ABSTRACT

PIERCE, EDITH GREEN. The Technology Connections Initiative in the Wake County Public School System and its Effect on Scale Scores and Passing Rates on State Tests. (Under the direction of Dr. Bill DeLuca.)

To determine the effects of the Technology Connections initiative on students' scale scores on eighth-grade North Carolina End-of-Grade Tests in reading and mathematics and on the Multiple-Choice and Performance North Carolina Tests of Computer Skills, the researcher used a quasi-experimental nonequivalent group. The population for the pre-post group for the reading and mathematics tests consisted students in the Wake County Public School System in Raleigh, North Carolina in 2000-2001. The population for the post test-only group consisted of students who were administered one or both parts of the Tests of Computer Skills. The experimental group consisted of students in schools that were Technology Connections Leader Schools, had computers in their classrooms, and were instructed using constructivist methods. The experimental and control groups had access to computer labs, but the control group did not have computers in their classrooms, nor were control group teachers trained in constructivist theory.

A pooled 2-tailed t tests was computed on students’ scale scores for the reading and the math tests for 10 subgroups designated in No Child Left Behind legislation. No statistical significance was found for any subgroup for the reading test and only the Asian subgroup in the experimental group realized higher gains in scale scores on the math test.
There was no statistical significance in students' scale scores on either the multiple-choice or performance section of the computer skills tests with the following exceptions: (a) the Black subgroup in the Technology Connections schools had a lower mean on the multiple-choice test than the nonTechnology Connections schools; (b) and both the Black subgroup and the Economically Disadvantaged subgroup in the Technology Connections schools had a lower mean on the performance section of the test. While the Technology Connections initiative and philosophy was no more or less effective than traditional methods with regard to achievement for most students, it appeared to have a negative impact on several subgroups.
THE TECHNOLOGY CONNECTIONS INITIATIVE IN THE WAKE COUNTY PUBLIC SCHOOL SYSTEM AND ITS EFFECT ON SCALE SCORES AND PASSING RATES ON STATE TESTS

by

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DEDICATION

To

my husband Tony, my sons Whit and Justin,

and

my dear mother

Mary Nell Eaves Green
BIOGRAPHY

Edith Pierce is an employee of the Wake County Public School System in Raleigh, North Carolina. She grew up in Norfolk, Virginia, with a sister, Mary Lou, who died at age 26 in 1974 due to complications of transverse myelitis and multiple sclerosis. Her father, Fulton Monroe Green, was a World War II veteran and retired submariner who was unable to work because of complications from diabetes and a thyroid condition. In his sixties, Alzheimer’s and blindness, resulting from diabetes, took its toll. He died at age 66 in 1982. When Edith was growing up, her father drilled into his daughters to get their educations, that it was the only thing no one could take away. Her mother, Mary Nell Eaves Green, taught second grade until she was 68 and swears she would still teach if she could—even at age 91.

Edith received an undergraduate degree at Campbell (College) University in 1971 and met her husband there. She received her Masters in Technology Education from North Carolina State University. She taught in elementary and middle schools in Wake County before being named Director of Local Testing for the Wake County School System in Raleigh, North Carolina. For the past four years, she has served as Senior Director of Testing for the Wake County School System.

She lives in Cary, North Carolina with her husband and is blessed to have two sons who live in the area.
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There are others to thank too—my sister-in-law and her husband, Joyce and Ad Andrews, Gig Harris and her husband, John, dear family and friends who kept me going and gave total encouragement. A special thanks to my dear friend, Leslie Jones, who has accomplished so much more in the area of academia than I could ever hope to do. She is a constant source of inspiration to me. I must also thank Dr. Craig Sanders, who continued to email me and give me support even after he had completed his doctorate (we started our master’s program together), and, of course, all the members of my committee, especially Dr. Bill DeLuca, whose patience, I am sure was sometimes tested.

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CHAPTER I
INTRODUCTION

In training a child to activity of thought, above all things we must beware of what I call “inert ideas”—that is to say, ideas that are merely received into the mind without being utilised, or tested or thrown into fresh combinations.

(Whitehead, 1929)

These words by Alfred North Whitehead are as true today, as they were when he wrote them over 75 years ago. Today, small business owners and large corporations agree that their pool of potential employees do not have the necessary core abilities to communicate with one another and with the greater public. In the early 1990s, the National Alliance of Business reported in a study of 2500 businesses that almost three quarters of their applicants lacked writing skills and more than half could not listen or follow oral instructions or understand manuals, graphs, or schedules. Over 58% of applicants could not speak well enough to be understood (Watson, 1996). The future workforce, who comprises the classrooms today, must be taught 21st-century skills. The process of educating students must consider not only what students learn but also how they learn it and how often that knowledge must be refreshed.

Future learners, teachers, and schools will differ in significant ways than those of the past. Paul Houston, Executive Director of the American Association of School Administrators (AASA), when speaking of a year-long study by the AASA,
said, “While our nation’s schools have done a masterful job of preparing students for an industrial age, we are moving at warp speed into a whole new era” (as cited in Winthrow, Long, & Marx, 1999, ¶ 1). He went on to say that we need schools “capable of preparing students for a global knowledge/information age” (¶ 1). The AASA study found 16 characteristics that schools and school systems would need to prepare students for the 21st-century workplace. At the top of the list was a reshaped definition of “school, teacher, and learner” (¶ 3). Traditional schools—the thought of which conjures up images of rows of desks and oft times disinterested students—will become nerve centers that connect one group of students—active learners—to others and their world. The role of teachers will evolve—according to the AASA—into “orchestrators of learning” who help students “turn information into knowledge and knowledge into wisdom” (Winthrow et al., 1999, Categories of Characteristics #9 section, ¶ 1). The learners of which AASA speaks will no longer be the 180-day, 6-hour-a-day learner, who by just sitting in a classroom for 12 years and passing certain subjects, eventually matriculates into a college or enters our society. The learner the AASA envisions is one who connects what is going on in the classroom to what is going on outside of the classroom and this learning prepares him for life. He is a curious and an eager learner who knows how to solve problems, to make sound decisions, and sees the interconnectedness of the classes and subjects about which he learns in school (Winthrow et al., 1999).

Researchers spent 2 years examining emerging characteristics of what is called the “Net Generation,” from which a framework called enGauge 21st Century
Skills was developed (Burkhardt et al., 2003). The investigators gathered input from educators and educator surveys, measured reactions from constituent groups, and examined business and industry trends and a report from the Secretary's Commission on Achieving Necessary Skills (SCANS) that determined the skills students need to succeed in the world of work. The *enGauge* framework identified six essential conditions or system-wide factors critical to using technology effectively in student learning:

1. forward thinking—shared vision,
2. effective teaching & learning practice,
3. educator proficiency,
4. digital-age equity,
5. robust access, anywhere—anytime, and
6. systems and leadership.

The *enGauge* researchers also reviewed literature about emerging research of what leaders in business, industry, and education identified as skills and proficiencies students will need in the 21st-century workplace. From this research, four recurring themes, or strands, were developed: digital literacy, inventive thinking, effective communication, and high productivity (Burkhardt et al., 2003).

In 1995 visionary leaders in the Wake County Public School System, including assistant superintendents, central office directors, and specialists, were charged with developing a prototype for integrating instructional technology into the classroom. Under the leadership of then Wake County Superintendent Dr. Jim
Surratt, 12 elementary school teachers were selected for a task force that would develop a system-wide model to improve elementary students’ understanding of the writing process. Surratt, an ardent advocate of a strong technology model, believed that writing is not only one of the most essential skills but also “the window to a child’s mind” (Wake County Public School System [WCPSS], 1997, Writing section, p. 1). The developers of the enGauge project agreed, listing digital literacy as highly important in the 21st century (Burkhardt et al., 2003). The school system (1997) task force wrote, “Because effective writing skills are necessary in school and in life, success in writing very likely will influence a child’s future opportunities” (Writing section, p. 1), a sentiment that was strongly voiced in the National Alliance of Business study (Watson, 1996). The task force wanted teachers “to personalize learning to students’ abilities and learning styles and to be able to evaluate their [students’] progress more comprehensively” (Millbrook High School, 1999). Central office administrators and other task force members posed the question, “How can teachers use computers and related technologies to create learning environments that actively engage students in meaningful instructional activities?” The task force envisioned technology that would be integrated throughout the curriculum and that would advance both student learning and teacher training (Millbrook High School, 1999). What evolved from the task force’s efforts became known as Technology Classrooms. Shortly thereafter, the name was changed to Technology Connections.
Research Problem

In 1995, technology leaders at the district level selected 12 Wake County elementary teachers who worked with administrators to develop a prototype of instructional technology classrooms. The teachers and leaders developed a model that encompassed seven beliefs:

1. Technology supports learning.
2. Classroom instruction and management are strengthened through the use of technology.
3. Appropriate changes in curriculum and instructional delivery must take place to meet the needs of today’s students.
4. Technology can and should facilitate the rethinking and the restructuring of what takes place in the classroom.
5. Technology can greatly assist students in acquiring skills for the rapidly changing society.
6. Technology helps bring the world into the classroom.
7. Technology should be curriculum driven, enhance the instructional process, and accelerate student learning. (Wake County Public Schools, 1997, Writing section)

By February 2000, 91% of Wake County elementary schools had at least one Technology Connections classroom with five computers and other classroom learning centers to assist teachers in instructing and evaluating students.
In fall 1996, the initiative was expanded to include secondary classrooms. A committee of eight teachers (four high school English teachers and four middle school language arts teachers) was charged with identifying compelling teaching and learning strategies and applying instructional technology to integrate these methods and strategies into the secondary curriculum. Once again, while the primary focus was on using technology to improve writing, the committee’s vision grew to encompass all disciplines and issues of student learning. Committee members also began devising classroom models for incorporating six networked computers into instructional activities. These secondary teachers believed that technology as an educational tool required students to become active in the learning process and teachers to become more effective facilitators in the classroom (Wake County Secondary Technology Connections Committee, as cited in Bowen, 1999). Christopher Smith, former Apex Middle School teacher, said it best, “Technology Connections is not about technology for technology’s sake. Rather, it is a tool to facilitate change or revolution in the teaching and learning process” (Wake County Public Schools, 1997, History section). Supporting these views, the CEO Forum (1999) reported, “To thrive in today’s world and tomorrow’s workplace, America’s students must learn how to learn, how to think, and have a solid understanding of how technology works and what it can do. Teachers hold the key” (p. 6).

By 1998, the Technology Connections model was expanded and enhanced to include a six-member school team comprised of administrative and teaching personnel. “School teams attended technology institutes as a group and returned to
their schools to train the remainder of their staff in software and best practices in instructional technology” (Wake County Public Schools, 2001, Instruction section, ¶ 2). Schools that wished to participate in the Technology Connections initiative were asked to apply. The school teams, which included the school principal, media coordinator, Curriculum Integration Coordinator (or the Assistant Principal for Instruction), Technology Resource Teacher, and two other teacher–leaders in the school, were rated on their readiness for the program. The application included short-answer responses from each committee member, an accounting of teachers’ technology readiness at the school, and an equipment report. An application did not necessarily mean acceptance into the program because a school’s selection was based in part on either its infrastructure readiness or its team’s instructional readiness (knowledge of Technology Connections) (Wake County Public Schools, 2001, Instruction section, ¶ 2). Members of this core team were to become change agents in their respective schools, but the members could not be change agents unless they envisioned the change themselves. Schools that were accepted into the program were then rated as novice, proficient, or leader.

1. Novice status was the beginning level for schools in the Technology Connections initiative. The term Novice did not indicate that the schools or the individuals of the teams were novice (beginning) teachers or had minimal technology skills. Novice indicated that the school was at the beginning level of the implementation of the Technology Connections program. In the Technology Connections Institute, the eight days of
training assured that professional in the program all had a common understanding of the performance of expectations, concepts, and vision of the Technology Connections program.

2. Proficient status indicated that a school had moved through the eight days of Novice training and that the participants had begun to integrate the curriculum and to use technology to strengthen an understanding of the basics. Time was given to nurture, mentor, and incubate the school team. Opportunities to learn from other schools and professional were an important part of the proficient level. Two or three days of follow-up training were provided for the Proficient level team and were delivered over a semester with training delivered in a variety of ways.

3. Leader status indicated that the school had developed a team that was ready to transfer knowledge, skills, and attitudes throughout the school. Leader level included four days of training in team building and strategies for designing, planning, and implementing Technology Connections throughout the entire school (Wake County Public Schools Technology Connections Institute Application).

All team members, including the school principal as the school’s instructional leader, attended training. For change to occur successfully, the principal had to embrace completely the vision of the Technology Connections philosophy and program.

Although most schools began their Technology Connections journey at the novice level, this did not mean team members were not computer savvy but, rather,
they would need to develop their vision and their “knowledge, skills and attitudes for building Technology Connections classrooms” (Wake County Public Schools, 1999, p. 8). Team members who did not already have a laptop computer supplied by the Wake County Public Schools System were given one.

Laptop computers give teachers the ability to learn at their own pace when they have free time, whether that happens to be on the weekend or before going to bed. Teachers will also have the opportunity to experiment privately or with people they trust. (Shaw, as cited in Wake County Public Schools, 2001, Staff Development section, p. 8)

Topics during the seminar-type training included the Technology Connections philosophy, cognitive learning theory, and technology integration. Once novice school members understood the Technology Connections philosophy and had demonstrated their acceptance of the philosophy, they were eligible to advance to the proficient level. At the proficient level, the school could begin to implement the Technology Connections program, and the school members could begin to apply their knowledge, skills, and attitudes for building Technology Connections classrooms. Mentoring, training support, and central office staff helped teachers at the proficient level implement the philosophy and strategies in their schools.

