, p. 1).

The Information Technology Policy Council, under Chairman Clyde Manning, managed the application and selection process. The request for proposals (RFP) delineated stringent detail required of applicants. In the Description of the Project section, applicants were required to "provide a comprehensive description of the project", including the following:

--Title

--Identification of Need/Problem (including statistical and demographic data to illustrate the "nature and extent of the needs and/or problems")

--Purpose and Potential Impact

--Detail, including

1. Organization(s) involved, explaining the "role and responsibilities of each entity relative to the project";

2. Target Population(s) Grade Levels, indicating how many students, classes, etc., would be in the participant pool;

3. Training, including a description of (a) "the planned training for staff use of application of the associated hardware, software, communications, etc.," and (b) "the planned staff training to integrate the technological tools into direct instructional strategies and delivery";

--Implementation Strategy, indicating "what, if any, elements are to be piloted and for what period of time," and "how a successful pilot implementation will be rolled out to a larger population to be impacted";

--Project Milestones

--Evaluation Measures

--Potential for Project Replication

--Qualifications of the Project Director

--Project Budget (Manning, 1994, p. 3-6).

Grant recipients were notified in January, 1995, and the grant implementation period was from January through September, 1995. Thirty projects were funded, twenty-three in kindergarten through twelfth grade, five in colleges and universities, and two in state technical institutes. Of the twenty-three k-12 public schools, twelve projects were elementary only, five were middle school only, three were high school only. The remaining three projects involved a combination of elementary, middle, and high schools.

Four single-school projects were for less than $100,000. Sixteen grant amounts in excess of $100,000 concentrated monies at the elementary or middle school level. Three high-school-only projects were for $364,876, $159,734, and $170,409. A fourth project, for $630,846, involved two elementary schools and a high school. Upon investigation, the researcher found that the high school had received well over $100,000 from the total funding.

Therefore, from the twenty-three funded projects, a total of four high schools were funded in excess of $100,000 (Manning, 1994).

Statement of the Problem

Businesspersons, taxpayers, and policymakers want objective assessment of the impact of taxpayer-funded initiatives (Dr. Nancy Paysinger, Director, Georgia Department of Education Division of Instructional Media, in conversation, February, 1993). They seldom understand program evaluation that is based on subjective measures such as attitudes toward learning and motivation. At the time this study began, there were no studies that analyzed student achievement test scores before and after widespread infusion of technology funds into the instructional program. Several studies evaluated specific types of software for their effectiveness in the classroom (Burnside, 1991; Denning, 1994; Ellis & Debrecency, 1994; Sansom 1989). Other studies subjectively evaluated specific types of technology for their impact on learning (Bozik, 1996; Fyock, 1994; Harvey & Nelson, 1995; Karayan & Crowe, 1997;

Legenhausen, 1991; Schroeder, 1993; Shipe, 1989), or studied student perceptions and attitudes toward learning engendered through technology (Losak & MacFarland, 1994; Dwyer, 1994; Wilder & Fowler, 1992). Haley (1991), and Luna and McKenzie (1997) evaluated technology's effectiveness in a single classroom setting. Few studies have evaluated the effects of instructional technology on standardized test scores; those which attempted such a study were limited in scope and mixed in conclusions (Brush, 1996; Hofmeister, 1990; Kulik & Kulik, 1991; Newman, et al., 1993; Uslick & Walker, 1994; Williams, 1993), and could be used neither as a basis for defending past use of taxpayer monies for instructional technology nor for soliciting future funding.

Although there has been an interest in accountability through increased test scores, and although massive amounts of tax and lottery dollars have been used to purchase instructional technology and to train educators in its use, sufficient research has not been conducted to pair extensive technology funding to achievement test scores. Research is needed to see what effect, if any, technology has had on learning as measured by standardized tests, that measure being used as the standard by which public education is currently being held accountable.

Purpose of the Study

The purpose of this study was to ascertain the impact of instructional technology funding on standardized test scores on the Georgia High School Graduation Tests (GHSGT).

Importance of the Study

With the current national emphasis on educational accountability, this study was important because it evaluated instructional technology funding's effectiveness based on objective, validated measures of academic achievement. The study generated relevant discussion and early conclusions were drawn as to the impact of technology on academic achievement.

Research Questions

The following research questions guided the analysis of Georgia High School Graduation Tests data, collected in the areas of English language arts and mathematics, from high schools receiving competitive technology grants in excess of $100,000 and from similar high schools that had not received such funding:

Question One: During the year prior to an infusion of $100,000 or more in instructional technology funds in Group One, was there a significant difference between Group One (Experimental) and Group Two (Control) schools' individual student achievement test scores on the eleventh-grade English language arts subtest of the 1994-95 GHSGT?

Question Two: During the year prior to an infusion of $100,000 or more in instructional technology funds in Group One, was there a significant difference between Group One and Group Two schools' individual student achievement test scores on the eleventh-grade mathematics subtest of the 1994-95 GHSGT?

Question Three: Was there a significant difference between individual student achievement test scores within each group on the eleventh-grade English language arts subtest of the GHSGT in the three years being studied (1994-95, 1995-96, 1996-97)?

Question Four: Was there a significant difference between individual student achievement test scores within each group on the eleventh-grade mathematics subtest of the GHSGT in the three years being studied (1994-95, 1995-96, 1996-97)?

Question Five: Was there a significant difference between Group One and Group Two schools' individual student academic achievement test scores on the eleventh-grade English language arts subtest of the 1996-97 GHSGT after one or two year's infusion of $100,000 or more in instructional technology funds in Group One?

Question Six: Was there a significant difference between Group One and Group Two schools' individual student academic achievement test scores on the eleventh-grade mathematics subtest of the 1996-97 GHSGT after one or two year's infusion of $100,000 or more in instructional technology funds in Group One?

Delimitations and Limitations

Delimitations

1. The 1995 Model Technology Grants were given to Georgia public schools, colleges, and universities. Because individual student standardized test score data were available only on nationally normed tests in kindergarten through eighth grade public schools, and on eleventh-grade criterion-based assessments in public schools, only Georgia public schools that received model technology grants and their comparable public-school counterparts were included in the study.
2. Because "the curriculum-based assessments that the State Board" had developed "measure student performance relative to the uniformly sequenced core curriculum approved for grades three, five, eight, and eleven" (Georgia Department of Education, 1994, v-d-1) and, because the reasoning behind funding of innovative technology grants was to "learn how to apply technology to the learning process most effectively" (Manning,

1994) only criterion-referenced tests which report individual student scores and which focus on Georgia's curriculum were used. Therefore, because the Georgia Curriculum-Based Assessment (CBA), for grades three, five, and eight reported only school scores and not individual scores, the basis of study was the Georgia High School Graduation Tests (GHSGT), a curriculum-based criterion-referenced, assessment which reports individual student scores on all eleventh-grade students.

3. The control group schools must be those that received only technology funding that all schools in Georgia received. Therefore, high schools that had previously received a Next Generation Schools Grant (Goals 2000) of over $100,000 for technology or other similar major funding for technology through the private sector or other grants were not used as a Group Two comparison school.
4. The study made no attempt to provide evidence of student academic achievement from means other than standardized test scores.

Limitations

1. Pupil-teacher ratio figures were not available for each school; therefore, this was not considered in the study.
2. The Georgia High School Graduation Tests examine in the areas of English, math, science, and social studies. However, the science portion of the test was field-tested in the 1994-95 school year, with only a range of scores being reported; the test was required in 1995-96 and individual scores are available. The social studies portion of the test was field-tested in 1995-96; only a score range is available. Therefore, this study did not consider science and social studies scores in the research.
3. The Georgia High School Graduation Tests must all be passed before a Georgia student can receive a high school diploma. They are required for the first time of all students in the spring of their junior year, and only those who fail one or more parts of the test repeat

the parts failed. Therefore, each year of the study used different students.

Assumptions

The following points were assumed:

1. That the technology chosen by the experimental-group schools was appropriate in meeting the academic needs of students whose test scores were used in the study;
2. That the technology was implemented in classroom instruction upon receipt of the grant and that staff had appropriate training in the use of the chosen technology prior to using it in class instruction;
3. That student access to technology was approximately equal among all experimental-group schools;
4. That control and experimental groups had similar teaching staffs, all having met the Georgia teacher certification requirements and schools being required by the state of Georgia to comply with Georgia Public School Standards (1993-

1994). In addition, schools met accreditation standards for instruction, such as those of the Georgia Accreditation Commission and/or the Southern Association of Colleges and Schools;

5. That, other than the infusion of major technology funding, all other variables were controlled by the matching and grouping methods discussed in this chapter and Chapter Three, and by schools being required by the State of Georgia to comply with Georgia Public School Standards (1993-1994). In addition, schools met accreditation standards such as those of the Georgia Accreditation Commission and/or the Southern Association of Colleges and Schools;

6. That all testing had been conducted in accordance with the procedures outlined in the Georgia Student Assessment Handbook (Georgia Department of Education, 1994) and verified by the Georgia Comprehensive Evaluation Service;

7. That the scoring and reporting done at the University of Georgia was valid and reliable; and,

8. That all test reports furnished by systems to the researcher had not been altered except to delete personally identifiable information.

Definition of Terms

Criterion-Referenced Test: A test in which scores are compared to a set performance standard (Woolfolk, 1990).

Georgia High School Graduation Tests (GHSGT) scores: The average scaled scores in English, math, science, and social studies which are computed for the eleventh-grade Georgia state-mandated test. As criterion-referenced test scores, they are considered to be better measures of curriculum attainment than norm-referenced tests.

Instructional Technology: Audio and/or video electronic means of disseminating knowledge in the classroom. This term may include, but not be limited to, computer-assisted instruction (CAI), audio production and/or viewing, video production and/or viewing, distance learning, and integrated learning systems (ILS).

Integrated Learning System (ILS): A large, networked instructional, management, and assessment system. The curriculum has lessons, tutorials, and simulations and includes branching to determine whether students are learning, either moving them forward or sending them back for remediation. The management system allows teachers to monitor student progress and to tailor the curriculum to particular objectives. The assessment portion correlates student performance to standard normed tests and criterion-referenced assessments (Levinson, 1994).

Norm-Referenced Test: A test in which scores are determined by a comparison to the performance of other people who have taken the test (Woolfolk, 1990).

Procedures and Methods

A causal-comparative research design was used that compared, over a three-year period, two groups of similar high schools, different only in the variable of the amount of technology funding. The study compared student test scores on the Georgia High School Graduation Tests from four Georgia public high schools that received $100,000 or more in model technology grant funding from the state of Georgia to the student test scores of similar Georgia schools that did not have such technology infusion during the same time frame. Matching schools were those whose system was in the same comparison group as the experimental school's system to which it was being matched, whose grade-level configuration (i.e. 9-12, 10-12) was the same or as close to the same as the experimental school with which it was being matched, and for which the difference in (a) total enrollment between Group 1 and Group 2 schools, (b) socioeconomic status as identified by the schools' percentage of free lunches, and (c) racial makeup was as small as possible.

For the three school years of the study, results in English language arts and mathematics in the eleventh grade on the criterion-referenced Georgia High School Graduation Tests (GHSGT) were gathered. Each participating system gave permission for data to be used by having an authorized person sign a data use permission form (see Appendix). Systems that chose not to participate did not return a signed form or send data.

First-year results from both groups were tested for significant differences using an independent t-test. This information was used to answer research questions one and two. First-, second-, and third-year results in each were tested for statistically significant differences using an independent-t test. This was used to answer research questions three and four. Second-year results of both the Experimental and Control Groups were compared for statistically significant differences using an independent t-test. This information was used to answer research questions five and six.

Organization of the Study

The study was arranged in five chapters: (1) Introduction, (2) Review of Related Literature and Research, (3) Methodology, (4) Findings and Analysis of the Data, and (5) Summary, Conclusions, and Recommendations.

