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The Association between the Use of *Accelerated Math* and Students' Math Achievement.

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The Association Between the Use of *Accelerated Math* and Students' Math Achievement

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ABSTRACT

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The purpose of this study was to explore the relationship between time spent on a computer managed integrated learning system entitled *Accelerated Math* and traditional mathematics instruction on achievement as measured by standardized achievement tests of elementary school students. The variables of ability level, special education, grade, socioeconomic status, gender, classroom teacher, school attended, and degree of implementation were also considered. The population consisted of 542 students who were sixth, seventh, and eighth graders during the 2003-2004 school year and took the *TerraNova* each year. Data were gathered that covered the three-year period beginning in 2001 and ending in 2004. A *t* test for independent samples, analysis of variance (ANOVA), and analysis of covariance (ANCOVA) were used to identify the relationship between variables.

The researcher's investigation of the relationship between *Accelerated Math* use and mathematics achievement might assist educators in planning for use of technology as a supplement to traditional instruction. The information gathered from this research might be beneficial to other school systems seeking information on the relationship between a computer-managed integrated learning system and math achievement. The findings in this study were mixed. The use of *Accelerated Math* was associated with no effects and negative effects depending on the degree of implementation.

The findings indicated that there were measurable differences in the performance of students who received *Accelerated Math* compared to students who did not receive *Accelerated Math*. Students who did not receive *Accelerated Math* had higher overall scores than students participating in the intervention. The study indicated that gender, special education, and ability groups did not have a significant interaction with the intervention (participation in *Accelerated Math*). The research revealed that there was a socioeconomic status interaction intervention with proficiency scores. The study revealed that there was a significant intervention interaction with school, teacher, and grade. There was a significant interaction intervention for both proficiency and value-added scores for each of these three independent variables. In addition, the research revealed that the degree of implementation was a significant factor in students' achievement.

DEDICATION

This work is dedicated to my wife LeVerne (Sissy) and daughter Whitney. Without their support, encouragement, patience, and understanding, this dissertation would not be possible. Sissy, you have been supportive over the years. Thank you for being so understanding for the many months of intense research.

Whitney, I hope my absence from your life during the past four years can be replaced with memories of attending ballgames together and enjoying more time together in the coming years. I hope that you will find a less stressful dad now that this project has been completed. Your "dad" is very proud of you.

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CHAPTER 1

INTRODUCTION

Over the past 20 years, schools have spent billions of dollars equipping their classrooms with the latest computers and software programs. Frequently, this was done without a plan as to how the use of this technology would improve education. When technology first entered the educational arena, it was expected to solve many problems by bringing excitement and greater understanding to the students. The guiding question technology leaders must keep in mind as they develop a plan to use technology is, "Are students using technology in ways that deepen their understanding of the academic content and advance their knowledge of the world around them?" (Barnett, 2001). Technology and national standards are two significant concepts infusing public education today. Numerous studies have been conducted to examine the effects of technology on academic achievement. Deubel (2001) reported that a meta-analysis involving 3,694 students from all educational settings and subject areas addressed the effectiveness of software on academic achievement of students in middle and high schools. The research involved 26 studies conducted between 1984 and 1995. A small positive mean effect size (0.187) was found indicating that students exposed to Computer-Assisted Instruction (CAI) showed higher achievement than students exposed to traditional instruction (Deubel, 2001). Technology can be effective in increasing mathematics achievement but its effectiveness depends on how it is used (Deubel, 2001). It is important for schools to collect more data to determine the degree to which technology programs are effective. The challenge is for mathematics teachers to use technology in the classroom that will make a significant difference in the achievement of their students.

Math is a crucial skill in the information age. We must improve math achievement to maintain our economic leadership in the world. Braswell, Daane, and Grigg (2003) reported that according to the 2003 National Assessment of Educational Progress (NAEP), the average math scores in grades four and eight have slightly improved. Math achievement is improving but more work needs to be done to ensure that students receive a better education in mathematics.

The association between the use of *Accelerated Math* and students' math achievement has the potential to influence mathematics instructional strategies throughout the country. The National Council of Teachers of Mathematics (2000) released a set of mathematics standards for grades kindergarten through 12. Since the launch of Sputnik by Russia in 1957, the federal government has played a role in influencing the curriculum and mandating assessments. As noted by Scanlon (1998), legislators, shortly after passing the *National Defense Education Act*, started encouraging mathematics and science instruction. In the middle of the 20th century, political leaders were fearful that the United States was falling behind other countries in math and science. Assessment and accountability eventually became vital parts of the government's attempt to monitor and regulate math and science progress. As a result of government intervention in the form of more rigorous accountability measures, schools are being evaluated by standardized test scores (Scanlon). Those trends continue today with the passage of the *No Child Left Behind Act* (NCLB). School districts are classified as successes or failures based on assessments identified in NCLB. In addition, test results are often used to rank schools and as criteria for receiving state and federal funds.

The NCLB Act, signed into law on January 8, 2002, established that all instructional programs must be grounded in scientific research. There is agreement (Shavelson & Towne, 2002) that scientific-based research should be:

1. grounded in theory,
2. evaluated by a third-party,
3. evaluated on quality and method,
4. relevant and significant,
5. published in peer-reviewed journals,

6. sustainable, and
7. replicable in schools with diverse settings. (n. p.)

School districts must decide whether the NCLB Act requires or suggests scientifically-based research. While federal officials claim the intent of NCLB is not to create a mandate, some educators remain skeptical. Speculation exists on whether a product must be classified as scientifically based in order to purchase it with federal funds. Fletcher (2004) reported that Christine Wolfe, director of policy in the Office of the Undersecretary at the U.S. Department of Education, said, "The overall policy is that the department is not creating a federal imprimatur on curriculum or specific products and services. Instead, they are trying to provide a way of synthesizing what research says" (p. 22). Even though the NCLB Act may not mandate the purchase of scientifically-based research programs with state and local funds, such provisions do apply with Title IID federal funds (Schneiderman, 2004). Despite the statements from Wolfe (as cited in Fletcher), the history of events pertaining to scientifically-based research suggests that a "federal purchasing policy" may be a valid fear of educators (Fletcher, p. 24). Researchers have agreed that more theory and evidence-based research in education is needed (Shavelson & Towne, 2002). These researchers also suggested that scientifically-based research needs to be defined within the context of specific academic content areas. Slavin (2003) noted that NCLB referenced scientifically-based research 110 times.

Based on previous studies, Renaissance Learning's (2004) *Accelerated Math* program is classified as having scientifically-based research. Over the past few years, the Tennessee Department of Education (1999) has required school districts to participate in annual assessments in grades three through eight. The results of these tests are used for evaluation of programs. In addition, they are used for the evaluation of schools and school systems. Educators are constantly seeking scientifically-based programs to improve students' test scores. If schools fail to achieve average yearly progress, consequences apply. These can range from school choice to state intervention.

Many of the key instructional elements included in *Accelerated Math* have been identified as factors relating to academic achievement. Kosciolek (2003) identified these elements as:

1. ensuring adequate practice time,
2. matching students' assignments to individual skill levels to encourage high success rates,
3. providing corrective instructional feedback frequently,
4. monitoring students' progress, and
5. encouraging students to monitor their progress toward meeting predetermined goals. (p. 18)

Researchers (Benbow & Stanley, 1982; Butzin, 2001; Walberg, 1984) have documented the association between time on task (academic learning time) and academic achievement. By drastically reducing paperwork, *Accelerated Math* provided more time for instruction. The second factor, that of matching students' assignments to individual skill level, increased academic performance (Gersten, Carnine, & Woodward, 1987; Walberg, 1984). Far too frequently, students have been exposed to instructional content that is below or above their functioning level. This can lead to frustration or boredom. The third factor was providing immediate corrective feedback to students. Researchers consistently mentioned immediate feedback as a crucial component of effective instruction (Bloom, 1984; Carnine & Gersten, 2000; Walberg, 1984). As documented by different researchers (Fuchs & Fuchs, 1998; Kosciolek, 2003), monitoring students' progress was important to students' performance. The fifth factor, goal setting, was documented by Fuchs and Fuchs as well as Kosciolek as an important component of effective instruction. These five important instructional factors are components of the *Accelerated Math* program.

Accelerated Math can generate for students unlimited practice assignments that are individualized. The program provides immediate corrective feedback and drastically reduces paperwork for teachers by automatically scoring assignments and providing reports. Because the assignments are individualized, students have an opportunity to work at their own pace. This prevents boredom and frustration for the students functioning considerably above or below grade level (Renaissance Learning, 2004).

This study focused on a small rural school system in Summitt County (pseudonym) in East Tennessee and its instructors' use of *Accelerated Math*, a computer-managed integrated learning system, as an alternate method of mathematics instruction. Some teachers used this program rather than traditional instructional methods. Instead of haphazardly using the same objectives for every state, *Accelerated Math* has different objectives for every state. Therefore, the program is aligned with the curriculum frameworks for individual states. Curriculum alignment is performed by grade level for each of the state's modules. Data were gathered over a three-year period from 2001-2002 thru 2003-2004 to determine if the use of *Accelerated Math* had a measurable impact on math achievement scores. This research might provide useful information in identifying effective methods of math instruction.

Statement of the Problem

Because a school district's success is determined by state and national assessment, officials in school systems across the country have sought to make changes to effectively address the academic deficits of students. America's schools are focused on providing the education needed for students to succeed in a global economy in the 21st century. Students can and should be proficient in mathematics. For students to become mathematically proficient, major changes must be made in instruction, materials, curriculum, assessments, and teachers' training (Braswell et al., 2003). The decline of mathematics test scores in schools throughout the country has prompted national concern (Gaeddert, 2001). It is well documented that educators are examining their own school districts' curriculum objectives and aligning them with state and national outcomes (Gaeddert). There has been a renewed focus on standards and achievement at all levels. Given the ramifications of scoring below the proficient level as identified by the state, school officials are searching for scientifically-based programs and methods with a successful record of increasing standardized test scores.