Few schools that first applied to the Technology Connections program entered at the leader level. At this level, the members were ready to create a Technology Connections school because they understood the Technology Connections philosophy and already demonstrated it in their schools. School
members at the leader level were ready to develop the skills to transfer Technology Connections knowledge, skills, and attitudes throughout the school. School members of leader schools required an additional 4 days of training to develop skills in team building and in designing, planning, and implementing Technology Connections throughout the school. At the leader level, members of each school’s professional staff were given laptop computers and workstations to create additional Technology Connections classrooms (Wake County Public Schools, 2001, Staff Development section). Staff development within the school, or in collaboration with other leader schools, assured that the Technology Connections philosophy and vision permeated leader schools.

Wake County Public Schools planned to implement Technology Connections in its secondary schools over a 3-year period beginning in the summer of 1999 (see Table 1). Seven middle schools and five high schools were accepted into the Technology Connections Secondary Institute in summer 1999. The institute’s purpose was to develop an effective Technology Connections Leadership Team at each school. Each team would then develop and implement a Technology Connections staff development program to infuse the Technology Connections philosophy throughout the school. The middle schools that were accepted into the institute were Apex Middle, Daniels, Davis Drive, Dillard Middle, Martin Middle, North Garner, and Wake Forest-Rolesville Middle.

“The strategic use of technology starts with a vision about school wide learning goals and standards necessary to prepare today’s students for tomorrow’s
world” (McNabb, Valdez, Nowakowski, & Hawkes, 1999, Develop a Vision and Policy section, ¶ 1). So it was with the Wake County Public Schools Technology Connections. Participating schools developed action plans to assess technology staff development needs, to identify priorities, and establish training models.

### Table 1

**Technology Connections Secondary Institute Roll-out Plan**

<table>
<thead>
<tr>
<th>Academic Period</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer ’99</td>
<td>Novice</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall ’99</td>
<td>Novice continued</td>
<td>Novice</td>
<td></td>
</tr>
<tr>
<td>Spring ’00</td>
<td>Proficient</td>
<td>Novice continued</td>
<td>Novice</td>
</tr>
<tr>
<td>Summer ’00</td>
<td>Leader</td>
<td>Proficient</td>
<td>Novice continued</td>
</tr>
<tr>
<td>Fall ’00</td>
<td>Building level</td>
<td>Leader</td>
<td>Proficient</td>
</tr>
<tr>
<td>Spring ’01</td>
<td>Building level</td>
<td>Building level</td>
<td>Leader</td>
</tr>
</tbody>
</table>

*Note.* Adapted from “Technology Connections Secondary Institute.”

During the early 1990s, all schools in Wake County increased the amount of computer technology in their facilities, but school administrators offered little direction to staff in how to use the technology. “Prior to 1995, teachers received individual and isolated training on software skills and technology integration” (Wake County Public Schools, 2001, Instruction section, ¶ 1). The computers were an “end,” not a means to an end. “Past research shows that placing technology in the classroom and even offering teachers technology workshops focused on the mechanics of hardware and software does not lead to innovative technology integration throughout the curriculum” (University of California, 2000, ¶ 1).

Technology plans addressed hardware needs but failed to tackle the more difficult
issues of how to integrate the hardware and software into the curriculum and how to change the educational climate of the classroom and the school. “What teachers really need is in-depth, sustained assistance as they work to integrate computer use into the curriculum and . . . [to] confront the tension between traditional methods of instruction and new pedagogical methods that make extensive use of technology” (Panel on Educational Technology, 1997, section 5).

Also during this same time period, the North Carolina State Board of Education put into effect increased standards for high school graduation. In May 1991, the North Carolina State Board of Education, as part of the Quality Assurance Program, established a computer proficiency requirement for graduation that was to begin with the class of 2000. In October 1995, the Board modified the requirement by making it effective beginning with the graduating class of 2001. Students who were in the eighth grade during the 1996–97 school year and thereafter had to meet the computer proficiency requirement to receive a high school diploma. (Public Schools of North Carolina, 2001, Introduction section, ¶ 2)

School administrators scurried to purchase more computers to create networked computer labs. Principals reallocated average daily membership (ADM) positions to hire staff to teach computer skills. These positions were separate from Career and Technical Education (CTE) positions that were designated for teaching keyboarding. The Career and Technical course (Keyboarding–Middle Grades), as the name suggests, does not cover all aspects of the North Carolina
Standard Course of Study (SCOS) for the computer skills curriculum that is
to be taught in grades K–8, and this course is traditionally taught in grade 6.
Business Education (Computer Applications I) is not offered until high school.
Although Computer Technology Skills is a K–12 curriculum, reality puts the focus of
the curriculum in middle schools because eighth grade is the first time students have
the opportunity to meet the computer skills standard, which is a requirement for a
high school diploma. The computer skills teacher was charged with instructing
eighth-grade students (and sixth- and seventh-grade students as time permitted) in
mastering the computer skills they would need to pass the North Carolina Tests of
Computer Skills. The strategy was hit or miss, as scheduling of students was
sporadic. If a student was absent from school on the days his or her class was
scheduled for instruction in the lab, the student could miss important skills. Little or
no connection was provided to students between what they were learning in the lab
and what they were being taught in the classroom.

In a lab setting, the computer is learned apart from other subjects and
activities. It is much more difficult to integrate technology into other areas of
the curriculum within the lab setting. The computer becomes a separate
course or activity, rather than a tool used to enhance learning in other areas.
(Culbertson, 1999, Should Computer Labs Be Phased Out section, ¶ 2)
Many teachers believed, as the Technology Connections philosophy advocated, that
schools needed a different approach to technology integration:
The traditional “computer lab” model of technology use is far outdated, as evidenced by school systems across the state who are struggling with accommodating the numerous requests to use such facilities. The need and escalating interest has simply outgrown the current construct of “the computer lab.” (School Administrative District #4, 2002, ¶ 6)

Technology Connections teachers and visionaries at the county level believed that computers should be not only in the classrooms but an integral part of daily instruction. Their view reflected the constructivist paradigm of the Technology Connections philosophy—students making meaning and knowledge through projects and curriculum integration and making students more responsible for their own learning. “Learning should be activity-based and designed to facilitate individual interests and learning styles” (Tennessee Technology Education Association, n.d., Technology Education Standards/Middle School section, ¶ 1). In essence, the facilitator in the constructivist classroom

1. encourages students to discover principles by themselves,
2. engages in active dialog with the students (i.e., Socratic learning), and
3. translates information to be learned into a format appropriate to the learner’s current state of understanding. (Arts in Education Institute of Western New York, n.d., ¶ 2)

Another key principle of constructivist theory is that the curriculum should be organized spirally so that students continually build upon what they have already learned (Arts in Education Institute of Western New York, n.d., ¶ 2).
For the Technology Connections initiative to be successful, the mindset of the classroom teacher and the principal would have to change. Overcoming resistance to change results from three factors:

- Dissatisfaction (with the way things are presently done) x Vision (what is possible in the future) x First Steps (what is achievable to begin with). For change to occur, these three factors must be present to overcome the resistance to change in the organization (Gleicher, as cited in Rouda, 1995, Some Major Large Group Approaches section, ¶ 3)

The Technology Connections teams were dissatisfied with the instructional paradigm at the classroom and school levels. Many middle and high school classrooms used the sage-on-the-stage model of teaching rather than the student-as-learner, teacher-as-facilitator model. Computer labs were a hit-or-miss way of helping students to learn the computer skills that would help them pass the North Carolina Tests of Computer Skills and meet one of the requirements for a high school diploma. Teams had envisioned how classrooms could look and created models of technology-rich classrooms. The teams made their successful first steps, with the full endorsement of Dr. Surratt.

For Technology Connections to be successful throughout the county, teachers would have to recognize that the initiative would benefit students and the teachers themselves. The hardware and software that teachers received for their classrooms from participating in the program was a definite incentive and seeing other teachers incorporate the Technology Connections philosophy in their
classrooms created additional interest. The sessions were about making teachers better instructors. Technology was added to Technology Connections classrooms: six computers networked for student use, a laptop computer for the teacher, a networked laser printer, Averkey and large screen television or data projector, a scanner, and software. The technologies were tools for students and teachers to use, not a substitute for teacher support and student inquiry. When the Wake County Public Schools’ Technology Education Plan for 2001–2005 was written, 40 schools had attained the Technology Connections leader level.

In March 1995, the North Carolina General Assembly ratified Senate Bill 16 which directed the State Board of Education to develop a plan “to establish additional means for making the education system at the State, local, and school levels accountable to the public for results” (Statewide Testing Program, 1995-96). The ABCs—Accountability, Basic Skills with high educational standards, and Control at the local level—ensured that teachers taught the curriculum, with tests being given at the end of each grade level from grades 3 through 8 in reading and mathematics. School and system accountability was measured in terms of growth and performance. Beginning in 2000–2001, student accountability measures ensured that students in grades 3, 5, and 8 were ready for the next grade level. Also, beginning with the 2000–2001 school year, the North Carolina Tests of Computer Skills became part of the performance composite in the North Carolina ABCs, thus raising the stakes for the test at the school level. The format of the test also changed that same year. The new format of the computer skills test more closely aligned to

The new curriculum reflected relevancy in real-life application. For students to incorporate the computer competency goals, they would need to have multiple opportunities to apply these skills. The Technology Connections initiative would afford these opportunities to students.

In 2002, the United States Congress enacted into law the No Child Left Behind (NCLB) initiative as a revision of the Elementary and Secondary Education Act. The NCLB measures are designed to close achievement gaps between different groups of students and to determine if adequate yearly progress (AYP) is being met by at least 95% of the students in 10 subgroups. Among these subgroups, one is the whole student population and others are related to ethnicity, limited English proficient (LEP) status, socioeconomic group, and disability. Schools were no longer required to meet just local and state standards of progress but also federal standards. While the computer skills curriculum and tests are not included in NCLB, end-of-grade (EOG) reading and mathematics tests are. The Technology Connections, incorporating brain research and a constructivist’s model classroom, would afford students the opportunity to make learning relevant to real-life applications with the expectation of improving student scores on standardized tests.

*Engaged Learning* . . . helps instructors make learning relevant for the learner. Moreover, engaged learning has been proven to be the most
effective approach to teaching technology related skills, skills that all successful students must master, as well as traditional knowledge and skills.”

(Oceti Sakowin Education Consortium, 2003, Services, School Improvement section, ¶ 5)

According to Ed Tech Action Network (ETAN) (n.d.), “Performance on standardized assessment in reading, writing, mathematics and other subjects improves when technology is part of the learning process” (Ed Tech and Student Achievement, ¶ 1).

Need for the Study

The theoretical support for Technology Connections, brain research, the constructivist classroom, and so forth appears solid. As federal requirements, graduation standards, and state tests become increasingly demanding, educators owe it to their students to ensure students can demonstrate a deep understanding of all curricular areas. “Technology empowers the education reforms of No Child Left Behind by expanding educational opportunities for students, equipping teachers with engaging instructional tools and enabling parents to become more involved in their child's education” (U.S. Department of Education, 2003, Press Room, Press Releases section, ¶ 2).

The information age poses a whole new set of challenges and questions to America’s schools. The quality of our nation’s political, social and economic future will depend on the ability of young people to become functioning members of society who understand how to access information (and determine its significance), manipulate data, draw independent rational
conclusions and communicate findings. A democracy requires contributing citizens who are informed and capable of independent, critical thought. (Watson, 1996, ¶ 1)

The problem, however, is that educators are teaching much the same way as they were 100 years ago.

Training teachers to integrate 21st-century technology into their classrooms amounts to an enormous undertaking. These professionals have been trained and socialized into a set of institutional norms and values that can too often be inflexible and reluctant, inflexible and reluctant, if not downright hostile, to change. Meanwhile, they are already inundated with lessons, homework, discipline problems and parent-teacher conferences. Some educators question the wisdom of investing vast sums of time, money and energy on technology, and the new media intimidates many. Some are even convinced that technology obstructs creativity and personal exploration. These concerns may be appropriate if technology is used to simply automate traditional methods of teaching. New technology gives teachers potential to create new models of teaching and learning. (Watson, 1996, Challenges for Teachers section, ¶ 1)

A study for the Bill and Melinda Gates Foundation (Fouts, 2000) reports that “computer technology can have a positive impact on student achievement if certain factors are present” (p. i). Among them are “a lower student to computer ratio,” extensive teacher training, buy-in for the initiative from the teachers, “planning time”
to help the teacher create exciting “new learning environments for students,” and “technological support” (p. i).

Few studies have tested the potential benefits of educational technology. The CEO Forum (1997) “identified significant data gaps where further research is required to gain a better understanding of how the nation, and our individual schools, are integrating educational technology throughout the curriculum” (Future Research section, ¶ 2). In their report, the authors further argued that “research on the benefits that technology brings to teaching, learning and the preparation of American students for life and work in the 21st century is scarce” (¶ 3). A number of factors frustrate researchers and can prevent them from finding simple yes or no answers to technology’s effectiveness. The overall context of the real-world educational environment is one such example. “Schools are messy and noisy environments for research, far from the pristine, controlled setting available in the research laboratory, the model on which most quantitative evaluation studies are based” (Office of Technology Assessment, 1995, p. 115).

The debate continues over whether computers should be in a lab or provided in groups of five or six in a classroom.

As schools obtain more technology, the question about how to use computers effectively rarely precedes the question of where to locate them: in the classroom or in the computer lab. The two questions are essential to each other. For schools who wish to use drill and practice software, who intend to teach mostly computer-based skills, and for those without knowledgeable
teachers to use them, the lab may be the best situation. For teachers who want to take advantage of “the teachable moment,” for those who want to emphasize group work and project-based learning, for those who want a change to fully integrate technology into their teaching in the most powerful way possible, then the five computers in the classroom arrangement is best. (Culbertson, 1999, Summary section, ¶ 1)

There is a compelling need for more studies to justify initiatives like Technology Connections. Little is understood about the relationship between educational technology and student test results.