CHAPTER TWO

REVIEW OF THE LITERATURE

As local, state, and federal governments invest dollars in technology for education, more attention is focused on its effectiveness. Brunner and McMillan (1994) stated that:

> If we had a nickel for every reporter who called us at the Center for Children and technology to ask us if our research proves that technology raises test scores, we wouldn't have to apply for any more government grants. (p. 22)

In 1991, Bork said that serious questions existed as to whether technology is effective in schools as compared to other learning tools. He said that further information was needed to plan rationally for education, that existing evidence for evaluating technology's effectiveness was inadequate. In the same year, Wellburn noted that "at present . . . studies do not seem to exist" that indicate how technology, "incorporated into a variety of curriculum areas," can result in learners having "better learning strategies, increased collaborative abilities, more higher-order thinking experiences, improved problem-solving, and so on." (1991, p. 18) She would be pleased to find that, between 1991 and today, there has been a small, but growing, body of literature on technology evaluation.

Background

As early as 1939, research on the effectiveness of instructional technology, in this case, radio, was conducted, finding that students who took "classes via radio performed as well as or better than those in a traditional classroom." In the 1960s, hundreds of studies compared televised instruction to traditional classroom instruction and found, for the most part, no significant differences in learning achievement between the two methods. Likewise, studies between 1983 and 1986 evaluating telecommunications technology (instructional television/ITV) found no statistically significant differences in achievement between ITV students and their traditionally taught peers (Johnstone cited in Horner & Roberts, 1991, p.51). Why, then, the push to fund instructional technology?

As Horner and Roberts noted, telecommunications is a way of life in today's world.

> Electronically mediated experiences permeate the lives of all Americans . . . . Electronically mediated

> learning experiences are, and increasingly will be, a regular feature of our youngsters' world. The question we face in educating is not whether these experiences should be part of the process but, rather, how to make intelligent use of them to best serve the needs of our youngsters and society. (1991, p. 9)

Barron and Orwig (1995) noted that, based on teacher perception, published literature, and available technology, benefits of instructional technology include multisensory delivery, increased self-expression and active learning by students, higher-level thinking skills, increased cooperative learning, enhanced communication skills, expanded multicultural education, individualization, and heightened motivation. Important and useful evaluation data, asserted Kinnaman (1992), include performance assessment, student attitudes, and teacher attitudes and behaviors, as well as student achievement on standardized tests.

Although many of these benefits give evidence of intrinsic value, as one state representative expressed to this researcher, funding for instructional technology cannot long be based on such "touchy-feely" evidence, but must be based on more concrete documentation (Poston, 1996). Educational technology as an integrated part of the curriculum and instruction "threatens to change the landscape of school funding." (Westbrook & Herr, 1996) The hardware itself (computers, printers, cameras, modems, and other high-technology items) is but the "tip of the iceberg"; more expensive than the hardware itself is the infrastructure required to sustain the equipment (software, cabling, networks), the continuous electronic upgrading needed to use the newest learning tools, and the "reconfiguration of classrooms to accommodate new patterns of instruction." (p. 49)

Wilder and Fowler (1992) stated that:

> as computers have been introduced more widely into schools, teachers and school administrators have been called upon increasingly to justify the expenditures for hardware and software. Typically, school boards and taxpayers have demanded evidence that computers are making a difference, usually in student achievement and most often measured by scores on standardized tests. (p. 82)

Austin and Garber noted in 1982 that "the only readily available evidence of how the schools are succeeding, other than teaching grades, is test scores". Teacher grades, they said, "are more a reflection of student characteristics than successful teaching". One could say the same thing about test scores, yet "in the area of standardized, normative testing, [the public has] adopted the assumption that the schools are failing . . . to teach effectively since . . . test scores . . . are declining." (p. 2)

The need and demand for a wealth of research on instructional technology's effectiveness comes late in a century that has seen educational evaluation of methods, programs, and materials slowly take shape since the early 1990s. Kinnaman noted that education has always had evaluation as a main component, but that is wasn't until the 1930s that "evaluation" came to mean more than the testing of students. Through the work of Ralph Tyler, Kinnaman said, evaluation came to mean the appraisal of a program by determining the extent to which the program achieved its objectives. As early as 1929, Tyler was stating educational objectives in behavioral terms and then designing tests to determine whether these behaviors had been achieved. What became known as the "Tyler Rationale," from his 1949 Basic Principles of Curriculum and Instruction, represented the four-step sequence of (1) identifying objectives, (2) selecting the means to obtain these objectives, (3) organizing the means, and (4) evaluating the outcomes (Saettler, 1990). This point of view was furthered in 1963 by Lee J. Cronbach in his "Course Improvement Through Evaluation," when he argued that programs should be more concerned with the degree in which desired results are reached and not with comparison to other programs (Kinnaman, 1992, p. 13).

The biggest influence on educational evaluation came through the Elementary and Secondary Education Act of 1965 (ESEA), a federal program requiring grantees to submit an annual evaluation report. A drawback to evaluation was that ESEA did not require that end-of-year reports be used for subsequent planning. The result, said Kinnaman, was that program evaluation has had little effect on education (p. 13-14).

Planning for and evaluation of technology in education has sometimes taken the form of student computer-literacy behavioral objectives, and gone no further than "providing a basic understanding of computer usage, processes, and systems." (Garrett, 1993, p. 103-104) While, as Garrett noted, this type of knowledge is necessary for all students, the success of any innovative approach to education must ultimately show improvement in student learning (Poirot, 1992, p. 30). Poirot stated the questions that must be asked: (1) What should we measure, and (2) How should it be measured? The review of literature shows that research results and researchers' beliefs are mixed on both these questions.

There are those who believe that technology should be evaluated by the improved skills of students in accessing information, by the improved abilities to apply higher-order thinking skills to learning (Bingham, 1992), by the heightened levels of motivation and attitude toward school and learning from both students and teachers (Kinnaman, 1992), by increased teacher and student collaboration, by the shifting roles of teachers from giver of knowledge to facilitator of learning (Brunner & McMillan, 1994). Others (Kulik & Kulik, 1991; Newman, 1993; Williams, 1993; Brush, 1996; Mann & Shafer, 1997) believe and show evidence that standardized testing can, indeed, be a valid measure of technology's impact on student learning.

Poirot stated that "an evaluation of the use of technology in a classroom would be incomplete without studying the effect that the technology had on a student's content-level ability." The most common type of evaluation comes after a student has used the treatment for an entire year, and the treatment is preceded by a pre-test using a standardized test instrument. The same test is administered again at the end of the treatment year and "the difference in scores of the treatment and the control group compared using statistical measures such as the t-test for difference of mean." Poirot stressed that a finding of "no significant improvement" does not necessarily mean the treatment has failed, only that other means should be identified to find potential areas of improvement such as those listed above (p. 30).

Student achievement as measured by standardized test scores, said Kinnaman, "may be an important measure of the success of an educational program, but it is almost never the only important measure." He said there are at least two possible problems with the emphasis on test data: (1) the test may not measure what the program is designed to teach, and (2) improvement in test scores may take more than one program cycle or school year to surface. Indeed, noted Kinnaman, "a program that represents a dramatic departure from traditional instruction may yield level, or even lower, test scores during the year's initial implementation." (p. 18)

Wilder and Fowler (1992) agreed with this overall assessment, noting that school boards' and taxpayers' demands for proof of technology's success in the classroom through the use of standardized test score data "take little account of the actual conditions that mark the implementation of technology in schools. These include the fact that implementation is a process" over a period of years. Furthermore, Wilder and Fowler asserted, "many schools and districts have only loosely specified objectives for the technologies that they adopt." (p. 82)

Atkins (1993) asserted there are two ways to evaluate "claims and counter-claims" of technologies. First, one can compare one type of media to another to determine the more effective/efficient, and, secondly, one can examine instructional techniques for learning effectiveness.

From these methods of evaluation, Atkins found that (1) students enjoy learning from interactive technology, sometimes in preference to traditional teaching methods; (2) learning through technology can be more efficient than from other media; time on task is high; (3) learning can be more effective than through traditional means; students have a better mastery level and remember more of what they have learned; (4) tightly structured and designer-controlled technology may be "suboptimal for high-ability students"; and, (5) some interactive technologies are "highly effective for the learning of prespecified factual content—but may actually hinder the learning of more complex knowledge or the development of higher-order skills." (p. 334-335)

In spite of the above findings, Atkins stated that there are faults with the two types of research. What is faulty, according to Atkins, is that there is no curriculum context, no value statements about what is good teaching or appropriate learning. Atkins averred that there is a need to examine learning through technology as (1) knowledge acquisition and (2) the development of conceptual understanding and change.

In the frame of reference of "knowledge acquisition", instructional technologies offer access to large quantities of accurate and updatable information, and offer a range of ways of structuring the learning material. However, learning may remain "divorced from . . . understanding and interpretation . . . . [Students] pass examinations and do well on assessment tests", but cannot explain fundamental theories or principles, or why people or events behave or happen the way they do. Students "have acquired knowledge but not learned at all. They have got the answers right without understanding what they meant." (p. 338-339)
In the development of conceptual understanding and change, Atkins found that instructional technology can help in the

transfer of learning to the real world, provide a simulation/model on which to test relationships between variables, and give students practice in the skills of inquiry. But to understand the full capabilities of learning technology, according to Bork (1991), studies must go beyond the small-group studies, with "at best a few hundred students" and, not surprisingly, find that no significant difference exists in student performance or that differences are slight (p. 9).

Technology Evaluation in Teacher Training

In the literature on technology evaluation, one large segment deals with teacher training in integrating technology into instruction. Teachers who entered the classroom more than ten years ago, noted Kopp and Ferguson (1996), preceded the personal computer, and their training in this technology tool was non-existent. "Obviously, teachers cannot just magically utilize technologies' many facets without training, guidance and models . . . ." Relevant and meaningful training is absolutely necessary, training that is more than simply teaching teachers how to operate a computer. Kopp and Ferguson averred that "to make a lasting change in the classroom, a practical application 'hands-on' phase must immediately follow the training sessions."(p. 80) A three-year pilot program comparing two groups of teachers under different variables showed that a second week of training and the presence of student learners "made a significant different in the overall confidence of technology application in mathematics and science."(p. 82)

Despot (1992) found five reasons why technology was not being effectively utilized in the classroom: (1) the establishing of isolated computer labs rather than placing computers into the regular classroom; (2) teachers receiving no, or inadequate, technology training in their teacher preparation and certification courses, creating unease and feelings of inadequacy toward technology use in instruction; (3) highly structured and crowded primary-grade scheduling which "limited flexibility and creativity needed when young students engaged in writing compositions at the computer"; (4) computers not being accessible to all students equally; and, (5) primary teachers having a tendency to use computers to reinforce basic skills (drill and practice) rather than in more creative, flexible ways (p. 9-11). An analysis of the training of teachers in the use of a particular technology and/or program showed student opportunities for success increased by increasing teacher knowledge of and experience in technology, as well as improving attitudes toward the use of technology in instruction, specifically as a tool in writing. By providing teachers with the tools and the training, support for student opportunities for computer use in writing increased.

Two other teacher-training experiments aimed to motivate teachers to improve instruction and learning through use of technology-based presentations (Sammons, 1995) and to pass those technology skills and experiences on to students (Holt, Ludwick, & McAllister, 1996). College teachers, elementary teachers, and teacher interns were provided with equipment and software, and were familiarized with both. Sammons verified that more than 500 students in seven subjects who evaluated the effectiveness of computer-aided instruction found the top three benefits to be (1) that classes were more interesting and a welcome change of pace; (2) classes were more organized; and, (3) students better understood material covered. Holt and his fellow researchers found the training resulted in "enduring innovations, affecting the teachers and interns taught, and students learned." (p. 81)

Lee County, Florida, school system personally developed a five-year technology plan that heavily emphasized teacher training through inservice incentives of time off and stipends (Spriggs & Bohannon, 1995). An evaluation of the "flex-time" incentive plan determined that its effectiveness on plan objectives was strong.