The purpose of this study was to determine if a relationship existed between the use of *Accelerated Math* and math achievement as measured by the *TerraNova* for elementary school students. Research findings could assist in determining what is possible for students to learn about certain content areas given certain conditions (National Council of Teachers of Mathematics, 2000). According to Carnine and Gersten (2000), "Well-controlled experimental research is the best vehicle for determining what is possible for students to learn and best practices" (p. 141).

Definitions of Terms

1. *Accelerated Math*: A software program that uses individual mini-lessons focused on direct skill development. It provides diagnostic and management tools for the teacher and presents an alternate method of teaching math (Renaissance Learning, 2004).
2. *Adequate Yearly Progress (AYP)*: Adequate Yearly Progress is a measure of a school's ability to meet NCLB required benchmarks with specific performance standards (Tennessee Department of Education, 2004).
3. *Computer-Assisted Instruction (CAI)*: "An instructional technique based on the two-way interaction of a learner and a computer with the objective of human learning and understanding" (UNESCO, 1987, p. 30).
4. *Concordance*: "A linkage between scores on two tests that do not measure the same underlying construct" (Hanson, Harris, Pommerich, Sconing, & Yi, 2001, p. 5).
5. *Criterion-Referenced Test (CRT)*: A CRT measures a set of learning outcomes or objectives. This type of test determines whether a student has learned a particular

skill. The skill is measured against a criterion regardless of what other students know (TestMate Clarity, 1997).

6. *Curriculum*: A district's written specification for what students should know and do as a result of instruction and how content is distributed and sequenced over time (Hanson, 2004).
7. *Curriculum Alignment*: The degree of agreement to which standards, assessments, and other important elements in an education system are complementary and work together to effectively guide students' learning (Webb, 1997).
8. *Economically Disadvantaged*: Students who are eligible for free or reduced-price lunch.
9. *Gain Score*: The difference in scale scores from one year to the next.
10. *Integrated Learning System (ILS)*: "Networked comprehensive basic skills software from a single vendor" (Becker, 1992, p. 1).
11. *Mastery Learning*: A system whereby the curriculum is broken down into skills and objectives and students must master one objective before moving to the next.
12. *Normal Curve Equivalent (NCE)*: A score of 1 to 99 that describes a student's level of achievement in relation to scores of other students in the same grade. NCE scores are interval levels of measurement.
13. *Norm-Referenced Test (NRT)*: A NRT is used to compare a student's progress in school with the progress of other students of the same age and grade throughout the country (TestMate Clarity).
14. *Scale Score*: The scale score describes the achievement on a continuum that in most cases spans the range of kindergarten through grade 12. These scores can range from approximately 100 to 900 (*Beyond the Numbers*, 1997, p. 3). They are units of a single, equal-interval scale that can be manipulated statistically (p. 48).

15. *TerraNova*: A national achievement test developed by CTB/McGraw-Hill and administered by the Tennessee Department of Education to all students in grades three through eight. School districts have the option of using it in grades one and two. The test has 14 subtests; however, the major components include reading, language arts, mathematics, science, and social studies.
16. *Value-Added Score*: A value-added score measures students' progress within a grade and subject that demonstrates the influence the school has on the students' performance (Tennessee Department of Education, 2004).

Research Questions and Hypotheses

The researcher investigated the following questions as they relate to the use of *Accelerated Math* as an alternative to traditional math instruction for sixth-, seventh-, and eighth-grade students in a small rural school system in East Tennessee:

1. To what extent, if any, is there a difference between the *TerraNova* math test scores of students who did and did not participate in the *Accelerated Math* program?
2. To what extent, if any, is there a difference between the *TerraNova* math test scores of male and female students who did and did not participate in the *Accelerated Math* program?
3. To what extent, if any, is there a difference between the *TerraNova* math test scores of students from different schools who did and did not participate in the *Accelerated Math* program?
4. To what extent, if any, is there a difference between the *TerraNova* math test scores of special education and nonspecial education students who did and did not participate in the *Accelerated Math* program?

5. To what extent, if any, is there a difference between the *TerraNova* math test scores of students of different socioeconomic status who did and did not participate in the *Accelerated Math* program?
6. To what extent, if any, is there a difference between the *TerraNova* math test scores of students of different ability groups who did and did not participate in the *Accelerated Math* program?
7. To what extent, if any, is there a difference between the *TerraNova* math test scores of students of different degrees of implementation of the *Accelerated Math* program?
8. To what extent, if any, is there a difference between the *TerraNova* math test scores of students in different grades who did and did not participate in the *Accelerated Math* program?
9. To what extent, if any, is there a difference between the *TerraNova* math test scores of students with different teachers who did and did not participate in the *Accelerated Math* program?

From the research questions, the following hypotheses were tested:

$Ho1_1$: There is no difference in the performance of students who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* based on the 2004 *TerraNova* CRT scores.

$Ho1_2$: There is no difference in the performance of students (based on value-added scores) who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* on the 2004 *TerraNova* while controlling for the 2002 and 2003 test results.

$Ho2_1$: There is no difference between the performance of males and females on the 2004 *TerraNova* CRT scores.

$Ho2_2$: There is no difference between the performance of males and females (based on value-added scores) on the 2004 *TerraNova* while controlling for the 2002 and 2003 *TerraNova*.

$Ho2_3$: Based on CRT scores, there is no difference in the performance of students by gender who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* on the 2004 *TerraNova* test results.

$Ho2_4$: Based on value-added scores, there is no difference in the performance of students by gender who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* on the 2004 *TerraNova* while controlling for the 2002 and 2003 test results.

$Ho3_1$: There is no difference in performance by school on the 2004 *TerraNova* CRT scores.

$Ho3_2$: There is no difference in performance by school (based on value-added scores) on the 2004 *TerraNova* while controlling for the 2002 and 2003 *TerraNova* test results.

$Ho3_3$: There is no difference in school performance of students who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* based on the 2004 *TerraNova* CRT scores.

$Ho3_4$: Based on value-added scores, there is no difference in school performance of students who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* on the 2004 *TerraNova* while controlling for the 2002 and 2003 *TerraNova* test results.

$Ho4_1$: There is no relationship between special education status and scores on the 2004 *TerraNova* CRT scores.

$Ho4_2$: There is no relationship between special education status and scores on the 2004 *TerraNova* test while controlling for the 2002 and 2003 *TerraNova* as determined by value-added scores.

$Ho4_3$: There is no relationship between the use of *Accelerated Math* and mathematics achievement by special education status based on 2004 *TerraNova* CRT test results.

$Ho4_4$: Based on value-added scores, there is no relationship between the use of *Accelerated Math* and mathematics achievement by special education status on the 2004 *TerraNova* test while controlling for the 2002 and 2003 *TerraNova*.

$Ho5_1$: There is no relationship between socioeconomic status and scores on the 2004 *TerraNova* test based on CRT scores.

$Ho5_2$: Based on value-added scores, there is no relationship between socioeconomic status and scores on the 2004 *TerraNova* test while controlling for the 2002 and 2003 *TerraNova*.

$Ho5_3$: There is no relationship between the use of *Accelerated Math* and mathematics achievement by socioeconomic status based on the 2004 *TerraNova* CRT scores.

$Ho5_4$: There is no relationship between the use of *Accelerated Math* and mathematics achievement by socioeconomic status based on value-added scores from the 2004 *TerraNova* test while controlling for the 2002 and 2003 *TerraNova*.

$Ho6_1$: There is no difference in the performance of students on the CRT portion of the 2004 *TerraNova* test in the five different quintiles (1^{st}, 2^{nd}, 3^{rd}, 4^{th}, and 5^{th} quintiles).

$Ho6_2$: There is no difference in the performance of students on the 2004 *TerraNova* test in the five different quintiles (1^{st}, 2^{nd}, 3^{rd}, 4^{th}, and 5^{th} quintiles) based on value-added scores while controlling for the 2002 and 2003 *TerraNova*.

$Ho6_3$: There is no difference in the performance of students on the CRT portion of the 2004 *TerraNova* test in the five different quintiles (1^{st}, 2^{nd}, 3^{rd}, 4^{th}, and 5^{th}) after participating in the *Accelerated Math*.

$Ho6_4$: Based on value-added scores, there is no difference in the performance of students on the 2004 *TerraNova* test in the five different quintiles (1^{st}, 2^{nd}, 3^{rd}, 4^{th}, and 5^{th} quintiles) after participating in the *Accelerated Math* while controlling for the 2002 and 2003 *TerraNova*.

$Ho7_1$: There is no relationship between the degree of implementation of the treatment and mathematics achievement on the 2004 *TerraNova* CRT scores.

$Ho7_2$: There is no relationship between the degree of implementation of the treatment and mathematics achievement on the 2004 *TerraNova* value-added scores while controlling for the 2002 and 2003 scores.

$Ho8_1$: There is no difference in the performance of sixth-, seventh-, and eighth-grade students on the 2004 *TerraNova* CRT scores.

$Ho8_2$: There is no difference in the performance of sixth-, seventh-, and eighth-grade students on the 2004 *TerraNova* value-added scores while controlling for the 2002 and 2003 *TerraNova* math scores.

$Ho8_3$: There is no difference in the performance of sixth-, seventh-, and eighth-grade students who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* based on the 2004 *TerraNova* CRT scores.

$Ho8_4$: Based on value-added scores, there is no difference in the performance of sixth-, seventh-, and eighth-grade students who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* on the 2004 *TerraNova* while controlling for the 2002 and 2003 *TerraNova* test results.

$Ho9_1$: There is no relationship between the use of *Accelerated Math* and mathematics achievement by teacher based on the 2004 *TerraNova* CRT scores.

$Ho9_2$: There is no relationship between the use of *Accelerated Math* and mathematics achievement by teacher based on the 2004 *TerraNova* value-added scores while controlling for the 2002 and 2003 *TerraNova* test results.