Evidence has consistently shown that drill-and-practice computer activities can help children develop basic skills, many researchers say. But the picture is murkier for more sophisticated uses of technology in the classroom, especially for the host of applications and methods that support “constructivist” learning, in which students are encouraged to work in rich environments of information and experience, and build their own understandings about them. (Trotter, 1998, Introduction section)

In February 2002, the Department of Education, through the Elementary and Secondary Education Act, launched a 3-year study to examine “the conditions and practices under which educational technology is effective in increasing student academic achievement, as well as the ability of teachers to integrate technology effectively into curricula and instruction” (Trotter, 2002, ¶ 4).
It may be that simply spending more time in drill and practice in a computer lab does not effectively teach the skills that students need to pass the North Carolina Tests of Computer Skills. “Yet in the hands of technology-trained middle school teachers, computers can enhance academic performance” (Mathews; Bonner; Fisher, as cited in National Science Foundation, 1999, Footnote †††). This remark is a plea for more study of educational technology, specifically computers, as an integral part of the curriculum and the effect of such technology.

Perhaps, the Technology Connections philosophy must be reinforced with more opportunities for students to use computers in all areas, both in labs and in the classroom, for the program to be effective. Did adding computers and changing the teaching and learning process in classrooms via the Technology Connections initiative increase the eighth-grade passing rates on the North Carolina Tests of Computer Skills, result in higher developmental scale scores on the multiple choice or performance section of the test, or produce higher scale scores on the North Carolina End-of-Grade tests in reading and mathematics for eighth-grade students when comparing Technology Connections leader schools to nonTechnology Connections schools? To determine the answers to these questions, the researcher examined passing rates and scale scores on the North Carolina End-of-Grade Tests in reading and mathematics and the North Carolina Tests of Computer Skills of students in Technology Connections Leader middle schools and compare them to the passing rates of students in schools that were not part of the Technology Connections initiative. The researcher used end-of-grade and computer skills tests
results for the year 2000–2001 to determine whether students in
Technology Connections schools had an increased passing rate on the tests
resulting from the change in teaching philosophy combined with more students and
teachers having more hands-on time with computers.

Purpose of the Study

The purpose of this study was to determine the effects, if any, of the
Technology Connections philosophy on the passing rates, as demonstrated by scale
scores on eighth-grade state-mandated tests, for eighth-grade students in each of
the No Child Left Behind subgroups. The accessible population for the North
Carolina Computer Skills Test study was students who took the North Carolina Tests
of Computer Skills in eighth grade in Wake County Public Schools and did not
repeat eighth grade. The researcher used eighth-grade scores for the 2000–2001
school year for two reasons. First, 2000–2001 was the first year the North Carolina
Tests of Computer Skills reflected the new curriculum that had been revised in
1998–1999. Second, it was the last year in which Wake County Public Schools fully
funded the Technology Connections initiative and worked closely with schools that
were in the leader schools category. No Child Left Behind (NCLB) legislation uses
140 or more days in membership before a student is included in a school's Adequate
Yearly Progress (AYP) calculations. Prior to the No Child Left Behind legislation,
North Carolina used 95 days in membership before a student would count toward
the ABC (Accountability, Basics, Control) growth calculations.
For No Child Left Behind inclusion, at least 40 students must be in the grades tested. However, for the purposes of this study, the researcher calculated data for the Limited English Proficient (LEP), American Indian, and Multiracial subgroups, even though the \( n \) counts were below 40. LEP students were not required to test during their first 2 years in U.S. schools and the American Indian and Multiracial subgroups were very small.

**Research Questions and Hypotheses**

1. What was the effect on the scale scores on the eighth-grade End-of-Grade reading test in Technology Connections schools as compared with nonTechnology Connections schools for each or any of the No Child Left Behind subgroups?

2. What was the effect on the scale scores on the eighth-grade End-of-Grade mathematics test in Technology Connections schools as compared with nonTechnology Connections schools for each or any of the No Child Left Behind subgroups?

3. What was the effect on the passing rates, as demonstrated the scale scores, on the multiple-choice section of the test for students in each of the No Child Left Behind subgroups in the Technology Connections leader schools compared to the traditional lab approach in nonTechnology Connections schools?

4. What was the effect on the passing rates, as demonstrated by scale scores, on the performance section of the test for students in each of the
No Child Left Behind subgroups in the Technology Connections leader schools compared to the traditional lab approach in nonTechnology Connections schools?

The null hypotheses developed for this study were:

\( H_01: \) No Child Left Behind subgroups that are exposed to a Technology Connections philosophy, which includes instructional technology, as a seamless part of the North Carolina Standard Course of Study, will perform the same on End-of-Grade Test in reading as students who are not exposed to the Technology Connections philosophy.

\( H_02: \) No Child Left Behind subgroups that are exposed to a Technology Connections philosophy, which includes instructional technology as a seamless part of the North Carolina Standard Course of Study, will perform the same on End-of-Grade Test in mathematics as students who are not exposed to the Technology Connections philosophy.

\( H_03: \) No Child Left Behind subgroups that are exposed to a Technology Connections philosophy will perform the same on the North Carolina Computer Skills Test– Multiple-Choice as students who are not exposed to the Technology Connections philosophy.

\( H_04: \) No Child Left Behind subgroups that are exposed to a Technology Connections philosophy will perform the same on the North Carolina Computer Skills Test– Performance as students who are not exposed to the Technology Connections philosophy.
Definition of Terms

_Accountability, Basics, & Control (ABCs) of Public Education_ - Established in 1995-96 as a means by which the state, Local Education Agencies (LEAs), and schools are held accountable for teaching the North Carolina Standard Course of Study and for student test results in mathematics, reading, science, and social studies.

_Average daily membership (ADM)_ - Defined for each school month based on the principal's report to the NCDPI. It is the sum of the number of days that a student's name is on the current roll of a school or class during a semester or the year (based on whether the school is a block schedule or traditional calendar school) for all students divided by the number of school days in the block or school year.

_Curriculum integration coordinator (CIC)_ - A teacher in each middle school who coordinates workforce skills into the four core subjects' (mathematics, reading, science, and social studies) standard courses of study.

_End-of-Grade Tests (EOGs)_ - Administered within the last 3 weeks of the school year and are based on the North Carolina Standard Course of Study in grades 3–8. Mathematics and reading are tested.
Goal Summary Reports - Goal Summary Reports provide specific breakdowns of EOG scores in reading and mathematics. The reports identify how many items are tested for each goal and the percentage of students in a class, school, or in the state that score proficient on each goal.

Local education agency (LEA) - Defined in this study as the Wake County Public Schools System. Each LEA is given a unique number for North Carolina Department of Public Instruction identification purposes. Wake County’s number is 920. Each school within the system is also given a unique three-digit number, or school code, which therefore gives each school a six-digit number for purposes of identification within the state.

Individual education program (IEP) - Document written for a student with one of the disabilities recognized by the United States Department of Education to ensure that the school meets the child’s educational needs.

IDEA Proficiency Test (IPT) - A battery of tests for students who speak, or hear, a language other than English in their homes. The tests determine a student’s LEP status and eligibility for accommodations on tests.
Limited English proficient (LEP) - Status given to any student whose language at home is a language other than English who takes the IPT and scores below Superior on any of the four subtests, listening, speaking, reading, and writing.

Masterbuild - A standardized spreadsheet created in each LEA that reports all students in membership and other information, including tests scores, requested by the North Carolina Department of Public instruction for each school at the end of each school year to determine school accountability (ABCs) and growth at the school and LEA level.

No Child Left Behind Act (NCLB) - A federal initiative signed into law in 2002, as a revision of the Elementary and Secondary Education Act (ESEA), to hold schools accountable for student learning by demonstrating adequate yearly progress for all subgroups and as a means of closing the achievement gap between subgroups.

Proficiency scale scores - The lowest scale score that a student can receive on a test and be considered proficient or performing on grade level. These scores are determined by the State Board of Education.

Scale scores - For reading and mathematics End-of-Grade tests, scores begin as raw scores that are converted into developmental scale scores. The scale scores allow comparison of the student’s end-of-grade scores by subject from one grade to the next (a pretest and posttest score) and also allow comparison from one norming
year to the next, when scale scores move from a 100 series to a 200 (as was the case in this study due to the change in the North Carolina Standard Course of Study). Scale scores for the Multiple-Choice and Performance Tests of Computer Skills allow comparison of one North Carolina Standard Course of Study to the next.

**North Carolina Standard Course of Study (NC SCOS)** - The curriculum that students are to be taught in grades K-12 in all subject areas. The standard courses of study are the curricula upon which tests are developed in reading, mathematics, all end-of-course tests, career and technical education, writing, and computer skills. The North Carolina Standard Course of Study curricula are revised on standard cycles.

**Subgroup** – No Child Left Behind recognizes 10 subgroups including six races (American Indian, Asian, Black, Hispanic, Multiracial, White), Socioeconomic status (in North Carolina defined by free/reduced lunch status), Students with Disabilities (including students with an IEP or 504 status), and limited English proficiency (LEP) status (as defined by IPT tests).

**Technology resource teacher (TRT)** - The teacher in each middle school who coordinates technology into the four core subjects. In many schools, the same person fills the CIC and TRT positions.
Assumptions

The assumption of this study was that students in leader Technology Connections schools and non-Technology Connections schools had access to a computer lab and that all of the Wake County Public Schools in the study were comparable. A second assumption was that all middle schools in Wake County gave eighth-grade students who did not score proficient in either the multiple-choice or performance section of the tests in the fall an opportunity to score proficient on an alternate administration of the tests in the spring. A third assumption was that, since the Wake County Public School System ascribes to the "Healthy Schools" philosophy, providing opportunity to students at all income levels meant:

1. Free and reduced lunch percentage was no higher than 40% (+ 15%).
2. Academic performance was no greater than 25% below grade level at a school. Facility utilization was between 85% and 115% of capacity, and there was ethnic diversity in all schools (Healthy Schools Task Force, 2003).

Because both the independent and control group populations were so large, the standard deviations for each of the four tests were assumed to be equal.

Limitations

1. There were 23 middle schools (grades 6–8) and 1 school (grades 6–12) in the Wake County Public School System in 2000–2001.
2. Seven of the 23 middle schools (grades 6–8) were named Technology Connections leader schools in 2000–2001.
3. Approximately 7,760 students were in eighth grade in the Wake County Public Schools in 2000-01.

4. Students in the sample for the North Carolina Tests of Reading and Mathematics had to be in membership in Wake County Public Schools for at least 140 days and have both a pretest (7th grade score) and a posttest (8th grade score).

5. Students who were repeating grade 8 during the 2000–2001 school year were not in the sample because they had been taken the North Carolina Tests of Reading and Mathematics during the 1999-2000 school year.

6. Students who were repeating grade 8 during the 2000–2001 school year may have scored proficient on the North Carolina Tests of Computer Skills the previous year and therefore already met the proficiency requirement.

Delimitations

The results of this study are generalizable only to students enrolled in Wake County Schools who are in eighth-grade classes and are preparing to take the North Carolina Tests of Computer Skills and End-of-Grade Tests in reading and mathematics.

Summary

Many theorists believe that brain-based learning and helping students to construct meaning of their classroom experiences are invaluable in creating knowledge. The premise of Technology Connections was for students to use computers and peripherals, focus their attention, collect their thoughts, share, and
collaborate with others. They were free to relate the information they were learning to prior knowledge and to clarify what they did and did not understand about the subject matter. By physically engaging students while the students were using computers, working with others, and learning, the teachers acted as coaches, getting the students to take responsibility for their own learning. By using inquiry techniques as they moved from group to group and having smaller groups work together, teachers made an almost impossible task (getting to know students’ individual strengths and weaknesses) possible. Because school administrators were also trained in the Technology Connections philosophy, they could act as coaches for students in the classroom. Students began to see the administrators as collaborative educational leaders instead of as disciplinarians.

Educators must understand that the addition of hardware, peripherals, and software to a classroom does not a Technology Connections classroom make. The Technology Connections philosophy must permeate the classroom and the school for the initiative to be successful.
CHAPTER II
REVIEW OF THE LITERATURE

Educational Technology and Student Academic Performance

The No Child Left Behind (NCLB) Act set forth three goals for educational technology which included the use of technology to improve the academic achievement of students in elementary and secondary schools, a means of ensuring that every student was technologically literate by the end of the eighth grade, and a way to encourage the effective integration of technology and research-based best practices (U.S. Department of Education, 2002, p. 28).

Students, our future workforce, must be technology literate. “Developing a technologically literate and capable citizenry should be a primary objective of all schools” (Tennessee Technology Education Association, n.d., ¶ 5). To that end, the curricular content in the classrooms must be rich with real-world problems, knowledge application, and teaching students how to think, not what to think (Tennessee Technology Education Association). “Research on learning and transfer has uncovered important principles for structuring learning experiences that enable people to use what they have learned in new settings” (Bransford, Brown, & Cocking, 1999, p. 3). However, learning is not automatically transferred to new settings, and researchers suggest that context is the key to understanding (Bransford et al., 1999; Kerka, 1992). If students learn in a passive setting, such as lecture, reading a text, or worksheets, then cognitive management skills are not
developed. Higher order learning is a construction of meaning, not just a change in behavior, and is achieved when authentic learning takes place. For students to shift from passive learners who memorize what is required of them to engaged learners who understand concepts and use higher order thinking, teachers must consider seamlessly incorporating computers into the curriculum (Coppola & Thomas, 2002). Rakes believed technology should be incorporated into the classroom so that the learner would have yet another means for representing and expressing what they know, for analyzing the world, accessing information, interpreting and organizing personal knowledge (Rakes et al., 1999). When teachers in five schools responded questions about the importance of technology in student learning, 79% of teachers felt that it was important or very important and fewer than 20% perceived technology to be “somewhat important. (Madden, p.71, 2002). Madden also found a correlation between the expectation for technology integration set by the building principal, the aggressiveness of the building technology coordinator, and teachers’ receptivity to constructivist/student-centered instructional methodologies (Madden, p. 63, 2002)

Under the leadership of Dr. Jim Surratt, the Wake County Public School System was about to make the leap to a technologically rich system in which engaged learners would develop higher order thinking skills through a computer-rich environment enabled by the Technology Connections initiative.