Mann and Shafer's (1997) research supported the above conclusions. They found that the success of technology in the classroom was strongly related to teacher "enthusiasm, initiative, and sense of improvement." The higher the levels of technology availability, the greater were teachers' perceptions of their technology skill. When schools provided enough technology for equitable success, required relevant training of teachers, then sequenced and concentrated application topics, teacher interest in technology was strong. Their survey showed that "the private sector aims to spend about 30 cents of every technology dollar on training, but the 55 districts [studied] were averaging less than at third of that." Knowing that educational technology dollars are in short supply, the researchers asked teachers in the districts in the study if they would be willing to allow their class size to increase by five students in exchange for an extra $15,000 for technology in the classroom and $10,000 in salary. Sixty-five percent of the teachers said they would accept such a package.

Evaluation of Instructional Technology Effectiveness In One Classroom/Program

While a body of research has focused on teacher training in the effective use of technology, as shown above, a very small amount of research concentrates on the evaluation of technology effectiveness in one classroom or program, or on the effectiveness of a specific application package in a limited environment. Haley (1991) found "no significant positive relationship between students' cognitive achievement" in a college economics class of forty-one students and "their use of computer-assisted instruction," and Luna and McKenzie (1997) found the link between multimedia and student exam performance in two community college political science courses to be weak (p. 80).

Evaluation of Effectiveness of a Specific Software Program

Effectiveness of particular applications brought similarly weak quantitative results. Sansom (1988) found that while students who used the computer-assisted instructional program WORDWORKS did not achieve significantly higher gains in grammar and reading than those who did not use the program, their mastery level scores were higher. Burnside (1991) participated in the design, development, implementation, and evaluation of an eighth-grade writing unit that incorporated the computer as a writing tool. Through student and teacher interviews, Burnside found that students experienced greater pleasure in independent learning, and their confidence level in using the computer for future projects rose. Ellis and Debreceny (1994), suing an Australian-developed product called Electronic Classroom, found that students using the product felt more involved in the learning process than did students who were exposed to more traditional classroom methods.

Denning (1994), using The Biology Sleuth, an application designed to help secondary students develop skills in diagnostic reasoning, had more measurable results. While her test pool was small, eighteen students, she found that students' post-test results showed a 22% improvement in reasoning ability to choose the correct diagnostic test to run in a particular instance. The students' post-testing also showed a 44% improvement in being able to use hypotheses to explain a pattern of data.

Evaluation of Effectiveness of Types of Technology

A stronger body of literature analyzes, not applications, but the technology itself. While Luna and McKenzie found no strong evidence through student examination performance in support of multimedia, their qualitative results more strongly supported the effectiveness of multimedia. They found that 43% of involved students believed that the use of multimedia in instruction improved their understanding; only 25% felt it did not. Seventy-three percent found instruction was strengthened by the use of multimedia, 64% preferred it to traditional lecture, and 67% thought it easier to see than visuals on a chalkboard.

Bozik (1996) and Karayan and Crowe (1997) used the same set of behaviors in analyzing two different types of technology. In assessing two-way interactive video classes, Bozik found only a slight effect on students' academic behaviors. The majority of students found no difference in their answering a teacher-asked question, in class attendance, in ability to learn class content, in developing their attitude toward the class, or in their motivation. Karayan, on the other hand, found that about 50% of participating students were more likely to exhibit behaviors such as answering a teacher-asked or peer-asked question, asking a peer a question, learning class content, developing a positive relationship with instructor and peers, participating outside the normal workday, and thinking more before answering, when participating in electronic discussion groups ("listservs").

Like Bozik, Fyock (1994) also evaluated the effectiveness of two-way interactive video technology in offering advanced placement and enrichment courses among three small New York school systems that could not have afforded the classes on their own. Forty-six students were enrolled in the program. Findings showed that the technology met student expectations and that these distance-learning classes were as effective as traditional classes. Students' grade-point averages were neither negatively nor positively impacted by the technology.

Harvey and Nelson (1995) and Schroeder (1993) evaluated hypermedia/hypertext technology. Harvey's research involved the training of executives in a Cities in Schools dropout prevention program. Harvey found that the overall mean usage over four days of training was only 8%. He took this to mean that the "trainers were not encouraging trainees to make appropriate use of the hypermedia." Therefore, "it was not possible to continue the analysis of the relationship between uses of hypermedia and the attainment of specific learning objectives." (p. 184) Schroeder, in working with 113 undergraduate students with a hypertext system found that most students were uneasy using the technology and sometimes felt lost or frustrated. Those who scored higher on a prior-knowledge-of-the-technology test did better in using the hypertext system than those who did not have prior technology knowledge. The same more technically proficient students showed a greater increase in score on a second knowledge test over their pre-experiment test score than did those without prior technology knowledge. Schroeder concluded that extended experience with the system was necessary before one could make effective use of the technology in learning.

Another study of students who also knew nothing about the technology being evaluated, but who were four-year-olds instead of college students, was conducted by Legenhausen in 1991. Pairs of students were allowed to "self-select" a computer for 10-minute intervals during "free play" time each morning. Legenhausen found significant differences between the experimental and control groups on the acquisition of school readiness skills, and that the experimental group "exceeded a criterion for success of 70% correct on the five areas of computer use."

Shipe's study (1989) looked at level-one laserdisc instruction, using an experimental and control group. Pre- and post-test scores showed that the use of laserdisc technology in instruction increased student comprehension of subject matter more than did traditional teaching methods. Shipe noted that his research "suggested that any student gains should be attributed to the instructional content and methodology of the instructional program and not to the medium itself, yet the medium allows for consistent modeling of instructional presentation."

To this point in the review, research has been limited in scope—teacher training, one class or small numbers of students, one application, one type of technology—and in time—one grading period, one year. Dwyer (1994), Wilder and Fowler (1992), and Losak and McFarland (1994) document research on a far larger scale, one in selected classrooms across the country, one in three counties in western Maryland over three years, and the third in the whole state of Florida over five years.

Evaluation of Instructional Technology Effectiveness In Broadly Focused Programs

The Apple Classrooms of Tomorrow (ACOT) program began its work in 1986 in seven classrooms across the United States, representing a cross-section of K-12 classrooms, and, in two years' time was a project involving twenty teachers and several hundred students. As Dwyer (1994) pointed out, "their experiences shattered the most commonly expressed fears of the time." At the end of two years (1988), ACOT had found teachers were not "hopeless technical illiterates," children were not turned into "social isolates," "children's interest in and engagement with the technology did not decline with routine use," children did not find the "keyboard a barrier to fluid use of the computer," and "software did not prove to be a limiting factor." (p. 4-5) While test scores were not a target of the overall study, "scores indicated that, at the very least, students were doing as well as they might without all the technology, and some were clearly performing better."

At the Memphis, Tennessee, site, however, increased test scores were one of the class objectives. After the first two years of the study, the district reported that students in the ACOT classroom had "significantly higher scores on the California Achievement Test" than did other students (p. 5).

After four years of the study at the high school level, the greatest student differences were found to be in "the manner in which they organized for and accomplished their work. Routinely, they employed inquiry, collaborative, technological, and problem-solving skills uncommon to graduates of traditional high school programs." (p. 8) Dwyer pointed out that, in the beginning, researchers believed that "knowledge could be 'transferred' to students more efficiently with the simple addition" of the computer in the classroom. While this was found to be true, broader implications were found, amounting to a "transformation" of the "learning culture." Teachers' instructional beliefs and practices changed immensely, and the greatest advances in student achievement were in classrooms where teachers had learned to "achieve a balance between the appropriate use of direct instruction strategies and collaborative, inquiry-driven knowledge-construction strategies." Dwyer and his researchers found that "an array of tools for acquiring information and for thinking and expression allows more children more ways to enter the learning enterprise successfully." (p. 9)

In the Maryland study, Wilder and Fowler (1991) collected samples of student work that demonstrated "the unique contributions of the computer to the learning process." The most common application use was word processing; the second most common, the organization and presentation of information from different sources; and the third most common, math drill-and-practice. Through teachers' discussion of the ways in which the technology had enhanced teaching and learning, several domains were identified where the technology appeared to be making a significant difference, and teachers were instructed to concentrate in these domains.

After a year of collecting data samples in each of the domains, a framework for assessment was devised. The result of the three-year process was a set of scaled indicators of performance within each domain that could be used to assess progress in the application and use of technology in learning. The researchers noted that another study should then follow which analyzed the data from the indicators.

In the Florida study, Losak and McFarland (1994) studied five schools (three high and two elementary) involved in the Model Technology Schools project and evaluated the project for effects of technology in learning after five years. Nine overall findings were: (1) student motivation was heightened through technology use; (2) information access was improved; (3) technology literacy was viewed as "critical to career and preparation for high school graduates"; (4) adaptive devices for special-needs students were insufficient although excellent for individualized instruction; (5) 91% of students spent one to ten hours per week on computers; (6) this usage was a much higher level than overall usage in the U.S.; (7) conditions known to support learning (enthusiasm, time on task, etc.) were much more in evidence with computer usage; (8) classroom management improved; and, (9) state-of-the-art, expensive computers are not essential to success (p. 102-104).

One high school in the study cited factors that advanced teaching in the school; the main student result reported was a 26% increase in computer use by students. A second high school documented the steady rise in SAT scores over five years after the model technology program was in place, at the same time the national trend was declining test scores. This same high school reported 100% of students using computer-delivered programmed instruction passed standardized tests.

Evaluation of Technology through Standardized Achievement Test

The mention of standardized test scores in the Florida study leads to the final group of studies, those that look at achievement test scores as a potential means of evaluating the effectiveness of technology. Linn (1991), in a discussion of why standardized test scores are so prevalently misused, stated that the misuses "sometimes lead to serious misinterpretations of educational achievement." Achievement tests intended to be diagnostic, to help teachers identify student strengths and weaknesses, may be used to hold teachers accountable for student achievement, to rank districts or schools, "or even to sell real estate." (p. 8) Linn's main point was that, unless instruction, with or without technology, has the specific objective to raise achievement test scores, such scores should not be used to evaluate the instruction. Several studies have been conducted since the early 1990's, however, that seem to present technology evaluation through achievement test scores in an objective light, whether raising test scores was an original objective or not. As early as 1979, Thomas had found that at-risk students usually score higher on standardized tests after having used computer-assisted instruction. The following four studies bear this out.

Fifty-four randomly selected sixth-grade student scores on the Stanford Achievement Test (SAT) were compared by Williams in a 1993 study before and after those students received computer-assisted instruction in a Chapter I class. Her results showed that there was a significant difference in the reading comprehension scores, but no significant difference in math application scores.

Brush (1996) studied 65 fifth-grade students in one elementary school who studied math through the use of an Integrated Learning System (ILS) in a computer laboratory, either in a traditional, individualized format, or in cooperative learning groups. The California Achievement Test, 5th edition (CAT5) was used as both the pre- and post-test for math achievement, completing Form A for the pretest and Form B for the posttest. Brush found that students using an ILS performed better on standardized tests and that attitudes were more positive when they used cooperative learning.

Newman's 1993 study involved seven teachers at the Ralph Bunche School in Harlem (New York) who conducted a "Computer Mini-School." The computer use in the project was not designed to improvement achievement test scores at the end of the year. The emphasis of the project was on collaborative projects and integrated curriculum, and excluded any kind of drill-and-practice. Nonetheless, at the end of the school year, the teachers were "pleasantly surprised" when the 120 students in the project made "real and quite substantial" gains, particularly in math achievement test scores (p. 5). Newman concluded that the change was caused by the "greater sense of community and emotional belonging" that included common technology skills and the design of work places that allowed groups to work together. "While technology was only indirectly the cause of the improvements," Newman concluded, "we can ask how technology can be designed to directly support the restructuring and communication within a school community." (p. 9)

Mann and Shafer, in their 1997 report of a study of 55 New York State school districts, said that investment in technology paid off in student performance. Combined with the teacher training already noted, they said that high schools with more instructional technology saw an average increase of over 8% in the percentage of high school students who took and passed the state's college preparatory exam. The average increase in math was 7.5%; in English, 8.8%. They found that "42% of the variation in math scores and 12% of the variation in English scores could be explained by the addition of technology in the school." (p. 22)

In New York elementary schools, Mann and Shafer "found a strong relationship between increased technology and higher scores on the state's Comprehensive Assessment Report." While they did not conduct an experiment containing a control group that had technology withheld, nor did they have a pretest from students prior to ever seeing technology (both scenarios which they said were unfeasible), they said that their "exhaustive amount of data—quantitative, qualitative, and longitudinal—in addition to anecdotal reports" pointed to the same conclusion, that "increased technology supports, facilitates, and encourages student achievement." (p. 22)

Two studies were located which found no significant increase in achievement test scores with the use of technology. Hofmeister (1990) presented three computer-assisted instruction modules to 89 reading-delayed junior and senior high school students in Utah and Wyoming and found that, with one exception, standardized test scores did not significantly increase. Only with one teacher's students in the area of total reading was there any significant increase. The program failed to produce significant increases in any other subtest (reading vocabulary, reading comprehension, social studies).