Significance of the Study

School leaders face the task of meeting the needs of all students while providing teachers with scientific-based interventions. Educators must ensure that the strategies and interventions they implement are for the best interest of the students. Teachers cannot be expected to blindly adopt every new program that is suggested. The same applies to technology programs. The use of technology in education is at a critical stage (Weaver, 2000). Software use for mathematics instruction appeared to have increased from 1994 to 2000. Teachers reported an increase in use from 3% in 1994-1995 to 52% in 1999-2000 (Deubel, 2001). However, it is unclear whether the software was an integral part of the mathematics curriculum. In addition, few studies have been conducted to examine the effects of software-based mathematics curriculum as a replacement for traditional mathematics instruction. Until recently, the basal textbook has been considered the primary curriculum to be used in the classroom. Technology is rapidly changing that concept.

Because of the scrutiny of test scores since implementation of the *No Child Left Behind Act*, educators are searching for more effective methods of instruction. Technology can play a major role in improving the educational system. Numerous research studies (Black & Wiliam, 1998; Christmann & Badgett, 2003; Elias, Cafolla, & Schoon, 2000; Fuchs & Fuchs, 1998; Molnar, 1997; Spicuzza et al., 2001; Traynor, 2003; Wilson, Majsterek, & Simmons, 1996) demonstrated a positive effect of the use of computer-assisted instruction on academic achievement. However, technology should not be viewed as the solution to all of the problems found in public education. While numerous researchers such as those noted above have found that computer-based learning informational systems have positive effects on test scores, some researchers warn that technology can be harmful if used incorrectly (Kroesbergen & Van Luit, 2003; Vargas, 1986). The computer cannot remediate some difficulties that students encounter in the classroom. Kroesbergen and Van Luit explained, "Computers are helpful when self-instruction is used. However, for the learning of basic skills, direct instruction appears to be the most effective" (p. 111). Kroesbergen and Van Luit further warned that traditional intervention with humans as teachers was more effective with teaching basic math facts.

Based on the 2004 report card issued by the Tennessee Department of Education for Summitt County Schools, the school district's math scores were lower than the state's math scores. Summitt County has a three-year CRT NCE average of 49 compared to a three-year CRT NCE average of 51 for the state. However, Summitt County's students who were classified as economically disadvantaged scored slightly higher than the state's average. In addition, the students in that subgroup in 2004 met minimum proficiency standards for NCLB. The performance of the economically disadvantaged subgroup has been a concern for the school system because it has a school that is classified as "School Improvement 1" as a result of performance in this subgroup. The significance of this study was to identify the effectiveness of *Accelerated Math* on increasing mathematics achievement as measured by the *TerraNova* test for elementary school students in grades six through eight in a small rural school system in East Tennessee. Furthermore, I explored whether students using *Accelerated Math* achieved significantly higher scores than those students receiving traditional mathematics instruction. I analyzed scores for the norm-referenced test items, criterion-referenced test items, and the value-added portion of the *TerraNova*. It was important to analyze the NCE math scores based on norm-referenced test data, value-added scores, and criterion-referenced test data. One of the major changes to the accountability system is the movement to a criterion-referenced test accountability system instead of a norm-referenced test system (Tennessee Department of Education, 2004).

The Summitt County School District in East Tennessee has recently placed emphasis on increasing test scores. It is hoped that the implementation of a computer-based instructional management system in mathematics will help students achieve to their fullest potential. States, districts, and schools can make a difference in the mastery of mathematics. However, learning ultimately depends on many factors including but not limited to genetics, parental influence, and teachers and the support they receive. The support includes a combination of curriculum, instruction, and assessment. Faced with students at different ability levels, teachers are challenged by the dilemma of presenting content that benefits all students--those performing two years ahead of grade level as well as those functioning two years behind grade level. In addition, teachers need management capability so they can provide immediate feedback. *Accelerated Math*, an integrated learning system that provides management capability, is a math program that combines research-based teaching practices with formative and diagnostic assessments. It is used to generate daily, individualized math practice for students. It keeps records of students' progress and provides numerous reports (Renaissance Learning, 2004).

The ultimate goal of the *Accelerated Math* program is to improve learning by providing personalized instruction for every child regardless of his/her ability or functioning level. The program is designed to motivate students by providing instruction on the students' functioning level and monitoring progress by setting goals. The goal of this type of instructional system is to assess ongoing work, monitor students' progress, provide immediate feedback to the students, and modify the instructional process to improve learning (Black & Wiliam, 1998).

Mathematics is entering a new era in which educators use scientific-based research and adopt best practices. The authors of the 1998 NCTM standards acknowledged that there were flaws in the conception behind the 1989 NCTM standards (National Council of Teachers of Mathematics, 2000). Over the past few years, research has changed the way educators think about teaching mathematics and students' learning development. Carnine and Gersten (2000) acknowledged, "We educators have also gained some powerful insights into how students develop either effective mathematical strategies or serious misconceptions. We need to build upon this base using rigorous controlled studies" (p. 142).

Limitations and Delimitations

The population consisted of students who were fourth, fifth, or sixth graders during the 2001-2002 school year and who had taken the *TerraNova* every year. The study consisted only of students who were enrolled and who had taken the *TerraNova* for three consecutive years beginning in the spring of 2002. These students attended one of the four elementary schools in a small rural school system in East Tennessee. During the three-year period for which data were collected, the control group received traditional math instruction while the experimental group received *Accelerated Math* instruction. The integrated learning and management system, *Accelerated Math*, was the sole source of instruction in the experimental or treatment group. Students' achievement was measured using the mathematics composite score on the *TerraNova* tests.

Each of the four elementary schools had at least one teacher participating in each group. Teachers were given the opportunity to select the method they preferred to use. Approximately two thirds of the teachers selected *Accelerated Math* while the remaining teachers used traditional math methods. Because the students were not randomly assigned to groups, the study used a nonequivalent control group design for a quasi-experimental study. The researcher analyzed the relationships of both students who received *Accelerated Math* instruction and those who received traditional math instruction. The instrument used in the assessment was the *TerraNova*. Even though randomized assignment to groups was not practical, the intact groups were similar. It was the desire of the researcher to have subjects randomly assigned to groups. However, school policies allowing students to select their teachers prevented a true experiment.

Overview of the Study

This study is organized into five chapters. Chapter 1 includes an introduction, statement of the problem, definitions, research questions and hypotheses, significance of the study, limitations and delimitations, and overview of the study. Chapter 2 presents a review of literature and includes the following sections: introduction, instructional factors and student achievement, curriculum-based instructional management, individualized instruction, curriculum alignment, mastery, accountability, computer-assisted instruction, integrated learning system, *Accelerated Math* studies, and a summary. Chapter 3 details the research methodology. Information is provided on research design, population, instrumentation, a description of Summitt County Schools' implementation of *Accelerated Math*, teacher quality, description of *Accelerated Math* courseware, data collection, and data analysis. Chapter 4 includes the findings or results of the study. In Chapter 5, the findings are summarized and interpreted and from the analysis, conclusions are made. In addition, limitations and recommendations for practice and further consideration are given.

CHAPTER 2

REVIEW OF LITERATURE

Introduction

Chapter 2 contains a review of literature related to the effects of the use of *Accelerated Math,* a learning information and management system, on math achievement as measured by the *TerraNova*. Educational research over the past few years has contributed to knowledge about factors related to students' success in math. The educational process is complicated. Some researchers claimed that technology has not appreciably changed the quality of instruction over the past 20 years despite anecdotal assurances of progress (Martorella, 1997).

Moursund (1999) questioned why education's large investment in technology has not produced significant improvement in education. Kindergarten through grade 12 schools typically spend 2% of their annual budget on technology. Over the last 30 years, the percentage of time U.S. businesses have spent using technology has risen from 3% to 45% (Deubel, 2001). The structure of schools in the form of organized grades by age and departments works against many of the advantages that technology provides. Schools must also deal with the rapid changes in technology. Along with the need to know how often students use computers is the need to know how students are using technology. Cuban, Kirkpatrick, and Peck (2001) reported that teachers and students used computers mostly for word processing. Both supporters and critics of school technology agreed that software and hardware had been used in limited ways (National Center for Educational Statistics, 1997). Teachers said that technology itself was unreliable. They alluded to inadequate wiring, crashing of servers, and obsolete software as well as inadequate computers (Cuban et al.). Educators who depend on technology for instructional purposes need reliable computers and software. According to Deubel (2002), many parents and educators admitted they believed computers were in schools to improve achievement test scores.

However, software that can lead to achievement gains by using individualized instruction has a high price tag. According to Soloway (1998), schools generally used only software that came bundled with the computer. Software is a key component for technology to play a vital role in improving education. Rarely did the infusion of technology into the classroom result in decreasing test scores (Soloway).

In reference to increasing achievement test scores, Deubel (2002) found that technology was more effective in helping students with lower initial achievement scores. Based on a survey of 113 teachers from 35 middle schools in 13 Ohio urban school districts in 2001, Deubel (2002) examined the use and effectiveness of software to help students pass Ohio's standardized test. The sample size (N) was 128. Of the sample, 88% responded to the survey. Deubel (2002) stated, "Teachers clearly pointed out the need for drill-and-practice software for students who were failing the proficiency test because they lacked basic skills" (p. 11). The research was based on teachers' perceptions of the software they used in the classroom.

Much progress has been made in the last few years in integrating technology into instruction. Educational researchers have identified the two major ways in which students use computers in schools: (a) learning from computers and (b) learning with computers. In the first case, the computer acts as a tutor. This type of student use includes *Accelerated Math* as well as other computer management and integrated learning systems. The latter type was that in which students used computers to write, analyze data, and do research (Barnett, 2003).

Researchers have found that technology use can impact learning under certain conditions. Some of those conditions included students having easy access to technology, ongoing teacher training, placing technology in the classrooms, and ensuring that the software was well matched with the students' needs and objectives of instruction (Barnett, 2001; Butzin, 2001).