About this same time, policymakers across the country began questioning whether the money spent on technology was making a difference in student
academic performance. The Policy Information Center, Research Division of ETS, acknowledged a “surprising lack of hard data” on the effects of technology in the classroom (Wenglinsky, 1998, p. 5). Wenglinsky used National Assessment of Educational Progress (NAEP) data from 1996, which, for the first time, had included items about technology in its questionnaires. Although his findings made a case for the instructional use of technology in the classroom, he concluded that more studies are needed. Former U.S. Secretary of Education Richard Riley also affirmed the need for more studies: “We are far enough along in the technological revolution and its application to learning that it is time for systematic review and analysis of what works best” (as cited in McNabb, Hawkes, & Rouk, 1999, ¶ 1).

Some teachers view technology as a way to facilitate more comprehensive educational reform while others view it as a passing fad, considering it more a distraction from school reform than anything else. Those who advocate for technology believe it serves five major purposes in supporting education: individual learning, group learning, instructional management, communication, and administration (Wenglinsky, 1998). According to Wenglinsky, of the few studies that have examined educational technology’s effectiveness, results showed that (a) students who use computer-aided instruction demonstrate higher academic achievement than students who do not, (b) more recent uses of technology support higher order thinking skills, and (c) technology-rich schools demonstrate gains in achievement, student motivation, and teacher morale.
Opponents of technology in the classroom argue that, even with technology in the classroom, teachers must be willing to use it and use it widely. To support their contentions, they cite:

1. historical precedence—teachers’ resistance to technological innovations such as educational television;
2. cost-effectiveness of innovations such as Computer Assisted Instruction (CAI) – tutoring produces greater gains for less money; and
3. educational theory—students’ social interaction with the teacher in order for learning to take place. (Wenglinsky, 1998)

The NAEP questionnaire measured technology use through the following indicators:

1. student access to computers in school for mathematics tasks,
2. student access to computers and frequency of computer use at home,
3. preparedness of mathematics teachers in computer use, and
4. the ways in which mathematics teachers and their students use computers. (Wenglinsky, 1998, p. 12)

Fourth and eighth-grade students, their school principal, and teachers in relevant subject areas completed the questionnaires. These grades were selected because those grade levels had participated in the NAEP mathematics assessment. The questionnaires asked the following:

1. percentage of fourth- (or eighth-) grade students who reported using computers at school at least once a week,
2. percentage of fourth- (or eighth-) grade students with access to home computers,
3. percentage of fourth- (or eighth-) grade students who reported using computers at home once a week or more,
4. percentage of fourth- (or eighth-) grade teachers who reported any professional development in technology use in the previous 5 years,
5. percentage of fourth-grade teachers who reported learning games and drill and practice as primary computer use, and
6. percentage of eighth-grade teachers who reported simulations/applications and drill and practice as primary computer use.

Wenglinsky’s research had three major findings. First, technology does matter in academic achievement, but how much it matters depends on how it is used. Second, when computers are used to apply higher order concepts, and when teachers are proficient in their use, computers do appear associated with significant gains in mathematics achievement as well as improved social environment in the school. This finding was especially true in grade 8. Third, while access to computers within and among schools does not suggest inequities between advantaged and disadvantaged groups, there are inequities in the way the computers are used with minority, poor, and urban students. These groups are not exposed to using computers to apply higher order thinking concepts and, in general, have teachers who are less computer literate. These findings are significant for technology policy and practice.
1. Policymakers should ensure that teachers are properly trained to use computers, especially in high poverty and rural schools;

2. teachers should focus on using computers to apply higher order thinking skills learned in class; and

3. the primary focus of technology initiatives should be on middle schools since the effects of technology appears higher in middle schools as the reports show that these students exhibit benefits from the application of higher order thinking skills.

Three studies from a review of several of the largest studies of educational technology and its impact on student achievement had particular relevance for this study because they deal with CAI and Integrated Learning System technology (ILT) (Schacter, 1999). Kulik’s meta-analysis (as cited in Schacter) of more than 500 studies of computer-based instruction and found that (a) students who used computer-assisted instruction scored from 9 to 22 percentile points higher on achievement tests than did control groups, (b) students learned in less time, and (c) students had a more positive attitude when their classes included CAI. One negative finding Kulik noted was that computers did not have a positive effect in all areas studied, but those studies took place between 1981 and 1991 when computer-assisted learning was in its infancy. The instructional level in those studies ranged from elementary to college and adult education. Similar to Kulik’s findings, Sivin-Kachala’s review of research studies (1990–97) reported that students in technology-rich environments had positive attitudes toward learning and showed
increased achievement in all major subject areas from pre-school through higher education and in regular and special education (as cited in Schacter, 1999). Sivin-Kachala felt more research was needed to show conclusively how much the specific student population, the software design, the educator’s role, and level of student access to the technology influenced the effectiveness of educational technology (as cited in Schacter). West Virginia’s Basic Skills/Computer Education (BC/CE) Statewide Initiative realized an 11% increase in student test scores on the Stanford 9 between the fourth and fifth grade (Mann, Shakeshaft, Becker, & Kottkamp, 1999). Schacter cited Mann who attributed this gain to the cumulative effects of computer technology: consistent student access to technology, teachers’ and students’ positive attitudes toward technology, and teacher training in technology (as cited in Schacter, 1999). The longitudinal study focused on students in fifth-grade for two reasons:

1. During the 1996–97 school year, West Virginia began using the Stanford-9 in grades 3–11. Previously, the state had used the Comprehensive Test of Basic Skills (CTBS) in grades 3, 6, 9, and 11.

2. Students in grade 5 had use of computers in their classrooms longer than did any other group because the initiative began in 1991.

These studies describe a link between educational technology and improved student academic achievement. However, because the West Virginia instructional learning system model was designed before the Internet became an integral part of the classroom and before the constructivist theory of learning technology was
prevalent, more studies using performance-based assessments may yield additional empirical data to support the use of educational technology in the classroom.

A number of other studies have shown that educational technology improves student academic achievement. In a study of at-risk students repeating grade 8, Eric Little found that integrating technology into the curriculum assisted students in improving their scores on the CRCT, with a mean gain of 14 points in writing and 28 points in reading (Meridian Middle School Computer Technologies Journal, 2006, ¶ 13). Missouri’s eMINTS’ (enhancing Missouri’s Instructional Networked Teaching Strategies) initiative is touted as “transform[ing] classrooms into places for learning where teachers and students use multimedia tools to better understand the world, work together and achieve at new and higher levels” (eMints National Center, 2006, ¶ 1). EdTech Action Network (n.d.) reported that elementary students in Missouri enrolled in eMINTS classes showed average gains of “5.5 points higher on the state’s communications arts test and 3.55 points higher on the mathematics” test “than students not enrolled in those classes” (¶ 3). Another study of the eMINTS initiative (Apple Computer, Inc., 2002) reported that fourth-grade students taking the Missouri Assessment Program (MAP) tests “consistently scored 10 to 13 points higher on Missouri Assessment Program (MAP) tests than students” in non-eMINTS programs (p. 2). Title I students and students with disabilities enrolled in eMINTS classes scored 10.1 points higher on the tests than their non-eMINTS counterparts. The EdTech Action Network article (n.d.) also reported significantly higher
standardized mathematics test scores for students in middle and high school in Georgia who use an “interactive software system to learn pre-algebra and algebra” than students in traditional classrooms (¶ 5). Five states now use the eMINTS system.

Creating an Atmosphere for Change

Classrooms must change if educators are going to prepare students for careers of the future. Educators can no longer use 1950s instructional techniques to prepare students for what they will be asked to do as members of the job force. When former U.S. Secretary of Education Richard Riley spoke at the 1999 Kentucky Education Technology Conference (KETC), he addressed the growing demand for workers with higher level technology skills.

By 2005, 60% of the new jobs will require a level of technology fluency currently held by only 20% of our current workers. The top ten jobs that will exist in the years 2010 do not exist today. We are preparing our students for jobs that don’t exist using technologies that haven’t yet been invented, to solve problems that we haven’t even considered yet. (as cited in Fryer, 2001, slide 8)

Almost 90 years ago Dewey called for “reflective attention,” what is now termed the “constructivist classroom,” to engage children.

The point is not to dwell with wearisome iteration upon the familiar and under the guise of object-lessons to keep the senses directed at material which they have already made acquaintance with, but to enliven and illumine the
ordinary, commonplace, and homely by using it to build up and appreciate situations previously unrealized and alien. (Dewey, as cited in Ward & Throop, 2001, The Development of Attention section, ¶ 12)

Dewey, in 1915, called upon educators to help their students construct from new situations instead of continuing to drill and practice. He believed in students being responsible for their own learning.

The child is simply absorbed in what he is doing; the occupation in which he is engaged lays complete hold upon him. He gives himself without reserve. Hence, while there is much energy spent, there is no conscious effort; while the child is intent to the point of engrossment, there is no conscious intention….

With growing power the child can conceive of the end as something to be found out, discovered; and can control his acts and images so as to help in the inquire and solution. (Dewey, as cited in Ward & Throop, 2001, The Development of Attention section, ¶¶ 15, 18)

Dewey’s philosophy of the engaged learner was a pillar of the Technology Connections initiative. Engaged learners are defined as “responsible for their own learning, energized by learning, strategic, and collaborative” (Jones, Valdez, Nowakowski, & Rasmussen, 1995, Introduction section). “Technology works in a school not because test scores increase, but because technology empowers new solutions” through systemic change (Jones et al., New Times Demand New Ways of Learning section, ¶ 7). “For schools to change, educators must do things very
differently. In the process, they must rediscover the very substance of excellent teaching in a new world” (Spielvogel, 2001, p. 1).

As more was written about computers in classrooms and the need for networking increased, schools looked to industry and the federal government to provide extra dollars for technology infrastructure and model programs (Cisco Networking Academy, 2002, Funding for Technology section). School systems purchased computers that sat in classrooms and were used seldom if ever. “In the rush to equip every classroom with computers, someone forgot the fundamental fact that teachers must be trained to use them before they can teach their charges” (National Center for Policy Analysis [NCPA], 2001, ¶ 1).

In a study that examined the difference between learning from computers, through CAI, ILS, eTechnology Connections., and learning with computers, Ringstaff and Kelley (2002) reported that learning “from” computers put computers in the role of tutor. Studies on the impact of using computers as tutors provide convincing evidence that these tutors are effective in presenting real-word simulations and other techniques that can be effective in teaching basic skills. Evaluations show that students who learn from computers outperform students in traditional classes, are retained in mathematics classes in greater numbers, and have higher attendance than students in traditional classes (Ringstaff & Kelley, 2002).

In his dissertation, David C. Baker cites three ways of implementing technology into the classroom. Wake County employed the most ambitious strategy, which was to implementation of technology “integration within and across learners.”
This strategy involves student collaboration and creation of an end product. Using this strategy, classrooms are student-centered and teachers increasingly take on the role of a facilitator of learning” (Baker, 2003, p. 15).

Learning with computers creates an environment in which students and teachers control the curriculum and instruction. Classrooms that are technology rich, have the right teacher, and become student centered, such as Technology Connections classrooms. Students spend less time doing mathematics calculations and more time creating strategies for complex problem solving. Students develop critical, higher order thinking skills and have a deep understanding of subject matter (Ringstaff & Kelley, 2002).

Some large corporations understand fundamentally that just supplying computer technology to schools and districts is not a solution. In IBM’s Reinventing Education program, corporate leaders planned partnerships of 3 to 5 years, with the goal of sustaining the momentum of systemic change after the grants ended (Emerick, 2000, Authentic Learning with Technology section). The partnerships enabled the schools to implement programs to serve as best practice models for other systems, to show positive and significant improvement in student achievement, to develop ongoing programs for teacher professional development, and to develop new technologies to improve teaching and learning. The program focused on “core educational processes that could be critical levers in school change, such as student assessment practices, continuous teacher improvement models, and teacher instructional planning” (p. 3). Many teacher improvement models (and staff
such as IBM’s Reinventing Education program and Wake County’s Technology Connections initiative, view authentic learning as “an approach to teaching and learning that has students working on realistic problems, to gain new knowledge and skills in context, rather than listening to lectures and memorizing vast amounts of information to be reproduced on tests” (Emerick, 2000, Authentic Learning with Technology section, ¶ 1).

In 1998, the AOL Foundation established an Interactive Education Initiative (IEI) to fund 54 educational technology projects across the country. These small grants were given directly to the schools and allowed them to use the money to maximize their visions of technology integration (Henriquez, Chang, & Thompson, 1999). The long-term goals of the initiative were

1. to maximize the benefits of interactive technology in K–12 learning environments,
2. to develop models and/or identify best practices that can be replicated by other schools and communities, and
3. to produce an expanding network of educators and others dedicated to promoting effective educational use of interactive technology. (p. 3)

The Center for Children and Technology evaluated the IEI project and found it successful. The project’s success was not attributable to demographic or technological factors but appeared to stem from characteristics, such as “leadership and vision, innovative educational designs, and reflective use of technology” (p. 38). The evaluators recommended the following:
1. Make small grants to individuals within a school and use the grants to change teachers’ circumstances.

2. Target teachers with technological competence and curricular innovation. First-year teachers may have technological competence, but most of the time they need support as educators before they can become curriculum innovators.

3. Develop clear criteria for what the foundation considers “innovative projects.”

4. Create a different model for grant dissemination other than the Intranet. Face-to-face visits with successful grant recipients would be more beneficial (Henriquez et al., 1999).

After the project’s second year, the evaluators added other reasons for the project’s success. First, in successful classrooms, teachers allowed students to express their intellectual curiosity and have a sense of autonomy. Second, teachers acknowledged that many of their students understood the technology better than they did, and they were comfortable allowing the students to use hardware constructively. Third, students taught other students and their teachers. Finally, the technology, rather than being used as an add-on, was seamlessly incorporated into the curriculum.