Uslick (1994) evaluated the Lighthouse Project in one urban and two suburban school districts, a project which sought to evaluate improvement in mathematics through use of the California Achievement Test (CAT) as a pre- and post-test. Her study concluded that the "focus on the results of a standardized achievement test in mathematics inhibited the implementation of mathematics reform in the elementary schools," that "accountability measures such as standardized tests should not be used to judge the impact of the program on student learning." (p. 19-20)

The drawback to the above studies is that there was no control group of students who received the same curricular instruction without using technology. Molnar (1997) cited Kulik and Kulik (1991) in their meta-analysis of

> several hundred well-controlled studies . . . at the elementary, secondary, higher- and adult-education level. He [Kulik] found that computer-based education could increase scores from 10 to 20 percentile points and reduce time necessary to achieve goals by one-third. He found that computers improved class performance by about one-half a standard deviation. (p. 65)

Molnar concluded that educational technology, when properly applied, can "provide an effective means for learning." He speculated that

> while education is changing, it is not changing fast enough . . . . In the future, we will see a major restructuring of our social, industrial, and

> educational institutions, and an increased reliance on computers and telecommunications for work and education. (p. 68)

In summary, research to date on the effectiveness of instructional technology funding has been limited to technology in teacher training, effectiveness of a specific application or technology, narrowly or broadly focused studies of outcomes other than achievement test scores, and achievement-test-score related studies which have no control group for comparison. Poirot's questions as to what we should measure and how it should be measured remain two topics of debate and concern. This study, analyzing achievement test scores over a three-year period, with large numbers of students and schools in both experimental and control groups, would appear to be a potentially valuable addition to the research, giving weight to the debate.

CHAPTER THREE

METHODOLOGY

The basic purpose of this study was to ascertain the impact of instructional technology funding on standardized test scores on the Georgia High School Graduation Tests (GHSGT). The study employed a quantitative analysis of test data, using procedures described in this chapter. The sections include the research design, the population and selection of the experimental- and control-group schools, procedures and data collection methods, and data analysis.

Research Design

The study employed a causal-comparative research design that compared three years of GHSGT scores in two groups of similar high schools, different only in the variable of the large amount of technology funding given to one group. School years chosen for the study were 1994-95, the year before the infusion of extra monies to the experimental-group schools; 1995-96 and 1996-97, two years after the infusion of monies to the experimental-group schools. Scores used were those English language arts and mathematics scores of first-time test takers, regular eleventh-grade students who took both the English language arts and mathematics portions of the test. The study did not use data from students who were retaking one or more portions of the test that they had failed in a previous test administration. Nor was data from science and social studies portions of the test analyzed, as these portions were either in the field-test stage in 1994-95, or had not yet been developed.

Population and Selection of Experimental- and Control-Group Schools

The individual school was chosen as the unit of study. Schools in Group One (Experimental Group) were those four Georgia high schools that received a 1995 Model Instructional Technology Grant in excess of $100,000 from the Georgia Information Technology Policy Council and the Georgia Board of Education. Schools in Group Two (Control Group) were Georgia schools that were similar to Group One schools in (1) socioeconomic status as evidenced by the percentage of free or reduced-price lunches at the school,

(2) student enrollment, (3) grade levels, (4) diversity of student population, and (5) accreditation standards. Socioeconomic status (SES) was chosen as the first match because the Georgia Department of Education uses this criteria in placing Georgia schools in groupings for test-score comparison purposes.

First, systems are grouped according to enrollment: large systems have 10,000 or more students; mid-sized systems have between 2,000 and 9,999 students; and small systems have fewer than 2,000 students. Within size groups, systems are ranked by their proportion of students eligible for free or reduced-price lunch and then divided into 21 groups, these groups being based on similar SES percentages and enrollment figures. Groups are defined so as to ensure that the systems within them are as similar as possible. Socioeconomic status was given a higher priority if individual schools within matching systems had disparate enrollment (see appendix for example).

Grade levels and student diversity indicators were used in order to narrow comparison groupings to the most similar schools within each group. Matching accreditation standards ensured that schools were similar in teacher/pupil ratio, teacher certification, provision of resources, etc. Documents used to provide this information were the Georgia Department of Education comparison groupings and the 1995-1996 Georgia Education Report Cards. (The specific comparison groupings may be found in their entirety in Georgia Student Assessment Program: Official State Summary [see appendix for a sample page]. The *1995-1996 Georgia Education Report Cards* may be found on the Internet at http://168.31.216.65/ [see appendix for a sample entry]).

Multiple schools were chosen as matches for each experimental-group school to lend weight and robustness to any statistically significant differences found in the data between the experimental and control groups. Permission was received for seventeen schools to participate, but the researcher determined that one of the seventeen had received massive technology funding through a special purpose local option sales tax (SPLOST). This brought the number of suitable control-group schools to sixteen. The first two groups had more matching schools that had given permission for student test scores to be used in the study. The third and fourth groups had only two matching schools per group that had given permission for student test scores to be used in the study.

In an attempt to balance the size of the four matching groups so that the first two were not overwhelmingly larger than the last two, the four closest matching schools were chosen for each of the first two experimental-group schools. Therefore, two experimental-group schools had four matches each in the control group, and two experimental-group schools had two matches each in the control group, for a total of twelve control-group schools and four experimental schools, sixteen high schools in all.

The Southern Association of Colleges and Schools (SACS) accredited all participating schools. Demographics for chosen schools appear in Table 1; experimental schools appear in bold, with their matching schools in the control group immediately following.

Methods and Procedures

Using information furnished by the Information Technology Policy Council, six Georgia public school systems who had high schools receiving funding in excess of $100,000 were sent a letter explaining the nature of the study and requesting permission to use school test score

TABLE 1

DEMOGRAPHICS OF PARTICIPATING SCHOOLS

School Number	Free/Reduced Lunch Percentage	Grades	Enroll-ment	Ethnicity W=White, B=Black, H=Hispanic, A=Asian, M=Multiracial	Accredi-tation
01	**16.0%**	**10-12**	**1,347**	**W/43.2 B/46.8 H/1.8 A/6.7 M/1.3**	**SACS**
02	16.0%	9-12	1,311	W/58.5 B/37.2 H/3.4 A/0.8 M/0.0	SACS
03	15.5%	9-12	1,044	W/50.7 B/35.3 H/7.3 A/6.1 M/0.6	SACS
04	15.2%	9-12	1,090	W/42.0 B/49.2 H/2.8 A/4.1 M/1.9	SACS
05	19.0%	9-12	1,108	W/55.2 B/37.1 H/1.8 A/4.3 M/1.4	SACS
06	**26.5%**	**9-12**	**1,925**	**W/70.5 B/23.8 H/1.8 A/2.0 M/0.7**	**SACS**
07	24.3%	9-12	1,108	W/64.0 B/13.2 H/19.9 A/2.7 M/0.2	SACS
08	27.4%	9-12	977	W/76.5 B/19.1 H/3.4 A/0.2 M/0.7	SACS
09	28.1%	9-12	1,112	W/72.8 B/24.6 H/2.1 A/0.2 M/0.1	SACS
10	28.7%	9-12	1,914	W/41.8 B/24.3 H/11.2 A/21.5 M/0.2	SACS
11	**6.8%**	**9-12**	**754**	**W/97.2 B/0.0 H/2.5 A/0.1 M/0.0**	**SACS**
12	7.2%	8-12	430	W/98.6 B/1.2 H/0.0 A/0.2 M/0.0	SACS
13	7.7%	9-12	1,275	W/98.4 B/0.1 H/0.9 A/0.5 M/0.1	SACS
14	**19.8%**	**9-12**	**751**	**W/95.6 B/1.2 H/2.1 A/0.3 M/0.4**	**SACS**
15	18.6%	9-12	967	W/94.0 B/4.7 H/0.5 A/0.5 M/0.3	SACS
16	18.0%	9-12	1,262	W/96.1 B/2.7 H/0.4 A/0.2 M/0.6	SACS

data in the study from the GHSGT (see appendix for letter sample). A permission form (see appendix for form) and a self-addressed, stamped return envelope were included, along with a sample of a data sheet with all identifying information (student names, social security numbers) removed. Two systems replied that their high schools were 6-12 schools and that the funding had been used in the middle grades, making their participation invalid. The remaining four systems gave permission and sent the requested test score data.

Having received approval of those four systems, matching schools were then selected for each of the four experimental-group schools. Explanatory letters and accompanying enclosures were sent to nineteen systems having twenty-two schools in the matched category. After written approval was received for all schools' participation, these approval forms were submitted with an application for involving human subjects (Form A) to the Office of Committee on Research Participation (CRP) at The University of Tennessee at Knoxville. Upon approval of the CRP Office, data were received from those systems chosen to participate, entered into a database and analyzed. The data included English language arts and mathematics test scores of 11,083 eleventh-grade students from 16 public high schools in 15 Georgia school systems over a three-year period, analyzing an average of 3,694 student test scores per year.

Data Analysis

Quantitative data obtained from school systems were coded for data analysis according to (1) experimental or control group, (2) matching group, (3) school identification number, (4) year of test data, (5) student identification number, (6) English language arts test score, and (7) mathematics test score. The researcher assigned random identification numbers to schools and students. No students, schools, or systems were directly identified or associated with a particular set of scores, nor were subjects placed at risk of criminal or civil liability. Blind test score data from the chosen schools for the school years 1994-95, 1995-96, and 1996-97 were collected from the systems of each school chosen for participation in the study. Thus, the anonymity of all data collected was assured.

Using the Statistical Package for the Social Sciences (SPSS), first-year results from both experimental and control groups were tested for significant differences using an independent t-test. This information was used to answer research question one ("During the year prior to an infusion of $100,000 or more in instructional technology funds in Groups One, was there a significant difference between Group One/Experimental and Group Two/Control schools' individual student achievement test scores on the eleventh-grade English language arts subtest of the 1994-95 GHSGT?") and question two ("During the year prior to an infusion of $100,000 or more in instructional technology funds in Group One, was there a significant difference between Group One and Group Two schools' individual student academic achievement test scores on the eleventh-grade mathematics subtest of the 1994-95 GHSGT?")

First-, second-, and third-year test results in each group were tested for statistically significant differences using an independent t-test. This information was used to answer research question three ("Was there a significant difference between individual student achievement test scores within each group on the eleventh-grade English language arts subtest of the GHSGT in the three years being studied?") and question four ("Was there a significant difference between individual student achievement test scores within each group on the eleventh-grade mathematics subtest of the GHSGT in the three years being studied?")

Third-year results of both the experimental and the control groups were compared for statistically significant differences using an independent t-test. This information was used to answer research question five ("Was there a significant difference between Group One and Group Two schools' individual student achievement test scores on the eleventh-grade English language arts subtest of the 1996-97 GHSGT after one or two year's infusion of $100,000 or more in instructional technology funds in Group One?") and question six ("Was there a significant difference between Group One and Group Two schools' individual student academic achievement test scores on the eleventh-grade mathematics subtest of the 1996-97 GHSGT after one or two year's infusion of $100,000 or more in instructional technology funds in Group One?")