Teachers have expressed the need for drill and practice software for students who are failing math because of the lack of such skills (Deubel, 2001). Drill and practice software can be especially useful in middle and high schools. Drill and practice software can make a difference in improving these achievement test scores (Deubel, 2002). As Deubel (2001) mentioned, expertness in a skill depends upon correct practice. Once basic underlying skills have been automated, the next step is to acquire broad background knowledge of the subject. The best way to develop a skill is to focus on that skill until it can be performed without conscious thought.

Educators have the responsibility to research the best ways to teach math and measure students' success. In a national survey by Education Week (1999), only 12% of teachers reported that their state or school system provided lists of software programs that matched the state's curriculum standards. Teachers are faced with the dilemma of satisfying curriculum requirements, especially in states with high-stakes tests, and attempting to select appropriate software programs aligned to state standards (Moursund, 1999). Wong (2001) investigated the effects of computer-based homework to paper-based homework on achievement, retention, and attitudes. He found that students who received computer drill and practice homework performed significantly better in achievement and retention than did the students completing paper-based homework. The primary reason for the computer-based success was the immediate feedback. Wong's research showed that no significant difference existed in students' attitude toward mathematics between traditional instruction and computer-based instruction. Singh, Granville, and Dika (2002) found attitude and time-on-task to be the two primary factors in mathematics achievement. Students' attitudes rather than standardized test scores were more useful in predicting academic performance.

Instructional Factors and Students' Achievement

Teachers do not have the opportunity to choose their students; consequently, they face the task of educating students who are very different. Although teachers have no control over individual characteristics of students, they do have control over the kind of classroom environment they construct with their students and the kinds of instructional practices they use. Instructional factors can have measurable effects on students' learning. When evaluating the components of an intervention program, it is important to recognize the effects of instructional and noninstructional factors (Turner & Patrick, 2004). Kosciolek (2003) separated factors related to a student's success into three categories: the students' characteristics, environmental characteristics, and instructional characteristics.

Several student characteristics have been evaluated to assess their relationship to mathematics achievement. Prior mathematics achievement and a student's ability have been identified as strong predictors of future achievement outcomes (Kosciolek, 2003; Walberg, 1984). Numerous studies document the relationship between gender and mathematics. Beckwith (1983) reported that males generally scored higher than females in math. Benbow and Stanley (1982) found large and consistent gender differences favoring boys in mathematical reasoning ability. This finding was consistent with their previous studies that were conducted in 1980 and 1981 (Benbow & Stanley). In their longitudinal study, they found consequences to linger in high school. Girls continued to score lower in mathematics assessments during the remainder of their public education. In addition to gender differences in mathematics performance, racial and ethnic differences have also been found (Catsambis, 1994). Catsambis found mathematics achievement for minority students to consist of limited learning opportunities and low achievement levels.

In addition to students' characteristics, factors in the environment have also been linked to mathematics achievement. Several sources indicated that students with lower socioeconomic status performed at a lower level in mathematics than did students with higher status (Quinn, 1984; Weaver, 2000). Students in high-ability groups viewed math more positively, exhibited more enthusiasm, and did more homework than students in low- or middle-ability groups (Burks, 1994). The use of computers and other technology led to higher test scores in mathematics classes (Weaver). Quinn found that a goal-based educational management system approach was much more effective for middle- to lower-socioeconomic-status students than a traditional approach. For students in a high socioeconomic-status group, the difference was not significant.

Accelerated Math can be used as a goal-oriented independent study mathematics curriculum. Researchers have found that a minimal relationship existed between students' achievement and educational expenditures except for direct instructional expenses such as classroom supplies (Childs & Shakeshaft, 1986).

Instructional factors are also important when planning educational programs and interventions. First, instructional factors have a great effect on students' academic achievement (Kosciolek, 2003). Teachers have more control over instructional factors than student and environmental factors (Bloom, 1984). Bloom went on to suggest that teachers use mastery learning, emphasize higher mental process learning, use goal setting, and provide corrective feedback. Shafer (1998) mentioned a three-point improvement plan to improve math scores. This plan consisted of stressing objectives to be tested, using manipulatives, and teaching problem-solving strategies. Shafer's research showed that math scores rose steadily thereafter when these techniques were implemented.

Walberg (1984) synthesized the results from thousands of studies on factors related to students' achievement and identified several factors relating to student outcomes. He focused on reinforcement, corrective student feedback, cooperative learning, individualized instruction, and adaptive instruction. Most of these factors can be categorized as student characteristics, instructional factors, or environmental factors. He computed the effect size and correlations for different factors and found some to have strong, positive relationships with outcomes. Reinforcement had the highest effect size (1.17). Feedback (0.97) and cooperative learning (0.76) also had strong positive relationships with students' achievement. He found that some factors had a much stronger relationship with academic achievement than did others. He also suggested the need for devoting more time to academic learning both in school and out of school and the importance of involving families in the educational process (Walberg, 1984).

Turner, Meyer, Midgley, and Patrick (2003) found that students in classrooms that encouraged individualized instruction and intrinsic motivation had fewer discipline problems and higher achievement than did their counterparts. Shafer (1998) identified a three-point improvement plan to increase low math scores. The plan consisted of identifying the objectives to be tested, teaching problem-solving strategies, and increasing the time spent on mathematics instruction. Shafer found that math scores steadily improved after implementing this plan.

Walker (1998) found three factors that substantially improved student achievement: increased instructional time, mastery learning, and instructional alignment. Instructional time refers to the need to increase academic instructional time; mastery learning is the process of defining an objective, teaching it, testing specifically what was taught, and enriching that objective and reteaching it, if necessary; and instructional alignment is the connection between the intended outcome, the instructional process, and the assessment. More quality time spent on instruction results in more in-depth learning. Walker contended, “The more quality academic time devoted to a concept, the better the student’s opportunity to master it” (p. 16). Educators continually discuss ways to increase instructional time. Mastery learning is a concept that is consistent with other research. Walker introduced the two concepts of mastery teaching and mastery learning as a single component--defining an objective, teaching that objective, testing specifically what was taught, enriching that objective, and reteaching if the objective is not mastered.

Bloom (1984) showed that students provided with individual tutors typically performed at a level of about two standard deviations (two “sigma”) above where they would normally perform with group instruction. This means that a student who would score at the 50^{th} percentile after group instruction would score at the 95^{th} percentile if the instruction were individualized. Bloom advocated trying to make group instruction as effective as individual instruction. He identified numerous variables that influenced students' achievement.

Walberg (1984) also identified variables associated with students' achievement. He found tutorial instruction to have the largest effect size (2.00), followed by reinforcement (1.20), corrective feedback (1.00), and time on task (1.00). He found the lowest effect size (0.25) was attributed to socioeconomic status. Socioeconomic status is generally independent of the instructional factors and cannot be easily altered by the classroom teachers. Bloom (1984) discussed independent instruction simultaneously with tutorial instruction. Vockell (1994) analyzed poor teaching methods and questionable class activities. He argued that if recommended techniques could move students up two standard deviations, poor teaching could move them down by two standard deviations. Vockell reasoned that if teachers are incompetent, they would lower the students' performance by an effect size of two. He suggested that teachers stop wasting instructional time. Students who mastered the objectives achieved at a substantially higher level than did their traditionally-instructed peers (Walker, 1998).

Gersten et al. (1987) conducted research on direct instruction with a particular emphasis on studies of instructional design and technology. They found that the same instructional variables affecting students' learning with traditional materials also affected learning with computer-assisted instruction. They also provided recommendations for effective teaching based on the Direct Instruction approach. Direct Instruction includes the following features: (a) teaching a step-by-step method, (b) ensuring mastery at every step of the instructional process, (c) providing immediate corrective feedback, and (d) moving from teacher-directed instruction to independent student work (Kosciolek, 2003). House (2004) identified factors that are associated with effective teaching and learning in mathematics. By assessing the relationship between instructional practices and mathematics achievement, he found that increased homework resulted in higher mathematics test scores. However, using class time for students to check other's homework or for the teachers to check homework resulted in lower mathematics test scores.

Weiss and Pasley (2004) indicated that the quality of instruction did not depend on whether the teacher used a traditional approach or a reform-oriented approach. They also observed a pattern of differential quality of instruction with minority groups and in classes of varying ability groups. They also found that one of the most important aspects of effective mathematics instruction was significant, worthwhile content. Researchers indicated that someone other than the teacher usually makes the decisions about the content (Ewing, 2003; Weiss & Pasley). The teacher's content knowledge did not guarantee high-quality instruction.

Factors associated with the instructional process are great predictors of learning. The relationship of curriculum coverage to growth is important. Students' achievement is related to many different factors and the most important factors may be different depending on the educational levels of the students. Student learning is a dynamic process. Likewise, factors that influence learning may be dynamic and subject to change as the goals and interests of students change (Wilkins & Xin, 2002).

Fuchs and Fuchs (1998) provided a list of factors that are important for mathematics education. Their findings were consistent with other researchers. Kosciolek (2003) stated that effective mathematics instruction includes student engagement, challenging achievement standards, and practice in problem solving. For lower-ability mathematics students, Fuchs and Fuchs suggested numerous adaptations. These included: individual goal setting, individualized instruction, proper curriculum alignment, computer-assisted instruction, mastery learning, and corrective student feedback. Kosciolek noted three factors that were consistently identified by research as having a positive impact on students' mathematics achievement. They were (a) matching instruction so that it is appropriate to the students' skill level, (b) providing corrective feedback to students, and (c) frequently monitoring students' academic progress. The *Accelerated Math* instructional components were consistently mentioned by the researchers as major components of effective mathematics instruction.