As an outgrowth of this pedagogical approach, many of the projects are engaged in the process of ongoing self-evaluation. This includes using students’ assessments to gauge what the targeted population is getting from
their participation as well as attending to changes that project leadership and teachers/instructors can make to improve the project. (Pasnik & Gersick, 2000, p. 11)

As schools and school systems go through the process of self-assessment regarding technology use in the classroom, the realization begins to unfold that how the computers are being used is more important than the number of computers in the classroom. “Vicki Rafel, a vice president of the national PTA, says many schools have the equipment, but very frequently ‘it's either underused or not used at all’” (NCPA, 2001, ¶ 3). For students to use computers merely for drill and kill or for teachers to use the computers for merely administrative functions is a waste of resources.

Value of Higher Order Thinking Skills

Since 1991, the Secretary’s Commission on Achieving Necessary Skills (SCANS) has set forth recommendations on what skills workers will need and what schools must do to prepare students for the workplace. Lawrence K. Jones cited the SCANS report in his book Job Skills for the 21st Century, written for middle and high school students, as he discussed the need for students to learn creative thinking skills. Technology-rich environments help students to learn not only the basic skills but also higher order thinking skills. “Years of brain research reveal that middle level age students learn best when they are actively engaged with content” (Quinn & Valentine, 2002, Summary of the Research section, ¶ 2). Higher order thinking skills should be taught in all curricular areas but most especially in technology education
courses because occupations are becoming more reliant on cognitive capacities, and vocational education provides a “real-world context for cognitive development” (as cited in Kerka, 1992, Why Vocational Education section, ¶ 2). The workplace requires flexibility and adaptability, and a technology-rich vocational education builds students’ ability to construct meaning from their experiences. In this environment, teachers are encouraged to assess students rather than test them.

Technology education students, including those in Technology Connections classrooms, use “creativity, problem solving, and logic” as they learn to work cooperatively (Kerka, 1992, How Are These Skills Developed in Vocational Education section, ¶ 1). Teachers in these classrooms are encouraged to develop lesson plans that include higher order components that, in turn, develop higher order thinking skills in their students. Planning cannot be hit or miss; it must be precise. “Curriculum planning must involve careful consideration of the goals of problem-solving instruction, how an activity fits in relation to the goals, and the teaching style that would best facilitate goal attainment” (DeLuca, 1991, ¶ 2). Teaching styles and instructional practices that facilitate “learning by doing, learning in the context of something interesting and challenging, learning by imitating experts, and getting immediate feedback on performance” are all aspects of Technology Connections classrooms and are useful instructional practices in education suggested by the National School Board Association (2002, ¶ 3).

A study of adult learners at Pace University in New York focused on content delivery that integrated instructional technology in the classroom (Coppola &
Thomas, 2002). The researchers also examined teamwork and student-centered groups. The California Critical Thinking Skills Test was administered to the control group (traditional teaching methods) and to the experimental group at the conclusion of a 14-week semester. Results showed that technology integration had a positive effect on critical thinking skills for the experimental group but not for the control group. The experimental group also expressed high satisfaction in teacher skills, room characteristics, and student interactions.

Younger students also glean opportunities to expand learning by participating in groups. Russian psychologist Vygotsky wrote about the social basis for student learning. “Social contexts give students the opportunity to successfully carry out more complex skills than they could execute alone” (Roschelle et al., 2000, p. 80). Roschelle et al. argued that computer technology supports learning through frequent interaction and feedback in three ways. First, computer tools themselves encourage rapid interaction and feedback. Second, computers engage students for extended periods, allowing the teacher to work with other groups of students. Third, the teacher can use computer programs to analyze student performance and to gain timely and targeted feedback and suggestions for remediation. One experimental group realized a 15% increase in scores over the control group when computer interaction and feedback was integrated into classroom activities and instruction. The researcher included a list of major studies that suggested computer-based programs increase students’ reasoning skills and independent thinking.
A national study conducted by the Center for Applied Special Technologies showed that students who were allowed to use online access to research an interdisciplinary unit on civil rights scored better on the nine pre-established learning measures than did the control group without online access (Follansbee, as cited in Quinn & Valentine, 2002). Five of the higher scores were found statistically significant, including students’ ability to “present their work, state a civil rights issue, present a full picture . . . , bring together different points of view, and produce a complete project” (Quinn & Valentine, 2002, Summary of the Research section, ¶ 6).

Summary of Related Literature

Studies of educational technology have focused on the effects of different types of computer technology and their correlation to higher test scores on standardized paper-and-pencil tests. What mattered in the studies reviewed was not so much the technology, but what the teachers and students did with the technology. Of the studies, all reported positive gains on standardized and national tests, yet many also indicated that technology was less effective if the learning objectives were not specific.

Most literature cited the positive effects of technology and student-centered learning on students’ attitudes toward learning, but studies of the effects of technology in the classroom showed mixed results. Classroom teachers with varying expertise chose to use the computers in different ways. When teachers used the
computers to teach higher order thinking skills and gave the students the chance to actively participate in the learning process, the students benefited.

The Technology Connections philosophy taps into many of the design features of the studies cited. Technology Connections offers a constructivist approach toward learning that incorporates an information- and experience-rich classroom model. The design of the performance section of the North Carolina Tests of Computer Skills incorporates real-life computer proficiencies that students will need to be successful as they go out into the workforce, or what educators feel they will need at this point. The effects of computers in the classroom have been measured in various academic settings though CAI and the seamless integration of technology into the curriculum. What would help is to learn how well suited the Technology Connections philosophy is to the success rate of students passing the performance section of the North Carolina Tests of Computer Skills in grade 8, which was the focus of this study.
The purpose of this study was to determine the effects of the Technology Connections initiative on the results of eighth-grade state tests, including North Carolina End-of-Grade Tests in reading and mathematics and the Multiple-Choice and Performance North Carolina Tests of Computer Skills. A review of the literature indicated that, while the link between instructional technologies, especially CIA and gains in standardized test scores, is theoretically sound, there is less evidence to support the theory that the seamless integration of instructional technology into the curriculum influences gains in standardized test scores. This chapter describes the study’s research design, population, sample, instrumentation, data collection procedures, and statistical analyses.

Research Design

To test the effects of the Technology Connections initiative, the researcher used what Cook and Campbell (1979) described as nonequivalent group design with pre and posttests, meaning that End-of-Grade tests on the North Carolina Standard Course of Study were given to the treatment group and the control group at the end of grades 7 and 8. Students had to have been in membership at least 140 days in grade 8 to be included in the reading or mathematics data. The quasi-experimental design did not include random assignment of students from which the treatment-caused change was inferred (Cook & Campbell, p. 6). Because the Wake County Public School System ascribes to keeping all schools healthy, meaning that all
schools had approximately the same number of free/reduced population students (40% plus/minus 15% per Wake County’s Health Schools initiative), the researcher assumed that the standard deviation of both populations was the same. Therefore, the researcher used pooled 2-tailed $t$ tests. The End-of-Grade populations were not independent because individual students’ scores were not used, only the means of the pretest and post test scores. Students in non-Technology Connections schools were the population for the control group, and all eighth-grade students in Technology Connections leader schools were in the population for the experimental group. Both groups were administered a pretest in seventh grade, which was the North Carolina End-of-Grade (EOG) tests in reading and mathematics in 1999–2000 and posttests 1 year later in the eighth grade, which were the North Carolina End-of-Grade Tests in reading and mathematics. Students who were retained in grade 8 were not included in the sample because their pretest score (grade 7 score) would have been 2 years old and the students would have been exposed to the eighth-grade End-of-Grade tests in their previous year (grade 8). The model for these tests, therefore, was:

$$0_1X0_2,$$

where $X$ was the treatment for the Technology Connections leader schools, and

$$0_10_2,$$

where there was no treatment for the nonTechnology Connections school.

The North Carolina Tests of Computer Skills is given at the beginning of grade 8, so there was no pretest score. Because all students in both the Technology Connections leader schools and the nontechnology schools received one of the
treatments, the model showed only the additional treatment given to the Technology Connections leader schools. The two-tailed $t$ tests for the computer skills tests were dependent groups of students rather than comparisons of students’ pre-and posttest scores. Additionally, there was no stipulation that students be in membership at least 140 days. The model for these tests, therefore, was:

$$X0,$$
where $X$ was the treatment for the Technology Connections leader schools, and

$$0,$$
where there was no treatment for the nonTechnology Connections schools.

Nonequivalent group design was used because the researcher compared two groups; that is, the control group received a treatment used in all schools (including Technology Connections leader schools) in preparing for the North Carolina Tests of Computer Skills instead of no treatment and the Technology Connections leader schools received two treatments (Cook & Campbell, 1979, p. 6). The independent variable in the present study was the treatment used in the 7 Technology Connections leader schools after summer 2000. Students in these schools were taught using techniques developed from brain research and in ways that enabled students to connect knowledge from the North Carolina Standard Course of Study to real life. Students used a bank of computers and worked together to solve real-life problems. The teacher served as coach and facilitator of learning. The dependent variables were the development scale scores on the reading and mathematics End-of-Grade tests and the Multiple-Choice and Performance tests of the North Carolina Tests of Computer Skills.
Scale scores for the North Carolina Skills Tests of Computer Skills, multiple-choice and performance, were obtained from the Wake County Public Schools Evaluation and Research Department and from the Wake County Public School annual masterbuild used to measure ABC growth and Adequate Yearly Progress (AYP) at the school level. The masterbuild sent to the NCDPI did not report scale scores for these tests, only whether a student met proficiency on one or both sections of the test.

Many factors can threaten internal validity, but the main threats are “history, maturation, and testing” (Gall, Gall, & Borg, 2003, p. 368). Wake County’s Healthy Schools’ philosophy helped control history as a threat to internal validity by ensuring that all schools basically had the same characteristics. The control group and experimental school groups were therefore similar in all aspects, so, except for the teaching philosophy and computers in the classrooms of the experimental group schools, history as a threat was negligible. Maturation (of students) as a threat to internal validity is a natural part of the educational process. In the population of eighth-grade students, all were exposed to the same North Carolina Standard Course of Study and all students were, in theory, supposed to make 1 year of educational progress for every 180 days in school. With the exception of students who were retained, maturation rates should have been approximately the same for students in both the control and experimental groups. Students in the control group had little or no exposure to the Technology Connections philosophy and had only computer labs at their schools. Testing as a threat to internal validity was controlled for in the type of tests that were used for the pretest and the posttest and the timing
of the tests. The North Carolina End-of-Grade tests of reading and mathematics are administered, per State Board of Education policy, during the last 3 weeks of the school year. Students in both the experimental and control group must have pretests score (seventh-grade mathematics and/or reading score) to compare to posttest scores. The North Carolina Tests of Computer Skills uses scale scores, but there was no pretest for this test. The researcher compared North Carolina Tests of Computer Skills scale scores of Technology Connections leader schools to those of non-Technology Connections schools.

Threats to external validity are more difficult to control. Even if an experiment has good internal validity, “generalizability of its finding to real classroom conditions—that is, its external validity—(can be) weak (Gall et al., 2003, p. 374). Could the Technology Connections philosophy be applied to students and settings beyond those that were in the experimental group? Bracht and Glass warned that the only population to which we can generalize is to the population from which the sample was drawn—the “experimentally accessible population” (Gall et al., p. 375). Wake County’s goal of keeping all schools healthy meant that all schools had basically the same characteristics, so one should be able to generalize the research findings to all Wake County School students.

The teacher effectiveness variable was difficult to control. While all teachers in Technology Connections leader schools were exposed to the Technology Connections philosophy and had computers in their classrooms, it was not known whether all teachers used the model in their classrooms. Likewise, while the Technology Connections model did include five computers in every classroom, all
schools in the Technology Connections leader schools did not have five computers in all of their classrooms because of unforeseen budget constraints and wiring issues.

Because this research was completed several years after the Technology Connections initiative and the test data had been analyzed, there was no Hawthorne Effect, because those in the sample were unaware of their participation. Special attention was given to teachers in the Technology Connections schools, but only because of their role in the Technology Connections initiative not because of research. There was, also, no John Henry effect for the same reason. Schools by nature compete with one another because of school pride and the desire of teachers to be awarded incentives (bonuses) for their school achieving growth in reading and mathematics scores. The control group schools might have wished to be part of the Technology Connections initiative and strived to improve their technological skills but not through “compensatory rivalry” (Gall et al., p. 373) because they did not know at the time that they were part of a control group.

Population and Sample

The population of eighth-grade students in the Wake County Public School System 2000–2001 school year was 7,760. Only students with a pretest (grade 7) and posttest (grade 8) score for reading and/or mathematics who were in Wake County Public Schools for at least 140 days and who had not been retained in the eighth grade were in the population for the reading and mathematics test results. Students had to be in membership at least 140 days because that is the number of days a student must be in membership to be included for the North Carolina
Accountability, Basics, and Control (ABC) model and for No Child Left Behind Adequate Yearly Progress. The standard of 140 days in membership does not apply to those assessed on the Tests of Computer Skills, so the only students not in the population were students who had been retained in eighth grade. For each test, the sample size for the experimental and control group varied because test results for each were reported independently. The whole group was the entire population that met the aforementioned qualifications, and each subgroup was pulled from that population.