Summary

This study employed quantitative research methods, statistically comparing standardized achievement test scores for significant differences in schools that had received a large input of technology funding to schools that had not received such dramatic funding. The sample for the survey consisted of 11,083 eleventh-grade students from sixteen public high schools in Georgia over a three-year period, 1994-95 through 1996-97. Statistical treatment of the data included independent t-tests utilizing the Statistical Package for the Social Sciences (SPSS). The study evaluated the impact of technology funding based on objective, validated measures of academic achievement that are recognized and understood by the policymakers who allocate educational funding to schools. Study strengths included (a) a large number of students, (b) diverse student populations from 16 high schools in 15 systems across the state of Georgia, (c) the use of a pre-test to compare experiment results, and (d) the use of a control group to compare experiment results.

CHAPTER FOUR

FINDINGS AND ANALYSIS OF DATA

Test scores on the Georgia High School Graduation Tests (GHSGT) of the four Georgia high schools that received a 1995 Georgia Innovative Technology Grant were compared to those of their matching schools that had not received such funding. How this comparison was achieved was the subject of the preceding chapter. Following are the findings of that comparison and the analysis of the findings, organized in terms of the research questions.

Research Question 1. During the year prior to an infusion of $100,000 or more in instructional technology funds in Group One, was there a significant difference between Group One (Experimental) and Group Two (Control) schools' individual student achievement test scores on the eleventh-grade English language arts subtest of the 1994-95 GHSGT?

In the year prior to the four experimental-group schools' receiving the influx of innovative technology grant money, there were 1,046 eleventh-grade students who took both the English language arts and mathematics subtests of the Georgia High School Graduation Tests. In the same year, 1995, there were 2,478 similar students in the twelve control-group schools, for a total of 3,524 students in the sample. The four experimental schools had slightly higher English test scores than the control schools in 1995, but, as shown in Table 2, the difference between the English scores of students in both groups was not statistically significant, using a .05 level of significance. Levene's Test for Equality of Variances showed that there was no significant difference in the variances of the two groups.

TABLE 2

INDEPENDENT T-TEST RESULTS FOR 1995 ENGLISH SUBTEST SCORES OF ALL STUDENTS

Group	N	Mean	Standard Deviation	Standard Error of Mean	t	df	Significance (2-tailed)
Experimental	1046	550.04	31.18	.96	1.045	3522	.296
Control	2478	548.81	32.29	.65			

Research Question 2. During the year prior to an infusion of $100,000 or more in instructional technology funds in Group One, was there a significant difference between Group One and Group Two schools' individual student academic achievement test scores on the eleventh-grade mathematics subtest of the 1994-95 GHSGT?

In the same year, 1995, prior to the four experimental-group schools' receiving the influx of innovative technology grant money, the same 1,046 eleventh-grade students in the experimental group had a slightly lower mean mathematics score than the same 2,478 students in the control group; however, there was no significant statistical difference, in math scores, as shown in Table 3. Levene's Test for Equality of Variances showed that there was no significant difference in the variances of the two groups.

TABLE 3

INDEPENDENT T-TEST RESULTS FOR 1995 MATH SUBTEST SCORES OF ALL STUDENTS

Group	N	Mean	Standard Deviation	Standard Error of Mean	t	df	Significance (2-tailed)
Experimental	1046	537.38	30.72	.95	-1.070	3522	.242
Control	2478	538.70	30.59	.61			

Research Question 3. Was there a significant difference between individual student achievement test scores within each group on the eleventh-grade English language arts subtest of the GHSGT in the three years being studied (1994-95, 1995-96, 1996-97)?

Since certain control-group schools were chosen because their demographics were similar to a specific experimental school, scores were broken down and compared according to matching groups (see Chapter 3, Table 1). Table 4 shows that Matching Groups' One and Four experimental schools had slightly higher English scores than did their matching schools in the year prior to technology funding. (1995) Matching Groups' Two and Three experimental schools had slightly lower English test scores than did their matching schools in the control group for the year 1995. None of the differences were significant, using a .05 level of significance. Levene's Test for Equality of Variances showed that there was no significant difference in the variances in any of the groups.

In 1996, the first year of the experiment, there were 1,047 students in the experimental group and 2,650 in the control group, a total of 3,690. In this year, matching Group One's experimental school dropped its English mean

TABLE 4

INDEPENDENT T-TEST RESULTS FOR 1995 ENGLISH SUBTEST SCORES OF 11TH GRADE

STUDENTS IN MATCHING GROUPS 1-4

Matching Group	Research Group	N	Mean	Standard Deviation	Standard Error of Mean	t	df	Significance (2-tailed)
1	Experimental	422	557.59	28.02	1.36	1.604	1291	.109
1	Control	871	554.81	29.84	1.01			
2	Experimental	318	542.49	31.93	1.79	-1.308	1223	.191
2	Control	907	545.42	35.15	1.17			
3	Experimental	173	548.10	31.26	2.38	-0.412	474	.680
3	Control	303	549.31	30.51	1.75			
4	Experimental	134	546.77	33.55	2.90	1.223	529	.222
4	Control	397	543.01	29.82	1.50			

score by nearly ten points; its matching control schools' mean also dropped, but by only 2.1 points. This was a significant difference in scores, as shown in Table 5. None of the other matching groups showed significant differences in their 1996 English test scores. Levene's Test for Equality of Variances did find a significant difference in the variances in matching group 2, but not in the other three. Therefore, equality of variances was not assumed for Group Two, but this made little difference in the non-significance of the t value for that year.

In 1997, the second year of the experiment, the experimental group had 1,032 students in the sample; the control-group, 2,800; for a total of 3,832. Matching Group One showed a significant difference in English test scores, but this time, the experimental school outpaced its matching control schools by having a higher mean score for the first time in three years. Table 6 shows that the Matching Group One experimental school's mean was significantly higher than the mean of its control schools, 4.68 points higher, as opposed to a 5.11 deficit the previous year. There were no significant differences among the other matching groups, nor did Levene's Test for

TABLE 5

INDEPENDENT T-TEST RESULTS FOR 1996 ENGLISH SUBTEST SCORES OF 11TH GRADE

STUDENTS IN MATCHING GROUPS 1-4

Matching Group	Research Group	N	Mean	Standard Deviation	Standard Error of Mean	t	df	Significance (2-tailed)
1	Experimental	420	547.60	30.64	1.49	-3.042	1373.000	.002*
1	Control	955	552.71	27.81	.90			
2	Experimental	331	541.95	30.35	1.67	-0.490	627.109	.642
2	Control	989	542.92	33.93	1.08			
3	Experimental	153	545.40	29.10	2.35	-1.477	460.00	.140
3	Control	309	549.45	27.09	1.54			
4	Experimental	143	548.15	35.40	2.96	1.163	538.000	.245
4	Control	397	544.63	29.30	1.47			

*indicates significance

TABLE 6

INDEPENDENT T-TEST RESULTS FOR 1997 ENGLISH SUBTEST SCORES OF 11TH GRADE

STUDENTS IN MATCHING GROUPS 1-4

Matching Group	Research Group	N	Mean	Standard Deviation	Standard Error of Mean	t	df	Significance (2-tailed)
1	Experimental	376	543.65	27.48	1.42	2.881	1526	.005*
1	Control	1152	538.97	28.14	.83			
2	Experimental	362	536.45	24.93	1.31	1.703	1206	.089
2	Control	846	533.57	27.78	.96			
3	Experimental	166	538.30	23.98	1.86	.026	546	.980
3	Control	382	538.24	26.07	1.33			
4	Experimental	128	537.27	26.80	2.37	1.159	549	.247
4	Control	420	534.27	25.23	1.23			

*indicates significance

Equality of Variances find a significant difference among variances.

Test scores from all participating schools in the pre-experiment year of 1995 demonstrated the similarity within and among matching groups. Comparisons of multi-year scores of the same schools could not be made, as the pool of students was different each year, due to the GHSGT being given in the eleventh-grade each year. However, differences could be noted among peer groups in the same years, showing differences after technology funding was applied in experimental schools. Differences in significance of the t value could also be compared from year to year.

Thus, from 1995 through 1997, after two years of applied technology funding, Group One had gone from a non-significant t value of .109 to a significant t value of .005 in English scores. While the 1996 Group One mean for the experimental group dropped significantly below its matching schools, after two years it was significantly above. This might be explained by the new instructional and assessment methods (composing, editing, and peer review on computer and/or portfolio assessment, for example) that were applied along with the technology in the first year of the experiment, thus creating a temporary decline.

Matching Group Two experienced a dramatic rise in mean scores. The experimental school increased its test score significance each year. In 1995, it was 2.93 points below its matching schools for a non-significance of .191. In 1996, its mean scores were only .97 below its matching schools, and, by 1997, the mean had surpassed the matching schools by 2.88 points, for a greater, though still not significant, difference of .089.

Matching Group Three experienced a net gain in mean from a -1.21 in 1995 to a +.06 in 1997. The experimental school, like its counterpart in Matching Group One, experienced a dip in the first year of the experiment, falling 4.05 points below the mean of its matching schools. This, also, might be explained by the new instructional and assessment methods that were applied along with the technology in the first year of the experiment, thus creating a temporary decline. Group Three had the greatest change in the significance of the t, going from .68 to .14 to .98 in the three years of the study.

The 1995 mean score for the experimental school in Matching Group Four was 3.76 points above its control schools, with a non-significance of .222. In 1996, that mean lead dropped slightly to 3.52 for a slightly less significance of .245. By the second year of the experiment, the mean was ahead by only three points, with basically the same significance of .247.

Research Question 4. Was there a significant difference between individual student achievement test scores within each group on the eleventh-grade mathematics subtest of the GHSGT in the three years being studied (1994-95, 1995-96, 1996-97)?

Unlike the 1995 English language arts test scores that were found to have no statistically significant difference, pre-experiment mathematics scores in one matching group tested significantly different. Table 7 shows that Matching Groups One, Three, and Four had no t values that were statistically significant. Matching Group Two, however, whose experimental school's math mean was 8.29 points below its control schools, had a t value significance of .000. The non-significant mean differences in the other three matching groups showed the experimental schools' means to be slightly above those of their matched schools. Levene's Test for Equality of Variances showed

TABLE 7

INDEPENDENT T-TEST RESULTS FOR 1995 MATH SUBTEST SCORES OF 11TH GRADE

STUDENTS IN MATCHING GROUPS 1-4

Matching Group	Research Group	N	Mean	Standard Deviation	Standard Error of Mean	t	df	Significance (2-tailed)
1	Experimental	422	544.00	30.61	1.49	.608	1291	.543
1	Control	871	542.92	29.90	1.01			
2	Experimental	318	530.01	29.77	1.67	-4.118	1223	.000*
2	Control	907	538.30	31.29	1.04			
3	Experimental	173	538.15	28.18	2.14	.431	474	.666
3	Control	303	536.97	28.99	1.67			
4	Experimental	134	533.22	32.10	2.77	.502	529	.616
4	Control	397	531.68	30.30	1.52			

*indicates significance

that there was no significant differences in the variances of the groups.

In 1996, the first year of the experiment, Matching Group Two's experimental school succeeded in diminishing the mean difference between it and its control schools by 1.2 points. It was still significantly behind by 7.09 points, with a t value significance of .000, as shown in Table 8. Groups One, Three, and Four all lost ground in the size of their mean score lead, yet the differences were not significant. Levene's Test for Equality of Variances found a significant difference in the variances in matching Groups One and Four, but this made little difference in the lack of significance of the t value for any of the three groups.