Curriculum-Based Instructional Management

Numerous educational standards exist in mathematics. Educators are seeking to improve their instructional process through the alignment of the curriculum to these standards. One of the methods now moving to the forefront of aligning the curriculum to standards is the use of computer-based instructional management systems (Elias et al., 2000). Information management is an important part of aligning the curriculum, instruction, and assessment as well as providing corrective feedback on students' performance. A curriculum-based management system is a standardized methodology that includes specific procedures by involving the students' curriculum, administering and scoring tests, summarizing the assessment information, providing student feedback, and using the assessment information to formulate instructional decisions (Spicuzza et al., 2001). It is necessary to use computer-based instructional management systems for student monitoring and reporting (Carter, 1997). Elias et al. found that curriculum-based management systems improved students' performance and created more meaningful classroom assessments. With more emphasis on "high stakes" testing under NCLB, schools are constantly seeking ways to improve instruction and assessment.

Ysseldyke, Betts, Thill, and Hannigan (2004) researched a curriculum-based instructional management system that was used to enhance the mathematics instruction of students in middle school grades three through six. They compared the math achievement of Title I students who participated in the instructional management system to those who did not participate in the program. Their findings indicated that the students who participated in the instructional management system significantly outperformed those who did not. Students in the experimental group gained 7.9 Normal Curve Equivalents whereas those in the control group gained 0.3 NCEs, a difference in gain of 7.6 NCEs. The effect size was 0.5. The researchers found the computerized curriculum-based instructional management system to have a significant effect on students' gains in mathematics achievement ($p<0.0001$). An analysis of nonTitle I students showed similar results (Ysseldyke et al.).

The computer-based curriculum instructional management system is a highly specialized application of the computer to assist in managing individualized instruction in the classroom. It is intended to supplement instruction whereas computer-assisted instruction (CAI) places emphasis on drill and practice, computer-based instruction. A curriculum-based instructional management system can help teachers with the day-to-day management tasks in the classroom.

In mathematics, teachers face the challenging tasks of deciding what to teach and how to teach it as well as deciding which objectives to assign, providing students with practice, scoring students' work, providing corrective feedback, and constantly monitoring students' progress. Most of these variables are addressed by curriculum information management systems (Szabo & Montgomerie, 1992).

One type of curriculum-based instructional management system is computerized. Fuchs and Fuchs (1998) examined the effects of a computerized curriculum-based instructional management system and found that overall student achievement increased with this type of treatment. Moreover, whenever corrective student feedback and mastery was incorporated with the computerized curriculum-based system, performance improved substantially (Fuchs & Fuchs).

Instructional match to the students' level of ability and academic learning time are two critical factors found in the computerized curriculum-based instructional management systems (Butzin, 2001). Walberg (984) documented the need to match academic assignments to a students' level of ability. In mathematics, a students' mastery of an objective will signify that the student is operating on his or her instructional level. Carnine and Gersten (2000) identified the link between functional instructional levels and assigned lessons with academic achievement.

Ysseldyke, Spicuzza, Kosciolek, Teelucksingh, et al. (2003) recommended that students' success rate on independent assignments be 80% for instructional lessons and 90% for review. The amount of time a student spends engaged in an academic lesson that is matched to his or her ability level is a strong predictor of academic achievement. This amount of time, commonly referred to as academic learning time, can be defined as "the amount of time a student spends engaged in an academic task that he can perform with high success" (p. 251). Academic learning time is made up of three components: (a) amount of time allocated for instruction, (b) students' rate of comprehending academic information, and (c) the students' success rate or mastery (Ysseldyke, Spicuzza, Kosciolek, Teelucksingh, et al.).

Students in the United States spend little time academically engaged in school, often minutes per day. Therefore, educational interventions that can alter the instructional features to increase the students' academic learning time hold promise to improve academic learning of all students (Benbow & Stanley, 1982).

Curriculum-based measures are a valid, reliable, and empirically based technology that can be used to effectively monitor students' performance (Fuchs & Fuchs, 1998). Teachers can use the information from the curriculum-based instructional management system to monitor students' progress and adjust the instructional assignments for each student on an individual basis. The goal of this type of instructional management system is to monitor students' progress, provide corrective feedback to students, and adapt instruction as needed (preferably on an individual basis) to improve overall academic achievement (Black & Wiliam, 1998).

Accelerated Math is an example of a computerized curriculum-based management system. It appears to incorporate many of the effective instructional factors previously mentioned in research. *Accelerated Math* allows teachers to manage multiple mathematics objectives by matching objectives to the students' skill levels, monitoring students' progress, and providing immediate feedback. This computerized curriculum-based management system automates the tasks of scoring, record keeping, and assigning practice (Spicuzza et al., 2001).

Individualized Instruction

In the 1950s, educational concepts centered around three related forces: behavioral psychology, programmed instruction, and individualization (Rose, 2004). Behaviorists such as Ivan Pavlov and Edward Thorndike provided an accepted basis for conceptualizing intelligence and learning (as cited in Jenkins & Keefe, 2001). B.F. Skinner dismissed the psychological processes taking place in the child. Skinner suggested that learning would occur if appropriate reinforcement were applied. According to Skinner, teaching machines reduced instructional time to half of that required to learn the same material in teacher-led classroom because the machines allowed each student to proceed at his/her own rate (as cited in Jenkins & Keefe). Skinner contended that holding students together for instructional purposes in a class was probably the greatest source of inefficiency in education (as cited in Rose, 2004). The alternative for holding the students together is individualization. Individualized instruction is simply adapting instruction to the individual. Students work through programmed materials at their own rates of speed (Jenkins & Keefe).

Effective, individualized instruction requires that: (a) students are assessed on a formative basis throughout the year, (b) appropriate instruction is assigned immediately upon completion of an assignment, (c) assignments are at the students' point of instructional need, (d) assignments contain assessments to determine mastery, and (3) data are available for teachers to track students' progress (O'Neal, 2004). Several factors have increased teachers' frustrations in the regular classroom as they try to meet the needs of students with varying ability levels. Limited educational funding and a push for increased heterogeneous grouping have contributed to a decrease in individualized instruction (Davalos & Griffin, 1999).

Individualized instruction supports the two most important conditions for active mental engagement: the intensity of motivation to learn and the quality of the instructional support for learning. Unlike standardized approaches to learning that hold time constant and allow achievement to vary, individualized instruction permits students to work on standards until they are mastered (Deubel, 2002).

Regardless of how hard teachers work, it is difficult for them to provide one-on-one instruction. Teachers are asked to ensure that each student is being taught at his or her appropriate instructional level and that all of the instruction meets their state's standards. In addition, teachers are typically dealing with larger class sizes now than ever before--with an average of 25 students in elementary classrooms (O'Neal, 2004). Therefore, even though one-on-one instruction is viewed as highly effective, it is not frequently implemented (Vaughn, Hughes, Moody, & Elbaum, 2001). The student-teacher ratio is usually low in classes using individualized instruction. The assumption is that small classes enable teachers to offer more individualized instruction to students. However, smaller classes do not necessarily ensure that one-on-one instruction will follow (Jenkins & Keefe, 2001).

In the latter part of the 20^{th} century, the argument was that "existing teacher-led modes of instruction had arisen from the need to deliver instruction efficiently to a mass of learners" (Rose, 2004, p. 49). As a result, teaching was presented to the average child. Therefore, students of differing abilities were forced to move through the curriculum in unison with everyone else.

Without individualized instruction, all students are expected to complete the same instructional activities in the same amount of time regardless of ability. Teachers can meet the needs of all students by careful use of a variety of grouping practices including one-on-one instruction (Vaughn et al., 2001). As Rose expressed, "Somewhere along the line, behavioral modification strategies to enhance the learner's acquisition of knowledge came to connote opportunities for a self-motivated learner to engage in independent discovery" (p. 50). One of the main challenges in education today is the assurance that each teacher will provide individualized instruction to every child including remediation or enrichment (O'Neal, 2004).

The traditional instructional format has historically placed the teacher in front of the classroom delivering instruction to the class as a whole. Researchers have agreed that whole-class instruction has been the dominant approach to instruction. A recent study involving 60 general education classrooms that were observed for over a year confirmed that whole-class instruction was the norm (Vaughn et al., 2001).

When teachers are not providing whole-class instruction, they typically circulate around the room monitoring students' progress. Many professionals have argued that teachers must decentralize some of their instruction if they are going to meet the needs of the students (Fuchs & Fuchs, 1998). Teachers indicated that it was more feasible to provide whole-class instruction in large groups rather than small-group instruction that is individualized. Teachers have reported that it was difficult to modify their instructional routines to include these concepts (Vaughn et al., 2001).

Teachers often continue to ignore an individual student's lack of response to current methods. Fuchs and Fuchs (1998) noted that teachers were not very responsive to suggestions of individualized instruction in an attempt to enhance students' learning. However, teachers' views of individual instruction appeared to change when assigned to a treatment group involving individual adaptations. Compared to teachers in the control group, those in the treatment group using individual instruction reported a greater variety of skills taught, more frequent reteaching of selected lessons, and more frequent deviation from the teacher's manual. They also noted that the reorganized setting was effective in enhancing the responsiveness of low achievers. Over multiple studies, they observed that 90% of low achievers experienced better-than expected growth (Fuchs & Fuchs).

"Traditionally, one-on-one instruction in which the student receives explicit instruction by the teacher is considered the most effective practice for enhancing outcomes for students" (Vaughn et al., 2001, p. 135). Most teachers realize that that their classrooms contain students with a wide range of skills but they can only teach one objective at a time in a traditional format.

Davalos and Griffin (1999) explored the impact of teachers' individualized practices with fifth-grade gifted students in rural classrooms containing students with varying levels of ability. Profiles of gifted students were developed using interviews and classroom observations. The researchers spent more than 200 hours observing teachers over a period of one and a half years. Teachers chose to focus on content, rate of learning, and modes of instruction. Generally, they found that individualization of instruction for learners of different abilities resulted in more appropriately meeting both the academic and affective needs of gifted learners. However, the setting of goals also played a role in the implementation of individualized learning. Some teachers chose goals that were easy to implement but had little or no real impact on instructional techniques, whereas others understood the need for individualized education and set more substantive goals (Davalos & Griffin). It seems like overwhelming work. However, current research shows that technology is a solution. Technology is still frequently overlooked by educators who adhere to the status quo methods. "Unless we can provide one-to-one instruction, we--and more importantly, our students--will fail" (O'Neal, 2004, p. 36).