For this study, the researcher wanted to detect differences between each control and experimental subgroup populations with a probability of committing a Type 1 error at the .05 (alpha level). If \( p < .05 \) for any of the subgroups, the researcher would reject the null hypotheses: (a) there were no differences in students’ posttest scale scores in Technology Connections schools and non-Technology Connections schools on the reading End-of-Grade test for those subgroups; (b) there were no differences in students’ posttest scale scores in Technology Connections schools and non-Technology Connections schools on the mathematics End-of-Grade test for those subgroups; (c) there were no differences in students passing rates in Technology Connections schools and nontechnology connections schools on the Tests of Computer Skills–Multiple Choice for those subgroups, (d) there were no differences in students passing rates between Technology Connections schools and nontechnology connections schools on the Tests of Computer Skills–Performance for those subgroups. Subgroup numbers for each study are reported in Table 2.
Table 2

*N Counts of Subgroups for End-of-Grade and Computer Skills Tests*

<table>
<thead>
<tr>
<th>Subgroups</th>
<th>Population</th>
<th>Non-Technology Connections (Control)</th>
<th>Technology Connections (Experimental)</th>
</tr>
</thead>
<tbody>
<tr>
<td>End-of-Grade in reading</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American Indian</td>
<td>17</td>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td>Asian</td>
<td>239</td>
<td>152</td>
<td>87</td>
</tr>
<tr>
<td>Black</td>
<td>1507</td>
<td>1080</td>
<td>427</td>
</tr>
<tr>
<td>Economically disadvantaged</td>
<td>967</td>
<td>671</td>
<td>296</td>
</tr>
<tr>
<td>Hispanic</td>
<td>198</td>
<td>130</td>
<td>68</td>
</tr>
<tr>
<td>Limited English proficient</td>
<td>69</td>
<td>38</td>
<td>31</td>
</tr>
<tr>
<td>Multiracial</td>
<td>57</td>
<td>41</td>
<td>16</td>
</tr>
<tr>
<td>Students with disabilities</td>
<td>807</td>
<td>527</td>
<td>280</td>
</tr>
<tr>
<td>White</td>
<td>4299</td>
<td>2750</td>
<td>1549</td>
</tr>
<tr>
<td>Whole group</td>
<td>6317</td>
<td>4166</td>
<td>2151</td>
</tr>
<tr>
<td>End-of-Grade in mathematics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American Indian</td>
<td>17</td>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td>Asian</td>
<td>239</td>
<td>152</td>
<td>87</td>
</tr>
<tr>
<td>Black</td>
<td>1509</td>
<td>1077</td>
<td>432</td>
</tr>
<tr>
<td>Economically disadvantaged</td>
<td>966</td>
<td>668</td>
<td>298</td>
</tr>
<tr>
<td>Hispanic</td>
<td>197</td>
<td>130</td>
<td>67</td>
</tr>
<tr>
<td>Limited English proficient</td>
<td>69</td>
<td>38</td>
<td>31</td>
</tr>
<tr>
<td>Multiracial</td>
<td>57</td>
<td>41</td>
<td>16</td>
</tr>
<tr>
<td>Students with disabilities</td>
<td>799</td>
<td>521</td>
<td>278</td>
</tr>
<tr>
<td>White</td>
<td>4290</td>
<td>2745</td>
<td>1545</td>
</tr>
<tr>
<td>Whole group</td>
<td>6309</td>
<td>4158</td>
<td>2151</td>
</tr>
<tr>
<td>Tests of Computer Skills – Multiple Choice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American Indian</td>
<td>19</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>Asian</td>
<td>260</td>
<td>164</td>
<td>96</td>
</tr>
<tr>
<td>Black</td>
<td>1775</td>
<td>1268</td>
<td>507</td>
</tr>
<tr>
<td>Economically disadvantaged</td>
<td>1186</td>
<td>830</td>
<td>356</td>
</tr>
<tr>
<td>Hispanic</td>
<td>257</td>
<td>165</td>
<td>82</td>
</tr>
<tr>
<td>Limited English proficient</td>
<td>104</td>
<td>61</td>
<td>43</td>
</tr>
<tr>
<td>Multiracial</td>
<td>71</td>
<td>50</td>
<td>21</td>
</tr>
<tr>
<td>Students with disabilities</td>
<td>990</td>
<td>662</td>
<td>328</td>
</tr>
<tr>
<td>White</td>
<td>4565</td>
<td>2917</td>
<td>1648</td>
</tr>
<tr>
<td>Whole group</td>
<td>6937</td>
<td>4579</td>
<td>2358</td>
</tr>
</tbody>
</table>

*(table continues)*
(table continued)

<table>
<thead>
<tr>
<th>Subgroups</th>
<th>Population</th>
<th>Non- Technology Connections (Control)</th>
<th>Technology Connections (Experimental)</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Indian</td>
<td>18</td>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td>Asian</td>
<td>257</td>
<td>162</td>
<td>95</td>
</tr>
<tr>
<td>Black</td>
<td>1756</td>
<td>1256</td>
<td>500</td>
</tr>
<tr>
<td>Economically disadvantaged</td>
<td>1176</td>
<td>817</td>
<td>359</td>
</tr>
<tr>
<td>Hispanic</td>
<td>245</td>
<td>163</td>
<td>82</td>
</tr>
<tr>
<td>Limited English proficient</td>
<td>104</td>
<td>61</td>
<td>43</td>
</tr>
<tr>
<td>Multiracial</td>
<td>71</td>
<td>50</td>
<td>21</td>
</tr>
<tr>
<td>Students with disabilities</td>
<td>969</td>
<td>643</td>
<td>326</td>
</tr>
<tr>
<td>White</td>
<td>4563</td>
<td>2899</td>
<td>1644</td>
</tr>
<tr>
<td>Whole group</td>
<td>6910</td>
<td>4545</td>
<td>2365</td>
</tr>
</tbody>
</table>

Note. The American Indian and Multiracial subgroups are small (N < 40) and would not be reported for ABC or AYP purposes for individual schools, but would be reported for the system because N > 40 for all grades tested for these subgroups.

Instrumentation

North Carolina State Board of Education policy states that the North Carolina Tests of Computer Skills must be offered to every student at least one time during their eighth-grade year, with alternate forms of the tests offered in the fall and the spring semesters of the school year. Students who do not score at the proficient level on both the multiple-choice and the performance tests are given a second opportunity to score proficient on the non-proficient part(s) of the tests. Schools may administer the tests to students in grades 9 through 12 in both the fall and spring semesters until proficiency is reached. Seniors who have not yet scored at the proficient level are administered the assessment one additional time in the last month of the senior year to determine whether the student will graduate with a diploma.
Between 1999–2000 and 2000–2001 school years, the North Carolina Tests of Computer Skills changed to reflect a new computer skills curriculum. The old Multiple-Choice test had two forms, each of which had 70 questions and covered a range of topics from the computer skills curriculum, including keyboarding, word processing, telecomputing, spreadsheet, societal issues, ethics, computer terms, operation and care, and independent use of curriculum software (Public Schools of North Carolina, 2002a). The old Performance test had six forms with four sections: keyboarding techniques, word processing and editing, database use and spreadsheet use. The old tests were administered to students who entered grade 8 from 1996–1997 through 1999–2000. The new tests, developed for the new curriculum, are administered to students who entered grade 8 from 2000–2001 and beyond. The new Multiple-Choice test has three forms, and the new Performance test has four forms. Each Multiple-Choice test consists of 70 questions based on societal issues, databases, spreadsheets, and keyboard utilization (word processing and desktop publishing, multimedia presentation, and telecommunications). The new Performance test requires students to use software and a computer to solve problems. The keyboarding section tests editing and formatting skills. Databases and spreadsheets require knowledge of sorting, querying, and database development (Public Schools of North Carolina, 2002b).

Because different forms of each test had to equate in order to determine a passing score, raw scores from each form of the tests were converted into developmental scale scores. Multiple-choice tests scanned by the Local Education Agency (LEA), or local school system, which uses scanning software programs
developed by the state. The scanning software (WinScan) scores incorrect responses as 0 and each correct response as 1. The software then tabulates the responses to produce a raw score, which it then converts (using the mean and the standard deviation) into a developmental scale score. For the Multiple-Choice test of computer skills, the range of the development scale score is 20–80 (Public Schools of North Carolina, 2002a, Multiple-Choice Test Question section: Scoring). The Performance tests are shipped to a contractor for hand scoring by at least two scorers to ensure the accuracy of the scores. Rubrics, or raw score scales, vary question by question according to each item’s difficulty. Each section’s raw score points are added together and converted to a scale score for the section. The scale scores for each of the four sections (keyboarding techniques, word processing and editing, database use and spreadsheet use) are then added together to create an overall weighted raw score for the Performance test (Performance Sample Test Questions section: Scoring, ¶ 2). This raw score is converted to the final developmental scale score on a range of scores from 18–92. The scoring rubrics were created to “accurately measure a student’s ability to successfully complete the requirements of the individual tasks without compromising the validity of the test questions” (Performance Sample Test Questions section: Scoring, ¶ 2).

Developmental scale scores for the North Carolina Tests of Computer Skills are used to compare all forms of the Multiple-Choice test or forms of the Performance test. Scale scores serve to “minimize differences between various forms of a test” (Public Schools of North Carolina, 1995, Scale Scores section, ¶ 9). After equating the differences between the raw scores of individuals of equal ability
who take various forms of the tests and adjusting for the standard error of measurement, the differences can be further minimized by converting raw scores into scale scores (Public Schools of North Carolina, 1995). “Equal ability” of individuals is determined by the test administrators in the school who must rate each student’s expected performance on the tests, giving them a score of I–IV, with IV being the students with the best knowledge of the skills measured on the test.

The old North Carolina Tests of Computer Skills and the more recent test use the same scale score for the proficient level. However, the year a student enters grade 8 for the first time determines which curriculum and therefore which test, the old or the new one, the student will be administered. That is, a student will continue to take tests that measures the North Carolina Standard Course of Study taught when he or she entered eighth grade until proficiency is demonstrated.

Developmental scale scores are used not only to determine proficiency on the North Carolina Tests of Computer Skills but also on other tests developed by the North Carolina Department of Public Instruction, including end-of-grade and end-of-course tests and are used to measure a student’s academic growth from year to year. Developmental scale scores for the seventh and eighth-grade tests of reading and mathematics for 1999–2000, mathematics for 2000–2001, and the North Carolina Tests of Computer Skills are listed in Table 3.
### Table 3

**End-of-Grade and North Carolina Tests of Computer Skills Scale Scores**

<table>
<thead>
<tr>
<th>Subject / Year</th>
<th>Grade</th>
<th>Developmental Scale Score</th>
<th>Proficiency Scale Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>End-of-Grade 1999–2000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading</td>
<td>7</td>
<td>126–183</td>
<td>≥ 155</td>
</tr>
<tr>
<td>Mathematics</td>
<td>7</td>
<td>134–203</td>
<td>≥ 161</td>
</tr>
<tr>
<td>Reading</td>
<td>8</td>
<td>132–187</td>
<td>≥ 156</td>
</tr>
<tr>
<td>Mathematics</td>
<td>8</td>
<td>137–208</td>
<td>≥ 165</td>
</tr>
<tr>
<td>Tests of Computer Skills (beginning grade 8)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiple-Choice</td>
<td>≥ 8</td>
<td></td>
<td>≥ 47</td>
</tr>
<tr>
<td>Performance</td>
<td>≥ 8</td>
<td></td>
<td>≥ 49</td>
</tr>
</tbody>
</table>


In 2000–2001, developmental scale scores for mathematics were changed to 200-level ranges due to changes in tests administered beginning in 2001. The North Carolina Department of Public Instruction (NCDPI) began to report all mathematics tests in the 200-level range, but in order to show growth from one school year to the next, 200-level scores are converted to 100-level scores. In this study, the researcher converted the 200-level scores to 100-level scores using the conversion formula used by the North Carolina Department of Public Instruction.

Experimental classes were taught using the Technology Connections philosophy, which was to “advance the teaching and learning process,” cognitive learning theory, and computer hardware consisting of six computers in each classroom so that technology could be better integrated into the core curriculum.
areas. Students in Technology Connections leader schools also had access to computer labs and were taught the same lab curriculum as non-Technology Connections schools. All schools are listed in Table 4.

Table 4

*Wake County Public Schools System Middle Schools, 2000–2001*

<table>
<thead>
<tr>
<th>School</th>
<th>Code</th>
<th>(N = 8\text{th-grade (not retained)})</th>
<th>(N = 8\text{th-grade &lt; 140 days})</th>
<th>(N = 8\text{th grade \geq 140 days})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apex *</td>
<td>312</td>
<td>346</td>
<td>7</td>
<td>339</td>
</tr>
<tr>
<td>Alternative School</td>
<td>324</td>
<td>13</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Carnage</td>
<td>356</td>
<td>353</td>
<td>17</td>
<td>336</td>
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<td>North Garner *</td>
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<td>West Cary</td>
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<td>West Millbrook</td>
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<td>Zebulon Middle</td>
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<td>Total</td>
<td>LEA</td>
<td>7118</td>
<td>387</td>
<td>6574</td>
</tr>
</tbody>
</table>

*Note:* * denotes Technology Connections school. Data from the Wake County Public Schools’ Masterbuild, 2000-2001.
Procedures

Data for this research were gathered from the Wake County Public School system after the Multiple-Choice and Performance tests of the North Carolina Tests of Computer Skills and North Carolina End-of-Grade Tests in reading and mathematics had been completed and the data were entered into several databases. One database, the masterbuild, is sent annually to the North Carolina Department of Public Instruction for reporting school accountability at the student level. The second database, maintained at the Wake County Public Schools’ Evaluation and Research Department, stores scale scores for all tests, including the test scores for the Multiple-Choice and Performance tests of the North Carolina Tests of Computer Skills.

Both the experimental and control group schools had technology (computer) labs in which all students were scheduled to participate in preparation for the North Carolina Tests of Computer Skills. Databases, word processing, and spreadsheet modules were developed by the North Carolina Department of Public Instruction and used at all schools to use as review for students and to prepare them for the tests. Students were scheduled to have 1 hour daily in the computer lab for 3 days, with time scheduled through social studies or science classes. If students were absent on scheduled days, their time was not usually rescheduled because of the teacher’s desire get on with teaching the North Carolina Standard Course of Study and not have those students absent from their classes.