In 1997, the experiment's second year, Table 9 documents that Matching Group Two again decreased the difference between its mean and that of its control schools; it was behind by only 3.97 mean points, and it was still significantly different, as its scores had been in 1995 and 1996. Adjusted for the non-equality of variances that Levene's Test found, the difference was still significant. Levene's Test also found Matching Group One's

TABLE 8

INDEPENDENT T-TEST RESULTS FOR 1996 MATH SUBTEST SCORES OF 11TH GRADE

STUDENTS IN MATCHING GROUPS 1-4

Matching Group	Research Group	N	Mean	Standard Deviation	Standard Error of Mean	t	df	Significance (2-tailed)
1	Experimental	420	543.09	30.04	1.47	-1.488	750.538	.137
1	Control	955	545.65	27.93	.90			
2	Experimental	331	531.29	31.41	1.73	-3.574	1318.000	.000*
2	Control	989	538.38	31.17	.99			
3	Experimental	153	536.33	27.15	2.20	-0.722	460.000	.471
3	Control	309	538.30	27.80	1.58			
4	Experimental	143	532.57	49.64	4.15	-0.599	176.543	.550
4	Control	397	535.20	28.38	1.42			

*indicates significance

TABLE 9

INDEPENDENT T-TEST RESULTS FOR 1997 MATH SUBTEST SCORES OF 11TH GRADE STUDENTS IN MATCHING GROUPS 1-4

Matching Group	Research Group	N	Mean	Standard Deviation	Standard Error of Mean	t	df	Significance (2-tailed)
1	Experimental	376	537.06	29.11	1.50	.494	682.082	.622
1	Control	1152	536.18	31.42	.93			
2	Experimental	362	526.98	25.47	1.34	-2.387	764.914	.017*
2	Control	846	530.95	28.75	.99			
3	Experimental	166	532.97	26.91	2.09	.981	546.000	.327
3	Control	382	530.07	33.71	1.72			
4	Experimental	128	528.65	26.92	2.38	-0.587	546.000	.557
4	Control	420	530.27	27.52	1.34			

*indicates significance

variances to be non-equal, but it made little difference in the non-significance of the t value.

Test scores from all participating schools in the pre-experiment year of 1995 demonstrated similarity within and among Matching Groups One, Three, and Four. Only matching Group Two's mathematics scores showed significant difference between the experimental school and its matched schools. As with the English language arts scores, comparisons of multi-year scores of the same schools could not be made, as the pool of students was different each year. However, just as for Question Three, differences could be noted among peer groups in the same years, showing differences after technology funding was applied in experimental schools. Differences in significance of the t value could also be compared from year to year.

From 1995 through 1997, after two years of applied technology funding, Group One, while having an initial year's increase in difference in the significance of the t value from .543 to .137, had an overall decrease in t value significance, from .543 to .622. Group One's mean score lead decreased from a 1.08 lead to a mere .88 lead, a net decrease of .2 in the mean difference. This would seem to indicate that the experiment, over two years, had no positive effect on math test scores in the experimental school.

Matching Group Two experienced a steady increase in mean scores, significantly different in all three years. The experimental school, behind its control schools by 8.29 points in the mean score, with a t value significance of .000, brought the difference to 7.09 points in the first year of the experiment, and to less than four points (3.97) the second year, 1997. This year's difference was not as pronounced as 1996's, yet still had a significant difference of .017 in its t value. This would seem to indicate that, for the experimental school in Matching Group Two, technology funding made a small but steady difference in test scores, enough to be statistically significant.

Matching Group Three, whose experimental school's math mean score was 1.18 points ahead of its control schools in 1995, had a non-significance in t value of .666. In 1996, it fell behind the control schools' mean by 1.97 points, but this was not a statistically significant loss, and ended the second year of the experiment 2.9 mean points ahead, with a non-significance in t value of .327. While the second year's drop might be attributed to implementation of new instructional and assessment strategies, the overall gain in mean was 1.72 points in two years. This was not statistically significant.

The mean score in 1995 for the experimental school in Matching Group Four was 1.8 points above its control schools, with an insignificance in t value of .616. In 1996, that mean lead dropped, trailing the control schools by 2.63 points. By the second year of the experiment, the experimental school's mean trailed the control group's by only 1.62 points. None of these differences was statistically significant; the three-year span of t value significance, .616, .55, and .557, remained basically the same.

Research Question 5. Was there a significant difference between Group One and Group Two schools' individual student academic achievement test scores on the eleventh-grade English language arts subtest of the 1996-97 GHSGT after one or two year's infusion of $100,000 or more in instructional technology funding in Group One?

In the three years of the technology funding experiment, eleventh-grade enrollment in the experimental group remained essentially the same, dropping only 14 students, from 1,046 in 1995 to 1,032 in 1997 (see Table 10). The eleventh-grade enrollment of the control group rose 322, from 2,478 in 1995 to 2,800 in 1997. English mean scores for both groups fell in 1996 and 1997. The experimental group's fell 10.57 points; the control group's mean dropped 12.27 points. Levene's Test found no significance in these variances.

TABLE 10

INDEPENDENT T-TEST RESULTS FOR 1996 AND 1997 ENGLISH SUBTEST SCORES OF ALL STUDENTS

Group	N	Mean	Standard Deviation	Standard Error of Mean	t	df	Significance (2-tailed)
Experimental 1996	1047	545.56	31.09	.96	-1.691	3695	.091
Control 1996	2650	547.47	30.67	.60			
Experimental 1997	1032	539.47	26.14	.81	2.976	3830	.003*
Control 1997	2800	536.54	27.43	.52			

*indicates significance

Comparison of means in each of the experimental years showed an increase in significance between means, with the 1997 scores having a t value with a significance of .003.

Comparison of means in each of the three years, pre-experiment through two years of experiment, showed a statistically significant change between experimental schools and control schools on the English language arts subtest. While means fell in both groups, the experimental schools moved from 1.23 mean points ahead in 1995 (see Table 2) to 2.93 mean points ahead in 1997 (see Table 10). The t value increased in significance each year, beginning at .296 in 1995, then .091 in 1996, and ending with a significance of .003 in 1997.

The drop to 1.91 mean points below the control group in 1996 might be explained by the application of new instructional and assessment strategies that accompanied the application of technology funding (such as composing, editing, and peer review on computer and/or portfolio assessment). The increase in significance each year seems to indicate that the application of technology funding did have a positive impact on the experimental schools as a whole in the area of English on the Georgia High School Graduation Tests.

<u>Research Question 6. Was there a significant difference between Group One and Group Two schools' individual student</u>

academic achievement test scores on the eleventh-grade mathematics subtest of the 1996-97 GHSGT after one or two year's infusion of $100,000 or more in instructional technology funds in Group One?

Levene's Test for Equality of Variances found significant differences in 1996 and 1997; thus equal variances were not assumed and the t value was adjusted accordingly. Math mean scores for both groups both rose and fell in the experimental years, as Table 11 documents. The test group's mean score fell .45 points in 1996, while the control group's rose 1.81 points. In 1997, the test group's mean score fell 5.11; the control group's fell 7.63.

TABLE 11

INDEPENDENT T-TEST RESULTS FOR 1996 AND 1997 MATH SUBTEST SCORES OF ALL STUDENTS

Group	N	Mean	Standard Deviation	Standard Error of Mean	t	df	Significance (2-tailed)
Experimental 1996	1047	536.93	33.80	1.04	-3.005	1708.915	.003*
Control 1996	2650	540.51	29.49	.57			
Experimental 1997	1032	531.82	27.57	.86	-1.026	2020.360	.305
Control 1997	2800	532.88	30.52	.58			

*indicates significance

Comparison of means in each of the experimental years showed an increase in significance between means, with the 1996 scores being statistically significant, with a t value of .003. The 1997 math mean scores were not statistically significant.

Comparison of means in each of the years, pre-experiment through two years of experiment, showed a statistically significant increase in the amount of negative difference between the two groups in 1996 with the 1996 scores having a t value significance of .003. The experimental group's mean fell in that year, while the control group's mean rose, a difference of 3.58 mean points. This significance might be attributed to the application of new instructional and assessment strategies that accompanied the implementation of the experiment in that year. By the second year of the experiment, the test schools' mean had pulled within 1.06 points of the control group's, though still beneath it. This difference was not statistically significant, but showed that, perhaps, the benefits of technology that the experiment provided were beginning to show positive gain. Nonetheless, there is no clear finding that technology funding made a significant difference in the math scores of the experimental group schools.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

Two of the major education initiatives in the State of Georgia in the 1990s have been the implementation of the Georgia High School Graduation Tests (GHSGT) that all students must pass before receiving a high school diploma, and the statewide lottery. Lottery proceeds fund instructional technology in the public schools, along with other educational initiatives. The GHSGT assess student knowledge of the Georgia Quality Core Curriculum (QCC) in English, math, science, social studies, and writing. Students must pass all five parts of the examination in order to receive a diploma. The test scores, reported through The Georgia Education Report Cards, are viewed by some as a means of measuring the effectiveness of schools in preparing Georgia youth for the world of work. Technology funds from the lottery are allotted to schools based on a set amount per student. The 1994 General Assembly also set aside $7.8 million from lottery revenues to establish competitive model technology grants, the 1995 Innovative Technology Grants, to selected schools that had received no major technology funding from other sources. One of the goals of these grants was to fund projects that might serve as a basis for influencing policymakers as to the benefits of funding technology in schools.

This study examined the impact of major technology funding, specifically the 1995 Innovative Technology Grants, on academic achievement as reported through English and mathematics standardized test scores on the GHSGT. The study tracked, over three years, the scores of 11,083 eleventh-grade students, in four high schools that received innovative technology grants of more than $100,000, and in 12 similar high schools that did not receive such major technology funding, comparing one group with the other. Statistical treatment of the data included independent t tests utilizing the Statistical Package for the Social Sciences (SPSS).

The study evaluated instructional technology funding based on objective, validated measures of academic achievement that are recognized and understood by policymakers who allocate educational funding to schools. The study made no attempt to evaluate program goals or software effectiveness. Study strengths included (a) a large number of students, (b) diverse student populations from 16 high schools in 15 systems across the state of Georgia; (c) the use of a pre-test to compare experiment results, and, (d) the use of a control group to compare experiment results. This study's findings may be summarized as follows:

1. In the year prior to funding through the innovative technology grants, there was no significant difference among English language arts or mathematics test scores among the four experimental schools as a whole and the twelve similar schools used as a control group. Mathematics and English language arts mean scores in the experimental group were slightly lower than the control group, but not significantly so.
2. In the first year of technology funding, Matching Group One's experimental school's English mean score dropped significantly more than did its matching schools. In none of the other matching groups was there a significant difference in English mean scores.

3. The difference in the means of English language arts test scores between the experimental group and the control group grew in the first two years of technology funding, ending in the third year of the study with a highly significant t value of .003 overall. This seems to indicate that technology funding made a significant positive difference in the English language arts test scores of the experimental schools.

4. Three of the four experimental schools increased the difference in English language arts mean scores over their control groups, while one school's mean difference decreased overall. The first of the three experimental schools that increased its mean scores over its control group did so at a significance level of .005. The remaining two schools came from a negative difference in mean scores to a positive difference over the three-year period. One experimental school in particular experienced the greatest increase in English language arts mean scores over its matching schools, coming from 2.93 mean points below its control group to 2.88

mean points above its control group. This indicates that the positive significance in English language arts test scores found in the study was created by three of the four experimental schools.

5. Only Matching Group Two's experimental school's initial mathematics mean score was significantly below that of its control group's schools. In the two years of technology funding, Matching Group Two's experimental school showed continuous improvement in mathematics scores, decreasing the mean score deficit between it and its control group by a significant amount each year.

6. There was no overall statistically significant finding that technology funding had made a difference in the mathematics scores in the experimental group after two years of technology funding. This indicates that the non-significance in mathematics test scores found in the study was created by three of the four experimental schools, since Matching Group Two's experimental school significantly increased its scores. The other three experimental schools'

pre-test mean scores were ahead of those in their matching control groups. Two of these schools' means dropped below their control group in the first years of funding, but rebounded in the second year of funding. None of this movement was statistically significant. The third of the three schools saw its mean drop below its control group in the first year of funding and remain below in the second funding year. This, likewise, was not statistically significant.

Conclusions

Using the research findings, the following conclusions were drawn relative to the impact of technology funding on standardized test scores on the Georgia High School Graduation Tests:

1. The impact of technology funding on standardized test scores in the first year of implementation appears to be negative, as experimental schools' scores actually dropped in the first year after technology funding was applied.