Curriculum Alignment

Curriculum alignment must follow the same principle that an auto mechanic uses. An auto mechanic will line up the direction of the wheels so the vehicle is pointed in a straight line. Research indicates that curriculum alignment can improve achievement in schools. However, curriculum alignment must be viewed as a process instead of an event. It cannot be completed in one day or one week. It includes the material outlined in the textbook, what is taught, and what is tested. Frequently, one or more of these areas will not be aligned with the others (Hanson, 2004).

Gaps often exist between the curriculum, what is taught, and what is tested. Blank, Porter, and Smithson (2001) documented the gaps when they examined the math instruction in 11 states. Research revealed that only a few content topics and subtopics were covered on state tests. The findings were consistent with other evidence about mathematics instruction such as those from the Third International Mathematics and Science study's results (National Center for Educational Statistics, 1997). The data showed that instruction was spread over numerous topics but lacked depth of study on each topic. A perfect alignment usually does not exist between instruction and state-level tests as this would result in a narrowing of the curriculum.

However, students score significantly higher on state tests after curriculum alignment has taken place (Blank et al., 2001). According to Hanson (2004), an analysis of international studies shows a curriculum alignment to result in a measurable increase (31 percentile points) in students' achievement. Each state's department of education ensures that state tests are aligned with state standards and state curriculum frameworks. Therefore, educators have a responsibility to ensure that the curriculum taught is carefully aligned to their state. Hanson reported that 80% of teachers and 82% of parents indicated they thought curriculum alignment helped improve academic performance. As Ewing (2003) found, the process of aligning instruction to the state standards based on the annual assessment provides teachers with prompt feedback on students' performance.

McGehee and Griffith (2001) found that teachers try to maximize students' performance by modifying their instructional techniques and aligning their taught curriculum with the test. They found that alignment with the written curriculum and the taught and tested curricula resulted in students performing better on state assessments. “The need for standards and assessments to work together to guide student learning has never been greater” (Ananda, 2003, p. 18).

Schools with aligned curriculum showed significant increases in standardized test scores as well as significant movement from below proficiency toward proficient and advanced. A small Arkansas district increased its standardized test scores by at least 10 percentile points after performing curriculum alignment. In addition, another school district that focused on curriculum alignment in the elementary grades had 72% of its 1999-2000 fourth graders in the proficient and advanced categories compared to 37% for the state (McGehee & Griffith, 2001).

The value in curriculum alignment is not limited to increased test scores. Instead, it is the process of teachers moving from static, traditional models based on teaching solely from the textbook to a dynamic model based on students' learning (McGehee & Griffith, 2001). NCLB requires states to adopt content standards for grades three through eight, perform annual testing of these standards, and to report the results of the assessment. The assessment must be aligned with states’ standards. NCLB also requires states to set up an accountability system in which all students will be expected to score at “proficient” level on state assessments by the year 2014 (Ananda, 2003). Therefore, school districts have only 12 years from the 2002 implementation date of NCLB to bring all students in every grade up to the proficient level. In moving toward the goal of 100% proficiency, the state minimum requirement for “proficiency” increases annually. Considering the ramifications for failing to meet the average yearly progress, educators must afford great attention to curriculum that is closely aligned to their states' standards and annual assessment program. For example, if a Tennessee school fails to meet minimum proficiency levels for four consecutive years, state policies call for the removal of the school administrators and, possibly, faculty.

Mastery

Goals can be either mastery or performance oriented. Mastery goals are concerned with improving competence whereas performance goals are concerned with proving competence to others (Schraw & Aplin, 1998). Schraw and Aplin found no relationship between mastery goals and grades. With mastery goals, students work toward improving their competence based on standards. Mastery goals are those designed to improve competence (Schraw & Aplin). According to Elliott and Dweck (1988), student goals are related to classroom behavior and academic achievement. Teachers express enthusiasm and expect students to learn whenever mastery goals are used in the classroom (Turner & Patrick, 2004). Mastery goal orientations are related to classroom behavior and academic achievement (Elliott & Dweck). Mastery orientation consists of task-focused goals (Shraw & Aplin).

A student’s advancement through the instructional process requires mastery of an objective prior to moving forward. In their research on mastery, Kulik and Kulik (1987) observed that mastery increased achievement results by .54 standard deviations or from the 50th to the 71st percentile (p. 339). They found that the effects of mastery were more apparent on low-ability students. Fuchs and Fuchs (1998) also found that mastery was more effective with low-ability students. The effects of mastery-based assessment are increased by effectively using corrective feedback to students (Kulik & Kulik). In addition, those who use mastery levels of at least 90% will do significantly better than those who use lower performance levels (Kulik & Kulik).

Mastery testing is consistently associated with more effective instructional programs. Mastery testing should include teaching, testing, reteaching, and retesting until most students are achieving at least 90% accuracy on assessments (Kulik & Kulik, 1987). Teachers using a mastery goal orientation are more likely to have students developing new skills, trying to understand the instruction, improving their test scores, and being more motivated (Elliott & Dweck, 1988). By using task-focused goals with mastery orientation, students have the opportunity to master one basic skill at a time and at their own pace prior to moving to another objective. Mastery should include the review of previously learned material (Kulik & Kulik).

Accountability

Accountability encompasses assessments, national mathematics performance, accountability requirements of NCLB, and Tennessee-specific accountability issues. The publication, A *Nation at Risk* (as cited in Walberg, 2003), foreshadowed the accountability movement. Even though the word accountability never appeared in the *Risk* report, it did call for higher academic standards and its focus on students' achievement laid the groundwork for the high-stakes testing that has come to fruition. Although rewards and sanctions were missing from the *Risk* report, NCLB included them. The development of state curriculum standards and tests aligned to the standards became prevalent following the *Risk* report and continued throughout the 1990s. The sanctions for poor performance under NCLB guidelines have been barely tested. In nearly all states, schools continue to function and teachers remain employed even when gross incompetence and malpractice exist. It remains to be seen whether the federal government will withhold funds from school districts that fail to comply with NCLB. Despite the policy of state standards, tests, and accountability, a difference exists between what teachers teach and what is called for in standards-based reform represented by NCLB (Walberg, 2003).

Recognizing the importance of public education, the federal government took on a larger role in financing it in the middle of the 20th century with the passage of the *Elementary and Secondary Education Act*. Through subsequent reauthorizations, this Act has continued to assist the states financially. In 2001, the reauthorization included the NCLB that required states to set accountability standards. The NCLB Act has an accountability system that is based on academic standards and assessments. It includes achievement of all students and accountability of nine different subgroups consisting of race/ethnicity, students with disabilities, and the economically disadvantaged (*No Child Left Behind*, 2004).

Accountability has become the centerpiece of educational reform. The underlying assumption is that if teachers and students are held accountable for students' scores on standardized tests, then academic standards will rise (Rotberg, 2001). Large-scale assessments are an important part of the educational system in America. In addition, mathematics achievement has been a particular target of interest (McGehee & Griffith, 2001). According to McGehee and Griffith, the National Assessment of Educational Progress and the Third International Mathematics and Science Study have brought about much discussion concerning the quality of mathematics instruction in the United States. Recent results from these reports comparing the level of mathematics education in the United States to other countries have generated concern among many educators. These findings have been disappointing and have led to political pressure to increase the accountability of public education (McGehee & Griffith). Rotberg contended that current accountability measures, particularly high-stakes testing, have weakened the academic standards they were intended to raise.

Since 1965, the United States has nearly tripled the amount of money spent on public education. However, over that same period, test scores have remained relatively constant (National Center for Educational Statistics, 1997). There is a strong effort across the country to implement NCLB. With the NCLB Act, states and school districts have received $23.7 billion to implement research-proven programs and practices to increase test scores (*No Child Left Behind*, 2004). School systems have great flexibility in deciding how to spend these federal funds. However, legislators suggest the use of these funds to purchase scientifically-based research programs. The first principle of accountability in NCLB involves the creation of state standards pertaining to what a child should know in reading and math in grades three through eight. With those standards in place, students' achievement will be measured according to state tests that are designed to those standards. States are to develop rigorous academic standards and those standards should drive the curriculum, which, in turn, must drive instruction. Each state must determine the minimum number of students (N) sufficient to provide statistically reliable information for reporting assessment results. The number of students (N) will be used to identify schools in need of improvement (*No Child Left Behind*).

The states that have instituted tough standards and accountability systems have experienced real gains in achievement. In particular, standardized test scores of states with accountability systems that included grade-by-grade standards aligned with the curriculum, statewide assessments linked to standards, and computerized feedback systems had the greatest advancements. Connecticut is the only state with more than a third of its students meeting the standards for "proficiency" in eighth-grade mathematics as set by the National Assessment Governing Board that congress created to set forth national standards and to measure their degree of attainment (Walberg, 2003).

Rotberg (2001) stated the current emphasis on accountability as measured by standardized testing had influenced educational practices as well as curriculum decisions in the classroom. Braswell et al. (2003) noted that new international academic achievement data revealed a dismal performance in mathematics. Braswell et al. disclosed that even though math results for fourth and eighth graders were positive, the percentage of improvement from the 1990 to the 1996 NAEP was insignificant.

However, mathematics performance in 2003 was higher. Braswell et al. (2003) found that 32% of fourth graders and 29% of eighth graders had performed at or above the proficient level in 2003. They found that average math scores were higher in 2003 than in all the previous assessment years at both grades four and eight. In addition, the percentage of both fourth graders and eighth graders scoring at or above the proficient level increased from 2000 to 2003. This included students in both the proficient and advanced groups. Of the 38 states participating in both the 2000 and 2003 assessments, all had higher average scores in 2003. Male students scored significantly higher than did female students in both grades in 2003. Braswell et al. also found that the gap between White and Black students decreased in 2003 as well as the gap between White and Hispanic students. Pertaining to socioeconomic status, the average score for students eligible for free or reduced-priced meals was significantly lower than the average score for students not eligible for free/reduced meals (Braswell et al.).