In both the experimental and control groups, the lab lessons could be incorporated into the classroom activities, but this was done consistently only in the
Technology Connections leader schools because of the number of computers (five or six) in the classrooms and the philosophy to integrate their use into the curriculum. Students were given access to computer applications, such as Microsoft Works, and to reading and mathematics programs in the Technology Connections classrooms. Teachers coached and helped students make connections between what they learned in the computer lab as they rotated through the classroom bank of networked computers. They were encouraged to create their own spreadsheets and databases and to work with one another as they incorporated filtering, queries, cutting and pasting, and spreadsheets into their North Carolina Standard Course of Study lessons.

In non-Technology Connections schools, some schools had one computer classroom, if any computers. Classrooms were also given access to Microsoft Works and to reading and mathematics programs, but there was no strategy for how to incorporate the software or to make it relevant to student learning. The North Carolina Standard Course of Study was taught using more traditional middle-school strategies: lecture, class and small group discussion, demonstration, worksheets, and question and answer.

**Data Collection**

To assure confidentiality of the students, student names and other student identifiers were removed from the masterbuild information and from a database that reported the scale scores (and therefore passing rates) on the Multiple-Choice and Performance tests of the North Carolina Tests of Computer Skills. The two
databases were combined through a relationship query in Access by means of a unique numerical identifier for each student.

In 2000-01, a change in the mathematics curriculum precipitated a change in the mathematics tests, with new scale scores at a 200-level as compared to the 100-level scores previously used. To run the statistics for comparing the Grade 7 End-of-Grade mathematics scale scores to the Grade 8 End-of-Grade mathematics scale scores, the 200-level scale scores had to be converted back to the 100-level used the previous year when the students were in the seventh grade. A chart of the equivalent 100-level scale scores was furnished by the North Carolina Department of Public Instruction through the Wake County Public School System. The combined database was then used to query students into Technology Connections and nonTechnology Connections schools by means of their school number into the 10 No Child Left Behind subgroups.

All students were eventually included in a subgroup because one of the subgroups was the \( n \) of the students in membership. Students with Disabilities (SWD) included students with an Individual Education Plan (IEP) or a student with a Section 504 Plan, any of whom may or may not receive accommodations on an assessment per their plans. *Economically disadvantaged* in North Carolina is defined as students who receive free or reduced breakfast and lunch.

For End-of-Grade tests in reading and mathematics, students who did not have both a pre- and post test were queried out of the sample, as were students who had not been in membership in the Wake County Public School System for at least 140 days. Students who had repeated grade 8 were also eliminated.
For the Multiple-Choice and Performance tests of the North Carolina Tests of Computer Skills, students who had been retained in grade 8 were queried out of the study as were students who did not have a score. According to the North Carolina State Board of Education Policy, all students must be tested. However, limited English proficient students who had been in United States schools for less than two years can be waived from the test during that time if the parents understand that the test is a diploma requirement. Another group of students that might not have a score would be students with a most significant cognitive disability that would receive a certificate and not a diploma.

**Data Analysis**

End-of-Grade tests are administered in every LEA throughout the state in grades 3–8 during the last 3 weeks of the LEA’s school year. Raw data for these studies consisted of the mathematics and reading scale scores from the Wake County Public School System’s 1999-2000 seventh-grade End-of-Grade Tests, which served as the pretest, and 2000-2001 eighth-grade End-of-Grade Tests, which were the post test scores. Students had to have both pretest and post test scores, could not have repeated grade 8, and had to be in membership in the school system for at least 140 days during 2000-01 for scores to be used.

Raw data for the Multiple-Choice and Performance tests of the North Carolina Tests of Computer Skills consisted of scale scores for each test. As there were no pretest scores for these tests, the only prerequisite was that the student could not have repeated grade 8. The reading and mathematics study prerequisite of
membership of at least 140 days was not used because the computer skills
tests are not included in the No Child Left Behind AYP targets.

All data in the Access database files were queried to meet the parameters of
each study and queried again to separate Technology Connections (experimental)
student scores from the non- Technology Connections (control) group scores for
each assessment. The data were analyzed using Statistical Analysis Software
(SAS).

To conduct significance tests of each hypothesis \( (p < .05) \), appropriate null hypotheses were developed for the research questions. Pooled variance \( t \) tests were used because the populations were large and therefore approximated a normal distribution. There was insufficient reason to believe the variances were different (Levine, Stephan, & Krehbiel, 2002, p. 4). The two-tailed \( t \) tests were calculated on the hypotheses that students in each subgroup exposed to Technology Connections strategies as a seamless part of their curriculum would score differently than students who were in the control group.

Summary of Methodology

The population for these studies consisted of eighth-grade students in all schools in the Wake County Public School System in Wake County, North Carolina. As this study was conducted after all testing had been concluded, there was no need for random assignment of students into the experimental or control groups and there was no possibility of the Hawthorne Effect. The researcher used Cook and Campbell’s (1979) quasi-experimental design, meaning that students in the
The experimental group were students in the Technology Connections leader schools who met the criteria of each study and students in the control group were the all eighth-grade students in non-Technology Connections schools who met the criteria.

The population for this study consisted of all students in eighth grade in the Wake County Public Schools System who were administered any of following tests:

1. The North Carolina End of Grade Test in reading,
2. The North Carolina End of Grade Test in mathematics,
3. The North Carolina Tests of Computer Skills–Multiple Choice,

The End-of-Grade tests data were analyzed with Statistical Analysis Software (SAS) using the untreated control group design with pretests and posttests (Cook & Campbell, 1979). The computer skills test data were analyzed using a posttest-only design.

The two-tailed $t$ tests computed for the End-of-Grade Tests and Tests of Computer Skills populations were not independent because individual student scores were not analyzed but, rather, the difference of the two means. The Wake County Public Schools’ philosophy and goal of keeping all schools healthy allowed the researcher to use pooled-variance $t$ tests because the two populations were so large, the independent and the control group could have no effect on one another and had approximately the same standard deviation. Only one standard deviation needed to be estimated, so the resulting test statistic followed a $t$ distribution with $n_1 + n_2 - 2$ degrees of freedom and was used in the pooled two-sample $t$ statistic,
which had a \( t(n_1 + n_2 - 2) \) distribution. (Yale University, n.d., 1997-98 Courses, Statistics, Comparison of Two Means)

There were differences in the number of students in each of the experimental and control groups for each test primarily because there were only 8 schools in the experimental group and 15 schools in the control group. Because \( t \) tests were performed for each subgroup for each test, the numbers varied widely. The eighth-grade students’ scale scores were used to determine if there was evidence of a difference in scale scores on the North Carolina End-of-Grade tests in reading and the North Carolina End-of-Grade test in mathematics if the students had been in membership at least 140 days, had a pretest score for either or both tests, and had not been retained in the eighth grade. The two-tailed \( t \) test was also used to find evidence of a difference on the Multiple-Choice test of the North Carolina Tests of Computer Skills and the Performance test of the North Carolina Tests of Computer Skills, if the student had not been retained in the eighth grade.
CHAPTER IV

RESULTS

The population for the reading and mathematics studies consisted of students who entered grade 8 for the first time in 2000–01, who were in membership in the Wake County Public School System for at least 140 days, and who were administered End-of-Grade pretests in grade 7 and End-of-Grade posttests in grade 8. A total of 6,317 students met the requirements for the reading study, with 2,151 students in the experimental group and 4,166 in the control group. For the mathematics study, 6,309 students met the requirements, with 2,150 students in the experimental group and 4,158 students in the control group.

The population for the Multiple-Choice and Performance studies consisted of students who were in membership in grade 8 for the first time in 2000–01. A total of 6,937 students met the requirements for the Multiple-Choice study, with 2,358 students in the experimental group and 4,579 students in the control group. A total of 6,910 students met the requirements for the Performance study, with 2,365 students in the experimental group and 4,545 students in the control group.

$H_0$: No Child Left Behind subgroups that are exposed to a Technology Connections philosophy, which includes instructional technology as a seamless part of the North Carolina Standard Course of Study, will perform the same on End-of-Grade Test of Reading as students who are not exposed to the Technology Connections philosophy.
To test Hypotheses 1, a pooled 2-tailed $t$ test was used. There was insufficient evidence to reject the null hypothesis that No Child Left Behind subgroups that are exposed to a Technology Connections philosophy, which includes instructional technology, as a seamless part of the North Carolina Standard Course of Study, performed the same on End-of-Grade Tests in reading as students not exposed to the Technology Connections philosophy. $P$-values between 0.1526 and 0.9155 indicated no significant difference in scale scores for any subgroup of students in the experimental and control schools. Therefore, Hypothesis 1 was not rejected (see Table 5).

$H_0$: No Child Left Behind subgroups that are exposed to a Technology Connections philosophy, which includes instructional technology as a seamless part of the North Carolina Standard Course of Study, will perform the same on End-of-Grade Test of Mathematics as students who are not exposed to the Technology Connections philosophy.

A pooled 2-tailed $t$ test was used to test Hypothesis 2. Results showed that the Asian subgroup showed an increase in the difference of the means of their scale scores between pre and post tests of 1.70, $p < .02$. While the White subgroup $t$-test resulted in a statistically significant $p$-value of $< .01$, the difference in the means of their pre and post tests was -0.42, leading to the conclusion that the White subgroup in Technology Connections schools did not show an increase in their scale scores from pre to post test, but, in fact, did not do as well as nonTechnology Connections schools. I will therefore not reject the null hypothesis for all other subgroups ($p$-
values ranged from 0.07 to 0.86) other than the Asian and White subgroups. There is evidence to suggest that the null hypothesis can be rejected for Asian and White subgroups.

Table 5

Subgroup Comparisons in Control and Experimental Groups on End-of-Grade Tests

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>N</th>
<th>df</th>
<th>Difference of Means**</th>
<th>SE of Difference</th>
<th>Pr &gt;</th>
<th>t</th>
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</tr>
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<td>0.29</td>
<td>2.67</td>
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<td>0.67</td>
<td>0.55</td>
<td>0.22</td>
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</tr>
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<td>1505</td>
<td>0.04</td>
<td>0.27</td>
<td>0.89</td>
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<td>0.79</td>
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<td></td>
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<td>0.29</td>
<td>1.22</td>
<td>0.81</td>
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<td>0.14</td>
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<td>965</td>
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<td>0.15</td>
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<td>237</td>
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<td>0.71</td>
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<tr>
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<td>0.16</td>
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<td>Economically disadvantaged</td>
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<td>0.47</td>
<td>0.35</td>
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<td>1.38</td>
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<td>0.49</td>
<td>0.39</td>
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<td></td>
</tr>
</tbody>
</table>

*p < 0.05 (2-tailed).

** Difference of means derived from Technology Connections schools’ mean for each subgroup subtracted from the nonTechnology Connections schools’ mean for each subgroup.

Data for the North Carolina Tests of Computer Skills are not reported to the United States Department of Education for No Child Left Behind, but since
proficiency on the test is a diploma requirement, the test does play a role in a high schools’ Adequate Yearly Progress (AYP) status. The North Carolina Tests of Computer Skills results are reported to the North Carolina Department of Public Instruction for ABCs proficiency in middle schools. Two hypotheses were developed for computer skills testing.

H₀₃: No Child Left Behind subgroups that are exposed to a Technology Connections philosophy will perform the same on the North Carolina Computer Skills Test–Multiple-Choice as students who are not exposed to the Technology Connections philosophy.

To test Hypothesis 3, a pooled 2-tailed \( t \) test was used at \( p < .05 \). There was insufficient evidence to reject the null hypothesis that 9 No Child Left Behind subgroups exposed to a Technology Connections philosophy as a seamless part of the North Carolina Standard Course of Study in grade 8 performed the same on the Multiple-Choice test as students who were not exposed to the Technology Connections philosophy. For 9 of the 10 subgroups, \( p \)-values ranged from 0.07 to 0.10, indicating there was no significant difference in passing rates in the experimental and control schools. Therefore, Hypothesis 3 was not rejected. The Black subgroup was the only group for which there was a statistical significance with \( p < .0002 \). However, for this subgroup, when looking at the difference of the mean of the scale scores, the nonTechnology Connections schools scale scores were 1.51 points higher than the Technology Connections scale scores. There is, strong evidence to suggest that the null hypothesis can be rejected for this subgroup.
H_04: No Child Left Behind subgroups that are exposed to a Technology Connections philosophy will perform the same on the North Carolina Computer Skills Test–Performance as students who are not exposed to the Technology Connections philosophy.

To test Hypothesis 4, a pooled 2-tailed t test was used at p < .05. There was insufficient evidence to reject the null hypothesis that 8 No Child Left Behind subgroups exposed to a Technology Connections philosophy as a seamless part of the North Carolina Standard Course of Study in grade 8 performed the same on the Performance test as students who were not exposed to the Technology Connections philosophy. For 8 of the 10 groups, p-values ranged from 0.14 and 0.75, so the null hypothesis was accepted for these subgroups. Two subgroups, the Black subgroup and the Economically Disadvantaged subgroup did have a statistically significant p-values of <0.0002 and <0.0077 respectively. However, both subgroups had higher mean scale scores in the nonTechnology schools. There is strong statistical evidence that the null hypothesis can be rejected for these subgroups. These two subgroups did not perform the same, but in fact, scored worse than the nonTechnology subgroups (see Table 6).
Table 6

*Subgroup Comparisons in Control and Experimental Groups on the Tests of Computer Skills*

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>N</th>
<th>df</th>
<th>Difference of Means</th>
<th>SE of Difference</th>
<th>Pr &gt;</th>
<th>t</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Multiple-Choice</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Whole group</td>
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<td>6935</td>
<td>0.27</td>
<td>0.20</td>
<td>0.18</td>
<td></td>
<td></td>
</tr>
<tr>
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<td>19</td>
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<td>6.62</td>
<td>3.75</td>
<td>0.10</td>
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<td></td>
</tr>
<tr>
<td>Asian</td>
<td>260</td>
<td>258</td>
<td>-1.20</td>
<td>0.82</td>
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<tr>
<td>Black</td>
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<td></td>
</tr>
<tr>
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<td>69</td>
<td>1.22</td>
<td>2.02</td>
<td>0.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
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<td>0.68</td>
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<tr>
<td>Economically disadvantaged</td>
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<td>0.49</td>
<td>0.44</td>
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</tr>
<tr>
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<td>102</td>
<td>2.76</td>
<td>1.49</td>
<td>0.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students with disabilities</td>
<td>990</td>
<td>988</td>
<td>0.67</td>
<td>0.61</td>
<td>0.27</td>
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<td><strong>Performance</strong></td>
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<tr>
<td>Whole group</td>
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<td>-0.18</td>
<td>0.23</td>
<td>0.44</td>
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*p < 0.05 (2-tailed).