2. Technology funding seems to make a significant positive difference in student achievement test scores in the area of high school English language arts after two years.
3. There appears to be no significant difference in student achievement test scores in the area of high school mathematics after two years of technology funding.

Comparison with Other Research

In studies looking at the role of technology in improving standardized test scores, mixed results were reported. Several studies reported positive change in test scores that were attributed to technology use, while two studies found no such link. This study found a significant positive difference in English test scores, as did Williams (1993), and Mann and Shafer (1997). This study found no significant difference in math scores, the same finding as Williams and Uslick (1994).

Dwyer (1994) reported that the one Apple Classroom of Tomorrow (ACOT) that had targeted higher test scores found that goal fulfilled in "significantly higher scores on the

California Achievement Test (CAT)." (p. 5) Losak and McFarland (1994) documented a Florida high school whose student Scholastic Aptitude Test scores steadily increased over five years of technology integration, at the same time that national scores were declining. That same school reported that 100% of students using computer-delivered programmed instruction passed the Florida State High School Competency Test.

Williams' 1993 study of sixth-grade student scores on the Stanford Achievement Test showed a significant difference in reading comprehension scores after the use of computer-assisted instruction. There was no significant difference in math application. Brush (1996) found that students using an Integrated Learning System (ILS) performed better on the California Achievement Test.

Newman (1993) found "real and substantial gains" in math achievement test scores, (p. 5) even though this was not a stated goal and Newman believed that "technology was only indirectly the cause of the improvements." (p. 9) Mann and Shafer, in 1997, found that the use of instructional technology was responsible for an 8% increase in the percentage of high school students passing the state's college preparatory exam. The average increase in math was 7.5%, in English, 8.8%.

Two studies found no significant increase in achievement test scores after the use of technology in learning. Hofmeister's 1990 study used 89 junior and senior high school students; Uslick's 1994 study looked at three school districts' California Achievement Test math scores that did not improve after technology use.

Recommendations

1. It is recommended that this study be extended for another three years to determine whether or not results from future years support this study's conclusions.
2. It is recommended that a study be conducted with the same schools, including the control groups, looking at instructional goals of technology funding in the experimental schools. It may be that (a) mathematics was not a targeted area for improvement, (b) mathematics instruction using technology takes more than two years to raise

mathematics test scores, (c) the technology (hardware and/or software) used in the experiment was not conducive to mathematics improvement, or (d) the use of technology in mathematics instruction does not significantly raise mathematics test scores.

3. It is recommended that a study be conducted with the same schools, looking at the type of technology used and the software application(s) applied to the experiment, to ascertain what types of hardware and software are more effective.

4. It is recommended that a study of cohort groups be conducted over a similar period of time, using both experimental and control schools in the study. This would enable researchers to track the achievement of the same students over a period of years.

5. It is recommended that a study look at specific populations within these schools to see the differences in scores among special needs' groups such as gifted, English to

Speakers of Other Languages, and special education.

6. It is recommended that a study look at ethnic groups within these schools to see the differences in scores by ethnicity.
7. Since a delimitation of this study was the use of the Georgia High School Graduation Tests, interpretation of the results was problematic. It is recommended that a study be made of the effectiveness of such state-curriculum-based "exit" tests.
8. Since there is a nationwide call for an increase in Scholastic Aptitude Tests, it is recommended that there be a study similar to this study that looks at technology funding in relation to SAT scores.
9. Since the 1995 Georgia Innovative Technology Grants were largely given to elementary and middle schools, it is recommended that a longitudinal study of cohort groups be conducted using the Georgia-required, nationally normed Iowa Tests of Basic Skills

(ITBS) in the third, fifth, and eighth grades.

10. It is recommended that a similar study be conducted including the science and social studies portions of the Georgia High School Graduation Tests, beginning in 1996-97, the first year individual student scores were available in both these areas.

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APPENDIX

SAMPLE LETTER SENT TO QUALIFYING SYSTEMS

May 9, 1997

Mrs. XXXXXX
Director of Curriculum and Testing
XXXXX County Public Schools
101 School Street
XXXXX, GA 00000

Dear Mrs. XXXXXX:

I am an instructional specialist in the Curriculum and Instruction Department of Catoosa County, GA, Public Schools. I am also a doctoral student in the Educational Leadership Studies Unit of the College of Education at the University of Tennessee, Knoxville. I am doing research on the impact of technology funding on student achievement as measured by the Georgia High School Graduation Test. XXXXX High School in your system has been chosen as one of the schools in the study because of its having received a 1995 Georgia Innovative Technology Grant in excess of $100,000. North XXXXX High School, which did not receive such a grant, has been chosen as a comparison-group school because of its similar demographics.

The data I need for the study includes individual student test scores on the Georgia High School Graduation Tests in English and math for the school years 1994-95, 1995-96, and 1996-97, the spring testing of each year. I will not use individual names or other personally identifiable data in the study, nor will the school or system's names be associated with particular test scores.

I would appreciate your assistance in sending me copies of the complete **GHSGT Student Achievement Roster for XXXX and North XXXX High Schools for Spring 1995, 1996, and 1997** (when the 1997 scores are returned). You may wish to delete personally identifiable information in making a copy of each page of the report (sample enclosed). The information sent to me will be held in strictest confidence; test scores, not names of individuals, will be used in the research. All data will be kept in a locked filing cabinet in my office and destroyed after the project is completed.

For documentation purposes, I have enclosed a permission form that I requested be signed, noting that I have the school system's approval to incorporate the test scores into the study. Should your system choose not to participate, you simply need not return the requested data and permission form. There will be no mention made that you were asked to participate, nor in any other way penalize your system for nonparticipation. If you choose to withdraw from the study once data has been sent, you need only make that desire known to me in writing. I will be happy to send you a copy of the completed study, should you desire one. I am enclosing a stamped, self-address manila envelope for your convenience. Thank you for your assistance.

Sincerely,

Jensi Souders

Permission Form Authorizing Test Score Data

Research Study Data Use Permission

_______________ School System gives authorization for use of student test data from the Georgia High School Graduation Tests for the years 1995, 1996, and 1997, under the following conditions:

1. No student names or other identifying data will be used in the study.
2. Neither the school nor the system will be associated with particular test scores.
3. The data will be kept in a secure location, with only the researcher(s) having access to documentation.
4. The documentation will be destroyed at the conclusion of the research project.

The School System wishes to receive a copy of the finished study. Yes No

___________________________ Name of person authorizing data use	___________________ Title
___________________________ Signature of person authorizing data use	___________________ Date

____

____
Address

____
Telephone Number

Please return this completed form with the requested test score data, to Jensi Souders, in the mailer provided.

1995-96 GEORGIA PUBLIC EDUCATION REPORT CARD
Percent of Students Receiving Free/Reduced Lunches
Schools Ranked by: % Free/Reduced Lunches

Rank	School Name	System	Percent
370	Jones-Wheat Elementary	DECATUR	72.4%
371	Anderson Elementary	CLAYTON	72.1%
372	Fort Valley Middle	PEACH	72.1%
373	Pulaski County Elementary	PULASKI	72.0%
374	Dry Branch Elementary	TWIGGS	71.9%
375	McNair Jr High	DEKALB	71.8%
376	Jacob G Smith Elementary	CHATHAM	71.8%
377	Magnolia Elementary	DOUGHERTY	71.8%
377	Wheeler County High	WHEELER	71.8%
379	Burke County High	BURKE	71.7%
380	Lanier Primary	BRYAN	71.6%
381	Barden Elementary	BIBB	71.6%
382	Copeland Elementary	RICHMOND	71.6%
383	Twiggs County Middle/High	TWIGGS	71.6%
384	Greene-Taliaferro Middle/High	GREENE	71.4%
384	Irwin County Elementary	IRWIN	71.4%
386	Washington-Wilkes Primary	WILKES	71.3%
387	Chattahoochee County Education Center	CHATTAHOOCHEE	71.3%
388	Memorial Drive Elementary	WARE	71.3%
389	Dawson Elementary	MUSCOGEE	71.2%
390	Early County Middle	EARLY	71.2%
391	Glennville Elementary	TATTNALL	71.1%
392	Atkinson County High	ATKINSON	71.1%
392	Johnson Elementary	MUSCOGEE	71.1%
394	Hunt Elementary	PEACH	71.0%
395	Tippens Elementary	CHEROKEE	71.0%
396	Homerville Elementary/Middle	CLINCH	71.0%
397	Crocker Primary	TROUP	71.0%
398	Sumter County High	SUMTER	71.0%
399	McLendon Elementary	DEKALB	70.8%
400	Brooks County High	BROOKS	70.8%
401	Appling County Primary	APPLING	70.7%
402	Roan Elementary	DALTON CITY	70.7%

1995-96 GEORGIA PUBLIC EDUCATION REPORT CARD

Percent of Students Receiving Free/Reduced Lunches

Schools Ranked by: % Free/Reduced Lunches

Rank	School Name	System	Percent
411	Rice Elementary	BIBB	70.3%
412	Jenkins County Elementary	JENKINS	70.3%
412	Toombs Central Elementary	TOOMBS	70.3%
414	Burke County Middle	BURKE	70.2%
415	Fair Street Elementary	GAINESVILLE CITY	70.2%
416	Mountain View Elementary	WALKER	70.1%
417	Oglethorpe Avenue Elementary	CLARKE	70.1%
417	McHenry Elementary	FLOYD	70.1%
419	Kelsey Avenue Middle	SPALDING	70.1%
420	Dasher Elementary	DUBLIN CITY	70.0%
421	Marion County Elementary	MARION	69.9%
422	Bailey Elementary	TIFT	69.9%
423	Schley County Elementary	SCHLEY	69.8%
424	Jones Elementary	BIBB	69.8%
425	West Bainbridge Elementary	DECATUR	69.7%
426	Fairview Elementary	WALKER	69.7%
427	Macintyre Park Middle	THOMASVILLE CITY	69.6%
428	Calhoun County High	CALHOUN	69.3%
429	Norton Park Elementary	COBB	69.2%
430	Turner County Middle	TURNER	69.2%
431	South Dodge Elementary	DODGE	69.1%
432	Southwestern Elementary	CRISP	69.1%
433	Radium Springs Middle	DOUGHERTY	68.9%
434	Luthersville Elementary	MERIWETHER	68.8%
435	Sandersville Elementary	WASHINGTON	68.8%
436	South Side Elementary	TROUP	68.7%
437	Wilkinson County Primary	WILKINSON	68.7%
438	Southside Middle	DOUGHERTY	68.7%
439	Randolph Elementary	FULTON	68.6%
439	Hand Elementary	TROUP	68.6%
441	Southwest Laurens Elementary	LAURENS	68.6%
442	Medlock Elementary	DEKALB	68.5%
443	Ralph Bunche Center	CHEROKEE	68.4%

1995-96 GEORGIA PUBLIC EDUCATION REPORT CARD

COUNTY SCHOOLS

County High School

Grade Range 6-12

The Georgia Public Education Report Card is designed to assist systems and schools in educational improvement. This report card contains a variety of data elements. An explanation of the terms is provided as a companion to the report card data. Please refer to the definitions for the most effective use of the reported data.