It should be noted that not all educators advocate high-accountability measures that are widespread in the United States. Rotberg (2001) contended that high-stakes testing weakens academic standards and the quality of education by encouraging or even requiring policies that may not be in the best interest of children. Standardized tests do not measure creativity, persistence, enthusiasm, leadership, or compassion (Bracey, 2001). Bracey concluded that between 50% and 80% of the improvement in annual test scores was temporary and caused by fluctuations that were not related to increased achievement. Some people contend that the high-stakes testing involves teaching to the test. However, these tests, especially criterion-referenced tests written to reflect state standards, are here to stay. The tests communicate what is important for the students to know and strongly influence what they are taught (McGehee & Griffith, 2001).

It is not reasonable to discuss accountability and assessment without discussing norm-referenced and criterion-referenced tests. States are in the process of moving from norm-referenced to criterion-referenced accountability systems. The problem with norm-referenced tests is that, by definition, half of the students will be below normal or below average. In criterion-referenced tests, the goal is to compare students' knowledge with some established criteria or standards. A problem with norm-referenced tests is that questions must be asked that most students would be expected to know and another group of questions that students are not expected to know. Therefore, not all of the questions are aligned with the curriculum. However, criterion-referenced tests generally reflect state standards and are more closely aligned with state standards. Henceforth, it is beneficial for educators to find instructional programs that are closely aligned with state assessments. Schools are constantly evaluating their curricula and seeking effective instructional strategies to improve their educational programs (McGehee & Griffith, 2001).

Several methods of evaluating assessment have been used over the past 30 years. The first of these methods used only students' scores from the current year to estimate school effects on student performance. This status-based method assumes that school effects are fixed. This method could fail to take into consideration schools' or students' variables that influence test scores. Status-based methods fail to adjust for students' incoming knowledge level. Therefore, alternate methods of assessment that adjust for incoming differences in knowledge level and ability are preferred. Most researchers suggest that a statistical method that relies on students' improvements rather than absolute scores is the only fair method of measuring the influence of schools and teachers on students' performance (Tekwe et al., 2004).

Methods that adjust for incoming knowledge of students produce value-added assessments. Tekwe et al. (2004) suggested that educators and researchers should consider value-added assessments to be better than status-scores. Measuring students' progress requires controlling for the initial level of achievement (Ballou, Sanders, & Wright, 2004). This can be done transparently if the pretests and posttests are vertically aligned or on the same achievement scale. In this case, the analysis can be based on the differences (gain scores) or value added (Ballou et al.).

Tennessee's *Education Improvement Act* (EIA) of 1992 established accountability standards for all public schools in the state and required the Department of Education to issue a

Report Card to the public. Tennessee state law (TCA 49-1-601) has been amended to include NCLB requirements. The goal of NCLB is to ensure that all students are proficient in math, reading, and language arts by 2014. Until then, schools and school systems will be evaluated on their progress of moving toward that goal. Tennessee's 2004 Report Card shifts from the traditional use of norm-referenced assessment (used with Tennessee's previous accountability system) to a criterion-referenced assessment (used under NCLB) to measure students' performance. Tennessee administered both norm-referenced and criterion-referenced tests in the spring of 2004. Each student took both tests; therefore, this enabled the statisticians to map the norm-referenced data to the criterion-referenced scale (Tennessee Department of Education, 2004).

Norm-referenced testing and criterion-referenced testing are two different ways of measuring performance. In the past, Tennessee has relied on NRT scores. This means that students' scores have been compared to a national sample to determine their performance. However, with criterion-referenced testing, students' scores are compared to a minimum proficiency standard for passing that area of the test. In 2004, Tennessee began an emphasis on criterion-referenced test reporting (Smith, 2004). Until 2004, value-added scores were determined based on norm-referenced test composite scores. During 2003-2004, Tennessee students were tested using both norm-referenced and criterion-referenced testing questions allowing for norm-referenced tests to be mapped to criterion-referenced testing scales (Tennessee Department of Education, 2004). This allows Tennessee to have value-added scores based on criterion-referenced test items for the first time (Smith, 2004).

Tennessee's value-added assessment system is among the most prevalent found in education. Although value-added assessments are popular, some researchers have been very critical of the Tennessee model because it fails to do enough to control for socioeconomic status and demographic factors. Researchers from the University of Florida (Ballou et al., 2004) found that these variables are usually statistically significant and estimates of teacher and school effects are sensitive to these variables. The omission of these variables from Tennessee's value-added assessment system has also led some educators to be critical of this model claiming that the effects of schools and teachers cannot be measured accurately without allowing for these variables. When data show that students from a higher socioeconomic status score higher on mathematics achievement, it is difficult to determine whether these differences in scores can be attributed to the quality of their education or their socioeconomic-status background (Ballou et al.).

Tennessee has a single statewide accountability system that ensures all school districts and schools make adequate yearly progress. The Tennessee accountability system implements the requirement of both NCLB and the *Education Improvement Act*. Value-added is an important component of that system (*No Child Left Behind*, 2004). The accountability system includes both rewards and sanctions. The Tennessee accountability system includes three levels of performance: advanced, proficient, and below proficient. Tennessee sets the cut-off scores for grades three, five, and eight for reading/language arts and math to determine the three levels of performance. Beginning in 2005-2006, Tennessee's accountability system will include grades three through eight instead of grades three, five, and eight. To meet adequate yearly progress, each school and the school district must meet minimum performance standards classified as proficient in three cells: math, reading/language arts/writing, and attendance/graduation rate (Smith, 2004).

As shown in Table 1, NCLB calls for all students to be proficient by 2013-2014. The quantitative values shown in Table 1 signify the percentage of students required to meet the minimum proficiency standards for that year. The minimum performance required to meet adequate yearly progress increases every three years.

Table 1

Elementary/Middle School Annual Targets

School Year	Reading/Language Arts Target	Math Target	Attendance Rate
2002-2003 through 2003-2004	77.1%	72.4%	93%
2004-2005 Through 2006-2007	82.825%	79.3%	93%
2007-2008 Through 2009-2010	88.55%	86.2%	93%
2010-2011 Through 2012-2013	94.275%	93.1%	93%
2013-2014	100%	100%	93%

From *No Child Left Behind* (2004)

TCAP Achievement Test (*TerraNova* Form C) national norms and norm gains can be found in Appendices A and B, respectively. In addition, the correct number of responses required to meet proficiency are shown in Appendix C. The ramifications for failing to meet the accountability system contained within NCLB varies based on the number of years the school or school district fails to meet minimum proficiency standards. For schools failing to meet the minimum requirement for one year, commonly referred to as “target” schools, no sanctions apply. For schools failing to meet minimum requirements for two consecutive years in the same category, referred to as “high priority schools," sanctions include free tutoring and school choice.

Furthermore, if schools fail to meet minimum proficiency standards for three or more years in the same category, penalties may include restructuring of the school.

Effective teachers make daily use of assessment information by adjusting instruction to meet the needs of individual students. Research shows that teachers who use student performance data to improve their teaching are more effective than are teachers who do not use such information (*No Child Left Behind*, 2004). Fuchs and Fuchs (1998) found that mathematics achievement of low-performing students accelerated when teachers received weekly summaries of their performance.

Computer-Assisted Instruction

Perceiving education in the United States to be in a crisis, some Americans began to look for ways to reform the educational system during the late 1980s (Stevenson & Stigler, 1992). About 5% to 10% of the students in American schools have major difficulties with mathematics (Kroesbergen & Van Luit, 2003). The seriousness of these difficulties can vary from problems within one area of mathematics to severe learning disabilities affecting all math content areas. Stevenson and Stigler stated that Americans believed substantial academic achievement was possible only in well-equipped schools. Stevenson and Stigler reported that the traditional American classroom was comprised primarily of teachers' lectures and textbooks. Carnine and Gersten (2000) stated that an important cause of math difficulties could be attributed to an inappropriate fit between the learning characteristics of the students and the instruction they received. In the case of an inappropriate or poor fit, the instruction must be adapted to the students' needs (Kroesbergen & Van Luit).

Stevenson and Stigler (1992) considered this "traditional instruction" as the primary reason why American children lag behind students in other countries. Their research was based on five major studies of what works in elementary education. They contended that factors such as class size, teacher salaries, and poorly trained teachers were not the only reasons for mediocre academic achievement. Americans tend to emphasize a child's innate ability as a key to his or her success whereas Asians emphasize the efforts they make. This basic difference in educational philosophy affects teaching strategies. Even though there does not seem to be a single factor that could solve the educational problems, Stevenson and Stigler suggested the first thing that needed to be done in the American educational system was to free up some time for teachers. One goal of computer-assisted instruction is to accomplish this task. In particular, a computerized management instructional system such as *Accelerated Math* is designed to perform many of the daily tasks with which teachers typically deal.

Computers appear to be the answer for today's most pressing need in education--the individualization of instruction (Rose, 2004). Rose described technology as an "ideal medium for delivering and promoting individualized learning" (p. 51). Technology expands learning opportunities for students by enabling students to work individually and proceeding through a curriculum at their own rate (Jenkins & Keefe, 2001). Technology enables teachers to monitor students' progress, observe students, provide immediate corrective feedback, and intervene when appropriate (Jenkins & Keefe).