** Difference of means derived from Technology Connections schools’ mean for each subgroup subtracted from the nonTechnology Connections schools’ mean for each subgroup.
Overview

The purpose of this study was to determine the effects of the Technology Connections initiative of shared vision and effective teaching practices, combined with a restructured classroom that included technology, to assist students in acquiring new skills and making meaning of the curriculum.

The following research questions provided a focus for the study:

1. What was the effect on the scale scores on the eighth-grade End-of-Grade reading test in Technology Connections schools as compared with nonTechnology Connections schools for each or any of the No Child Left Behind subgroups?

2. What was the effect on the scale scores on the eighth-grade End-of-Grade mathematics test in Technology Connections schools as compared with nonTechnology Connections schools for each or any of the No Child Left Behind subgroups?

3. What was the effect on the passing rates, as demonstrated the scale scores, on the multiple-choice section of the test for students in each of the No Child Left Behind subgroups in the Technology Connections leader schools compared to the traditional lab approach in nonTechnology Connections schools?
4. What was the effect on the passing rates, as demonstrated by scale scores, on the performance section of the test for students in each of the No Child Left Behind subgroups in the Technology Connections leader schools compared to the traditional lab approach in nonTechnology Connections schools?

The population for this study consisted of all eighth-grade students in the Wake County Public School System in 2000–01 who were administered the North Carolina End-of-Grade Tests in reading and mathematics and the Multiple-Choice and Performance tests of the North Carolina Tests of Computer Skills. The sample consisted of all students in 7 Technology Connections leader Schools. These students were in technology-rich classes and had teachers whose teaching methods were based in brain research and constructivist’s theory. The control group consisted of all other eighth-grade students in the county. There was no random selection of students. There were 7,720 students enrolled in grade 8 in the Wake County Public School System in the 2000–01 school year. Of those, 7,118 were in grade 8 for the first time, and 6,574 had been in membership for 140 or more days. Membership was used as an additional requirement for students to be in the reading and mathematics studies, and students had to have both a pre- and posttest score to be in the reading or the mathematics study. For the purpose of all studies, the students were divided by the 10 No Child Left Behind subgroups, one of which was all students.
A quasi-experimental design was used for the study. Because the study was conducted after both the pre- and posttests were administered, entire school populations of grade 8 students were either in the experimental or the control group. One variation of Cook and Campbell’s (1979) nonequivalent control group design, the untreated control group design with pretest and posttest, was used for the mathematics and reading study. A second variation was used for the multiple choice and performance study, the posttest-only design with nonequivalent groups.

The researcher did not control for teacher effect since the study was completed after the tests were administered. Neither the teachers nor the students had any idea they would be part of a study, so there was no Hawthorne Effect. Teachers and students remained anonymous to the researcher throughout the study. All students in both the experimental and control groups were given computer lab time in preparation for the Tests of Computer Skills. Only the experimental group of students had banks of computers and other technologies in their classrooms.

The data were analyzed by means of Statistical Analysis Software (SAS) after the student scores were entered into two databases, one of which was a modified masterbuild file and the other a database that contained the computer skills scale scores. The databases were combined through relationship queries in Microsoft Access. Scale scores from the 2000–01 mathematics tests, which were 200-level scores, were replaced with equivalent 100-level scores. SAS software performed a pooled 2-tailed $t$ test for each subgroup for each of the four studies.
Discussion

Findings from this quasi-experimental study show that, for most of the No Child Left Behind subgroups, the Technology Connections initiative was no more effective than the traditional method of teaching with regard to scale scores on End-of-Grade Tests in reading and mathematics and on the North Carolina Tests for Computer Skills.

Pooled 2-tailed $t$ tests performed for all subgroups on North Carolina End-of-Grade test in reading indicated that the variances of the scores was not statistically significant at $p < .05$ level for any of the 10 subgroups. Reading is not a curriculum area in middle school, but some studies, such as eMINTS, have shown that there is significant growth in reading when students use computer assisted technology to teach reading skills in middle school” (eMints National Center, 2006, ¶ 3).

The $t$ tests performed for all subgroups on the End-of-Grade Test in mathematics showed statistically significant variance for the Asian subgroup, $t(239) = 1.70, p < .02$ (0.0174) (2-tailed), and the White subgroup, $t(4290) = -0.42, p < .01$ (0.0093), but not for any of the other 8 subgroups. For the Asian subgroup, the Technology Connections philosophy appears to have been an effective teaching strategy. It did not appear so for the White subgroup, since their mean scale scores was lower in nonTechnology schools. It cannot be determined, if more students in the Technology Connections schools were also in higher mathematics courses, such as Algebra 1, which might have a positive or negative effect on the 8th grade
mathematics skills tested on the End-of-Grade test. Future studies should include the Algebra I variable.

For the North Carolina Tests of Computer Skills, only the Black subgroup, $t(1775) = -1.51, p < .00 (0.0002)$, had a statistically significant result on the Multiple-Choice Test. However, when looking at the difference of the means of the scale scores for this subgroup, the Black subgroup in the Technology Connections schools, was lower than for the nonTechnology Connections schools. The mean of for the Technology Connections schools was -1.51 scale score points lower than for the nonTechnology Connections schools. This indicates that even though both means were passing scale scores, there were fewer passing scores in the Technology Connections schools on this test.

For the Performance test, the Black subgroup, $t(1756) = -2.05, p < .00 (0.0001)$, and the Economically Disadvantaged subgroup, $t(1176) = 1.63, p < .01 (0.0077)$, did have a statistically significant difference. Again, however, the mean scale score for the Black subgroup was 2.05 points lower and 1.6 points lower for the Economically Disadvantaged subgroups at the Technology Connections schools meaning that fewer students passed the test.

While the overall results failed to show evidence to support or expand the initiative, some subgroups in the experimental group did appear to experience more growth than the same subgroups in the control group. These findings suggest a need for more study. Additional statistical modeling might determine the true relationships.
Students who realized the highest gains in mathematics were the Asian subgroup. Because all middle schools offer Algebra 1 and some offer geometry, it would be advantageous to examine each school’s results instead of just examining a group of Technology Connections leader schools and non-Technology Connections schools. By determining the curriculum offered in each school, it may help to determine whether schools that offered geometry and used Technology Connections strategies had higher scale scores in the mathematics study than did the other schools. In other words, was mathematics course level a factor at the school?

Rakes indicates that the use of technology has a profound effect on schools, but that constructivist behaviors are used much more frequently in lower grades than in the middle and high schools (1999). Madden drew the same conclusion (2003). It would be of interest, therefore to construct a longitudinal study of a cohort of students in technology connections and nontechnology connections elementary schools to see if there was more evidence to continue to look at initiatives such as Technology Connections.

One of the more important findings in this research was the statistically significant performance scale score differences for the Black and the Economically Disadvantaged subgroups. As schools struggle to close achievement gaps for both of these subgroups and to increase graduation rates, it will be important to know why these two subgroups mean scale scores at the Technology Connections Schools were lower. Eric Little’s 2006 study of high-risk grade 8 students who were
repeating their grade showed a positive impact of technology integration (Little, 2006, Results section, ¶ 1). While his study spoke to gains in reading and writing, more studies in all North Carolina Standard Course of Study areas are needed.

The No Child Left Behind legislation encourages states to seek Educational Technology State Grants, which are mainly for use in low wealth counties, and to participate in National Technology Activities to improve student academic achievement in elementary and secondary schools through integrating technology into the instructional program. The No Child Left Behind charge to have each child become technologically literate by the end of eighth grade could be realized by best practices such as those incorporated in the technology connections initiative. As schools and systems disaggregate data into No Child Left Behind subgroups, effective teaching strategies will surface for all subgroups. Not all these strategies will be effective with all groups. With more data to support various types of instruction, the achievement gaps will narrow and the journey of leaving no child behind will truly begin.

Other studies support the effectiveness of technology-based instruction, such as the Technology Connections initiative as occurred in the present study in some subgroups. Wenglinsky’s (1998) research indicates that students who use computers individually or in groups have higher academic achievement than students who do not. Yipling Abrami, and d’Apollonia’s (2001) meta-analysis concluded that small groups working together and learning to use computer
technology had significantly more positive effects than individuals. Moreover, “when students worked in pairs, and when programs involved tutorials or practices or programming languages, there was a small but significant positive effect on both group task performance and individual achievement” (p. 480).

Recommendations

This study found that the Technology Connections initiative and constructivist approach was more effective for only one subgroup, emphasizing the need for further study. Most studies discussed in the literature review were based on older data and meta-analyses of older data. The researcher makes the following recommendations for Wake County:

1. This study was based on 1 year’s data at each school. Longitudinal studies should be conducted to determine the long-term effect of the Technology Connections initiative.

2. Future studies should include whether the Asian subgroup at the Technology Connections leader schools was enrolled in higher level mathematics courses (e.g., Algebra 1 and geometry) at a higher rate than in nonTechnology Connections schools. All students in grade 8 who take a higher level mathematics course must take the eighth-grade End-of-Grade test in mathematics even though they are not scheduled into an eighth-grade mathematics course. They must also take the corresponding End-of-Course for the higher level course. Would exposure to higher level
mathematics courses in grade 8 help some students to score higher on the mathematics End-of-Grade test?

3. Do students having computers at home have an effect on whether they score higher or perform better on standardized tests?

4. Additional research should be conducted to examine the effectiveness of the Technology Connections initiative in other grade levels that take the End-of-Grade tests in reading and mathematics.

5. With increased emphasis on effective teaching, No Child Left Behind, Adequate Yearly Progress, and closing the achievement gap (between ethnic groups and socio-economic groups), it is important that teaching methods for different subgroups are studied to ensure that educators are effective with all students and that the teaching method used does not result in less growth for the student.

6. An examination of End-of-Grade reading and mathematics Goal Summary Reports could determine whether students in Technology Connections schools showed more growth in higher order thinking skills than students in nonTechnology Connections schools.

Prior research shows that instructional technology does not have a positive effect in all areas of the curriculum. Kulik (as cited in Schacter, 1999) concluded that instructional technology is more effective in mathematics and science, while other researchers - such as Little- found the effect is stronger in reading and writing (Little, 2006, Results section, ¶ 1). The present study's findings provide little support for the
use of instructional technology but further studies could determine whether the effect is stronger in reading or mathematics.

The No Child Left Behind initiative uses mathematics and reading scores in elementary and middle schools to look at growth trends over time. At the high school level, the initiative requires a report of the number of students in grades 9–12 who graduate within 4 years and the number of students who dropped out of school. Would a retooled Technology Connections initiative result in fewer dropouts of those eighth-grade cohorts? Does more technology in the classroom result in high school graduates being offered higher level jobs due to their computer skills?

This study examined only 1 year of data due to a lack of funding. A failed bond referendum in 1999 meant the Technology Connections initiative was not supported fully beyond the 2000–2001 school year. At that time, the Wake County Public School System was growing at the rate of 3,500 students a year, so funds were cut for all non-essential programs. Greater priority was given to building new schools to accommodate the rapid growth. As a result of the failed bond, the system is still trying to catch up with its building initiative. Even though there have been two successful bonds since 1999, the first did not include a technology component and the gains in hardware and software that were made before 1999 were lost.

Currently, in the 2006-07 school years, the school system is growing by over 7,500 students a year. In fall 2006 a $970 million school bond passed that included a technology component to put classroom computers on a 5 year replacement cycle in all schools and the integration of wireless technology into new school design. This
technology component will need to be paired with new policy that requires teacher Continuous Education Units (CEUs) that have an emphasis on instructional technology that support higher order thinking skills and that engage students in authentic tasks. Policy should also include a requirement that principals’, TRTs’, or IRTs’ observations that include teachers in classrooms working collaboratively with students on units that includes the integration of instructional technology and higher order thinking skills into the Standard Course of Study.

The Wake County system is larger and more diverse than ever. To fulfill the commitment to leaving no child behind, preparing students with 21st century skills, and lowering dropout rates, more study of teaching strategies that can be shown effective, including the integration of technology into the curriculum must be identified.
REFERENCES


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Wake County Public School System. (1997, April). *Secondary technology connections.* (Publication no longer available via the Internet. Raleigh, NC: Wake County Public School System, Curriculum and Instruction. For information contact Evelyn Mullen at EMullen@Wake County Public Schools.net)


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*Note.* 0 = nonTechnology Connections schools, 1 = Technology Connections schools.
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*Note. 0 = nonTechnology Connections schools, 1 = Technology Connections schools.*
Table 9

*Multiple Choice Scale Score Mean, Standard Deviation, and Standard Error of the Mean for Subgroups in Experimental and Control Groups*

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<td>0.34</td>
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</tr>
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<td>0.51</td>
<td>9.22</td>
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<td>7.66</td>
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*Note.* 0 = nonTechnology Connections schools, 1 = Technology Connections schools.
Table 10

Performance Scale Scores Mean, Standard Deviation, and Standard Error of the Mean for Subgroups in Experimental and Control Groups

<table>
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<tr>
<th>Subgroup</th>
<th>0</th>
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<th>N</th>
<th>Difference</th>
<th>SE</th>
<th>SD</th>
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<td>62.92</td>
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</tbody>
</table>

Note. 0 = nonTechnology Connections schools, 1 = Technology Connections schools.