STUDENT DATA

Enrollment, by Race/Ethnicity and Sex

Total	Blac	Whit	Hispanic	Asian	American Indian	Multi-racial	Male	Femal
563	432	127	4	0	0	0	286	277
	76.7%	22.6%	0.7%	0.0%	0.0%	0.0%	50.8%	49.2%

Enrollment in Selected Programs

Program	Total Enrollment	% of Student Population
Gifted (Grades K-12)	0	N/A
Non-Vocational Labs (Grades 9-12)	196	62%
Vocational Labs (Grades 9-12)	290	91%
Alternative Programs (Grades 6-12)	7	1%
Pre-Kindergarten	0	N/A

Enrollment in Compensatory Programs

Program		Total Enrollment	% of Student Population
Special Education (Grades PK-12)		52	9%
English to Speakers of Other Languages (ESOL) (Grades K-12)		0	N/A
Title I (Grades K-12)	Reading	129	23%
	Math	136	24%
Remedial Education (Grades 2-5, 9-12)		21	7%
Special Instructional Assistance (SIA) (Grades K-3)		0	N/A

Students Eligible to Receive Free/Reduced Lunches

	Number	Percent
School	390	69.3%
System	858	80.2%

Dropout Rate for Grades 6-12

	Numbe	Percen
School	42	7.6%
System	42	7.6%

Retained Students, by Race/Ethnicity and Sex

Total	Blac	Whit	Hispanic	Asian	American Indian	Multi-racial	Male	Femal
38	38	0	0	0	0	0	25	13
	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	65.8%	34.2%

GRADUATE / POSTSECONDARY DATA

1996 Graduates by Credentials, Race/Ethnicity and Sex

	Total	Blac	Whit	Hispanic	Asian	American Indian	Multi-racial	Male	Female
Diplomas with Both College Prep. & Voc. Endorsements	0	0	0	0	0	0	0	0	0
Diplomas with College Prep. Endorsements	27	10	17	0	0	0	0	9	18
		37.0%	63.0%	0.0%	0.0%	0.0%	0.0%	33.3%	66.7%
Diplomas with Vocational Endorsements	33	21	12	0	0	0	0	16	17
		63.6%	36.4%	0.0%	0.0%	0.0%	0.0%	48.5%	51.5%
General High School Diplomas	3	2	1	0	0	0	0	1	2
		66.7%	33.3%	0.0%	0.0%	0.0%	0.0%	33.3%	66.7%
Special Education Diplomas	0	0	0	0	0	0	0	0	0
Total All Diplomas	63	33	30	0	0	0	0	26	37
		52.4%	47.6%	0.0%	0.0%	0.0%	0.0%	41.3%	58.7%
Certificates of Performance	6	6	0	0	0	0	0	6	0
		100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%
Total Graduates	69	39	30	0	0	0	0	32	37
		56.5%	43.5%	0.0%	0.0%	0.0%	0.0%	46.4%	53.6%

HOPE Scholarships

	School	Syste
Number of 1996 Graduates	69	69
Number Eligible	31	31
Percent Eligible	45%	45%

High School Completion Rate
Percent of 1992 Grade 9 Enrollment in Graduating Class of 1996

	School	Syste
Completion Rate '92-'96	79.3%	79.3%

1995 Graduates Entering Georgia Public Colleges in 1995-96

	Number	Percen
School	11	18%
System	11	18%

1994 Graduates Entering Georgia Public Colleges in 1994-95

	Number	Percent
1994 Graduates Entering	24	29%

1995 Graduates Entering Georgia Public Colleges in 1995-96 and Requiring Learning Support (LS)

	Number	Percent
1995 Graduates Requiring LS	0	N/A
College Prep Endorsement	N/A	
Other	N/A	

1994 Graduates Entering Georgia Public Colleges in 1994-95 and Requiring Learning Support (LS)

	Number	Percent
1994 Graduates Requiring LS	12	50%

Graduates Entering Georgia Public Technical and Adult Schools

	Entered 1995-96		Entered 1994-95	
	Number	Percent	Number	Percent
1995 Graduates	1	1.6%	—	—
1994 Graduates	0	N/A	3	3.7%

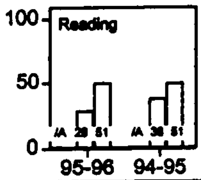
STATE-REQUIRED TEST DATA

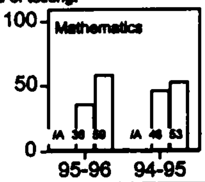
NORM-REFERENCED TESTS

Iowa Tests of Basic Skills (ITBS)

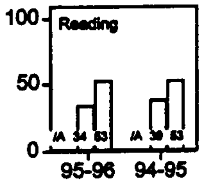
Each chart reflects data for two years of testing.

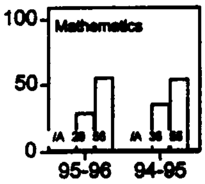
Grade 3



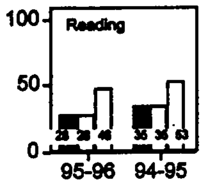


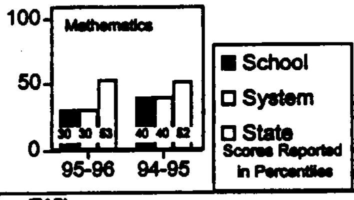
Grade 5





Grade 8

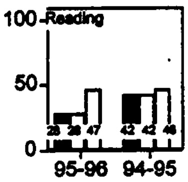


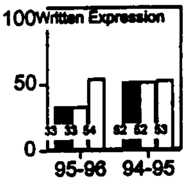


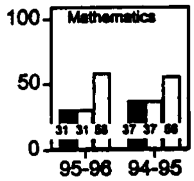
Tests of Achievement & Proficiency (TAP)

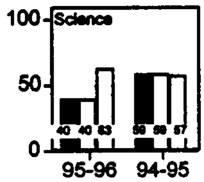
Grade 11

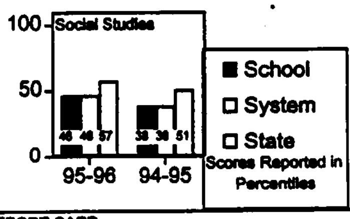
Each chart reflects data for two years of testing.











STATE-REQUIRED TEST DATA

CRITERION-REFERENCED TESTS

1995-96 Curriculum-Based Assessments (CBA)

	Scaled Scores (Range 100-225)	Performance Levels Met: State Goal of Adequate Performance	Performance Levels Met: Quality or Exemplary Performance
Language Arts: Reading			
Grade 3	N/A	N/A	N/A
Grade 5	N/A	N/A	N/A
Grade 8	159	No	No
Mathematics			
Grade 3	N/A	N/A	N/A
Grade 5	N/A	N/A	N/A
Grade 8	169	Yes	No
Science			
Grade 3	N/A	N/A	N/A
Grade 5	N/A	N/A	N/A
Grade 8	162	No	No
Social Studies			
Grade 3	N/A	N/A	N/A
Grade 5	N/A	N/A	N/A
Grade 8	150	No	No
Health			
Grade 5	N/A	N/A	N/A
Grade 8	174	Yes	No

PERFORMANCE ASSESSMENTS

No fifth-grade students are enrolled at County High.

1995-96 Grade 5 Writing Assessment

Percent at Developmental Stages:		School	System	State
Stage 1:	The Emerging Writer	N/A	0%	0%
Stage 2:	The Developing Writer	N/A	11%	2%
Stage 3:	The Focusing Writer	N/A	30%	13%
Stage 4:	The Experimenting Writer	N/A	44%	36%
Stage 5:	The Engaging Writer	N/A	6%	33%
Stage 6:	The Extending Writer	N/A	5%	15%

Grade 8 Writing Assessment

		1995-96 Percent Scoring			1994-95 Percent Scoring		
Categories of Scaled Scores		School	Syste	Stat	School	Syste	Stat
Inadequate	(less than 162)	56%	56%	17%	40%	40%	14%
Minimal	(162-209)	37%	37%	51%	36%	36%	47%
Good	(210-247)	6%	6%	29%	20%	20%	34%
Very Good	(greater than 247)	1%	1%	3%	4%	4%	6%
Average Scaled Score: (Range 100-300)		162	162	192	178	178	197

COLLEGE ADMISSIONS / CREDIT TEST DATA

Scholastic Assessment Test (SAT)®							
	Based on students' highest verbal and highest math scores.				Based on students' last test administration.		
	No. Taking Tests	Average Score Verbal	Math	Total	Average Score Verbal	Math	Total
School	34	437	408	845	429	401	830
College Prep. Endorsement		N/A	N/A	N/A	N/A	N/A	N/A
Other Diplomas		N/A	N/A	N/A	N/A	N/A	N/A
System	34	437	408	845	429	401	830
College Prep. Endorsement		N/A	N/A	N/A	N/A	N/A	N/A
Other Diplomas		N/A	N/A	N/A	N/A	N/A	N/A
Georgia	43,224	488	482	970	484	477	961
Nation	1,064,725	N/A	N/A	N/A	505	508	1013

American College Testing (ACT)			
Number taking tests: 4 *	School	System	State
English	N/A	N/A	19.7
Mathematics	N/A	N/A	19.8
Reading	N/A	N/A	20.8
Science Reasoning	N/A	N/A	20.4
Composite Score	N/A	N/A	20.3

* Scores are not reported when fewer than 5 take the ACTs.

Advanced Placement Exams (AP)®			
	School	Syste	Stat
No. of Students Taking Tests	N/A	N/A	10,032
No. of Tests Taken	N/A	N/A	14,290
No. of Test Scores 3 or Higher	N/A	N/A	8,686
Percent of Test Scores 3 or Higher	N/A	N/A	61%

STATE-REQUIRED TEST DATA

CRITERION-REFERENCED TESTS

HIGH SCHOOL GRADUATION TESTS

Percent of 1995-96 Regular Program 11th Graders Passing the Georgia High School Graduation Tests on First Administration

	School	System	State
English Language Arts	92%	92%	92%
Mathematics	82%	82%	86%
Social Studies	76%	76%	81%
All Three Components	70%	70%	76%
Writing	80%	80%	89%

CERTIFIED PERSONNEL DATA

Certified Personnel

		Administrators	Support Personnel	Teachers
Numbe	Personnel	6	2	38
Sex	Male	4	0	14
	Female	2	2	24
	Not Reported	0	0	0
Certificate	4 Yr Bachelor's	1	0	17
	5 Yr Master's	3	0	20
	6 Yr Specialist's	2	1	1
	7 Yr Doctoral	0	1	0
	Other*	0	0	0
Years Experienc	<1	0	0	1
	1-10	0	0	12
	11-20	0	1	11
	21-30	4	1	11
	>30	2	0	3

*Includes One- and Two-Year Vocational Certificates.

ACCREDITATION DATA

Accredited by Southern Association of
Colleges and Schools (SACS)
Secondary/Middle Commission

AWARDS / RECOGNITION DATA

Schools in Georgia may receive recognition in the following programs:

Charter Schools
Schools for the Future
Pay for Performance Program
Georgia Schools of Excellence
National Schools of Excellence

County High did not receive recognition in any of these programs during the 1995-96 school year.

VITA

Virginia Peck Souders, known as Jensi, was born in Lenoir City, Tennessee, on December 8, 1946. She attended elementary and secondary schools in Chattanooga, Tennessee, where she was graduated from Chattanooga High School in 1964. She received a Bachelor of Arts degree in 1968 from Middle Tennessee State University, with a double major in English and history; requirements for a Master of Arts degree, also from MTSU, were completed in 1973, with a major in English. She was graduated from The University of Tennessee, Knoxville, in the summer of 1998 with a Doctor of Education degree.

Her career in education began in Giles County, Tennessee, in 1969. She was employed by the Catoosa County, Georgia, Public Schools in the summer of 1969 as an English teacher at Lakeview-Ft. Oglethorpe High School. She taught English, speech, and drama for ten years before moving into the school's library media center as media specialist in the fall of 1979, having taken library courses for certification from West Georgia College in Carrollton. In the fall of 1989, the author became an instructional specialist in the Office of Curriculum and Instruction for Catoosa County Schools.

A member of the Delta Kappa Gamma Society International, a professional honor and service organization for women educators, Souders served as state president and state newsletter editor of the Tennessee organization of the Society, as a member and Chairman of the International Research Committee, and as Chairman of the International Communications Committee. A 1988 graduate of the Society's International Leadership Management Seminar at the University of Texas in Austin, Souders was awarded the Society's M. Margaret Stroh International Scholarship for doctoral study in 1993 and the Maycie K. Southall State Scholarship for doctoral study in 1994.

The author is a member of the Georgia Association for Instructional Technology, The Georgia Association for Curriculum and Instructional Supervision, the Georgia Library Media Association, and the Professional Association of Georgia Educators. As a member, board member, and Vice President for Community Development for the Catoosa County Area Chamber of Commerce, the author was recognized in 1996 as the Chamber's Outstanding Member.