The history of technology is relatively short because the first computer developed was the ENIAC around 1950. Its development began as a classified military project in World War II. The computer encompassed a very large room at the University of Pennsylvania. These early computers were used for problem solving purposes in science and engineering. The history of technology in education is even more recent. Most of the educational technology has developed over the past 20 years. In education, the original use of the computer was for drill and practice purposes (Becker & Hativa, 1994). The software was based on a Skinnerian model that emphasized drill and practice problem solving on an individualized basis (Becker & Hativa). In 1959, an individualized computer-based learning system called Programmed Logic for Automatic Teaching Operations (PLATO) was developed by the University of Illinois (Molnar, 1997). The project placed terminals in elementary schools, high schools, and community colleges around Chicago for reading instruction. In 1963, a significant CAI model named the Stanford Project developed from the PLATO system (Molnar). The Stanford Project was the first attempt to use CAI in public education. This math, reading, and language arts tutorial program was released in 1963 and provided students with rapid corrective feedback (Becker & Hativa). The individualized instructional program was considered a form of drill and practice instruction (Molnar). The program was effective in increasing students' test scores (Becker & Hativa). Therefore, it brought about the aggressive development of similar programs based on the same premise. Vargas (1986) identified drill and practice, simulations, tutorials, and writing as the four primary areas of emphasis in CAI. Major improvements in computerized instructional programs flourished during the 1980s and 1990s with the rapid development of technology. Rose (2004) defined CAI as "The use of the computer to present instructional content to the learner" (p. 50).

Wilson et al. (1996) found that effective software included an opportunity for students to respond and provided frequent corrective feedback. Traynor (2003) investigated how CAI improves student performance among various types of students. His study included 161 middle school students of various program types. Using ANCOVA, he found that regular education students had greater pretest-posttest gains than special education students ($F1, 156, 0.95 = 15.59$, $p<0.0001$). Collectively, Traynor found that students showed significant pretest-posttest gains (t, $160, 0.95 = 6.02$, $p<0.0001$) using a dependent t test. CAI increases motivation, which in turn, increases students' learning (Traynor).

Christmann and Badgett (2003) conducted a meta-analysis comparing the academic achievement of elementary students who received traditional instruction to traditional instruction supplemented by CAI. The study revealed that CAI was more effective in some academic content areas than in others. CAI was more effective than traditional instruction in mathematics. Meta-analysis uses a technique that relies on the calculation of effect sizes for establishing statistical meaning. Effect size is the degree to which a phenomenon is present in the study. In meta-analysis, the effect size is calculated to determine the statistical difference between the mean standard deviation of the two groups. Christmann and Badgett found a mean effect size of 0.342 from 68 studies. The mean effect size is positive because higher scores were attained by the students receiving CAI instruction. However, an effect size of 0.342 is small. They determined that the typical student using CAI instruction moved from the 50^{th} percentile to the 63^{rd} percentile (Christmann & Badgett).

Kulik and Kulik (1987) found that increased technology had a positive relationship with students' performance for most special education students. Research pertaining to the effects of CAI on mathematics achievements for special education is limited. Some researchers doubt the effectiveness of CAI. Applications of CAI in special education have been limited to drill and practice software (Wilson et al., 1996). Wilson et al. found that teacher-directed instructional delivery was superior to CAI under some circumstances for students with learning disabilities. They found that students' mastery of multiplication facts was higher for the teacher-directed format. They went on to say that research comparing teachers' delivery to computer delivery for special education students was difficult to interpret. Trifiletti, Frith, and Armstrong (1984) found that special education students produced greater gains in math using a CAI program rather than traditional workbook-based instruction.

Although the benefits of using CAI have been documented, there is a lack of research showing the impact of CAI on various types of students (Traynor, 2003). America is considered the great "melting pot." Public education in the United States includes students in various types of programs.

Some researchers distinguished between CAI and Computer Managed Instruction (CMI). Whereas students interact directly with CAI programs, CMI provides management data for the teacher in addition to instruction (Rose, 2004). The management data include a record of the students' performance including pretest and posttest scores and prescribe instructional activities for the students. In addition to providing instructional assistance, CMI operates to assist teachers in management functions in a nonthreatening way. CAI and CMI were based upon the belief that individualized instruction can best be monitored by a computer (Rose). *Accelerated Math* can be classified as both a CAI and CMI program.

Integrated Learning System

During the 1980s and 1990s, CAI and CMI programs were known as Integrated Learning Systems (ILS). Becker (1992) defined an ILS as "individualized computer software supplied by a single vendor and containing instruction and practice problems covering a curriculum" (p. 1). Integrated learning systems use computers for both instruction and management. The courseware includes a management information system that monitors students' performance and provides diagnostic as well as prescriptive information based on students' progress (Jenkins & Keefe, 2001). Advantages of ILS and CAI include their ability to individualize learning and provide immediate feedback to students. Students have an opportunity to proceed through the curriculum at their own pace providing for a greater opportunity for mastery.

Longitudinal research studies have been conducted to see how students learn from using computers. Educators in West Virginia began implementing computer technology one grade at a time up through grade six. Barnett (2003) documented that researchers followed students from the first grade through the sixth grade and found that students using computers had consistently higher gains on statewide tests.

Another important study was the Project CHILD from Florida (Butzin, 2001). Project CHILD placed computers in classrooms and provided teachers' training, as did the West Virginia project, and had students use software that was aligned with the state's content standards (Barnett, 2003). According to Butzin, Project CHILD confirmed that when students used computers, the students and schools achieved higher scores in both low- and high-achieving schools (Butzin). Barnett (2003) documented that the boost in achievement scores in Project CHILD was sustained over time; this was also the case in the West Virginia study.

Barnett (2003) found that students could achieve higher test scores when computers were used to complement the classroom instruction and that the effects of learning from computers were lasting. Becker (1992) found that ILS appeared to work best for low achievers and high achievers. The overall effectiveness of an ILS appears to be moderate for students in the middle of the class distribution (Becker).

The West Virginia and Project CHILD studies used the computer as a tutor. Barnett (2003) documented that the effect of technology was even more powerful when the computer was used as a tool in the classroom, as it is with *Accelerated Math*. In a study sponsored by Apple Computer that spanned 10 years, researchers from institutions of higher education and not Apple employees analyzed Apple's Classrooms of Tomorrow (ACOT) project. In ACOT, where computers were prevalent in every classroom, Barnett (2003) concluded that students demonstrated enhanced ability when computers were used. He documented that students maintained time on task for longer periods and this discovery led to changes in teachers' beliefs about teaching and learning. Numerous researchers conclude that technology can make a difference in how and what students learn in schools (Barnett, 2003).

Accelerated Math Studies

Accelerated Math is a "task-level learning information management system designed to generate individualized assignments or assessments for students" (Yamagata, 2001). The teacher assigns objectives from a software library that has been closely aligned to standards for that state. The program has numerous libraries linked to various states. For example, when a school in Tennessee purchases the program, the software contains mathematics objectives aligned to the Tennessee curriculum frameworks. These objectives can be assigned to an entire class or to individual students. Ideally, the objectives are assigned to students on an individualized basis to maximize academic learning. After the objectives are assigned, the program then prints personalized multiple-choice exercises, practice assignments, tests, or diagnostic tests.

Assignments are graded as soon as the student finishes. Assignments can be graded by typing the answers into the computer or by using an optical scanner. Teachers are encouraged to use the scanner to expedite the scoring process. For example, if using a scanner, the teacher can score a typical class of 30 students in less than one minute. It is irrelevant how many problems are included in the assignment. The computer and scanner can score 100 problems per student as quickly as it can score 5 problems.

The program automatically scores the activity and produces a report for the student and teacher. It can generate the next practice assignment, test, diagnostic test, or exercise for each student while taking into account the objectives already mastered. The program can also create open-ended practice assignments along with the answer key; however, these assignments cannot be scored by the computer (Yamagata, 2001). The program can assess students' achievement and provide instruction matched to the students' skill level. In addition, it provides personalized goals, significant amounts of practice, and immediate feedback to students and teachers on the students' performance (Ysseldyke et al., 2004). The program provides printouts for teachers showing class and students' progress. This information can be used to match specific objectives to each student's ability. These reports provide diagnostic and assessment information that can be used to identify students' difficulties and help develop interventions to address them (Ysseldyke et al., 2004). *Accelerated Math* allows students the opportunity to work at their own pace. It includes a problem generator that is capable of generating an endless supply of unique problems for every objective.

Students spend more time off task than on task (Benbow & Stanley, 1982; Butzin, 2001). In a typical classroom in the United States, there is a large amount of time spent working on objectives that are not matched to the students' ability. Teachers are faced with time-consuming paperwork grading and correcting students' problems. By eliminating most of the paperwork associated with instruction, the program frees teachers to work individually with each student (School Renaissance Institute, 2000). Teachers are also faced with a lack of information on what objectives students have mastered. This lack of information often forces teachers to teach to the middle of the class; this could mean that two thirds of the students are operating outside their zone of proximal development (School Renaissance Institute). The *Accelerated Math* program drastically reduces the amount of time that teachers spend on daily instructional activities. It also addresses the problem of students operating outside their ability levels. By providing individualized instruction, every student is able to operate within his or her ability level.

Kosciolek (2003) reported that most of the instructional elements included in *Accelerated Math* have been identified as factors relating to academic achievement. Kosciolek identified these elements as:

> (a) ensuring adequate practice time, (b) matching student assignments to individual skill levels to encourage high success rates, (c) providing corrective instructional feedback frequently, (d) monitoring student progress, and (e) encouraging students to monitor their progress toward meeting predetermined goals. (p. 18)

Numerous researchers (Benbow & Stanley, 1982; Butzin, 2001; Walberg, 1984) have documented the association between time on task (academic learning time) and academic achievement. By drastically reducing paperwork, *Accelerated Math* provides more time for instruction. The second factor that of matching student assignments to individual skill levels also increases academic performance (Gersten et al., 1987; Walberg, 1984). Far too frequently, students are exposed to instructional content that is below or above their functioning level. This can lead to frustration or boredom. The third factor is providing immediate corrective feedback to students. Researchers constantly mention immediate feedback as a crucial component of effective instruction (Bloom, 1984; Carnine & Gersten, 2000; Walberg, 1984). As documented by several researchers (Bloom; Fuchs & Fuchs, 1998; Kosciolek, 2003), monitoring a student's progress is important to his or her performance. The fifth factor, goal setting, was documented by Fuchs and Fuchs and Kosciolek as being an important component of effective instruction. These five instructional factors are components of the *Accelerated Math* program.

Accelerated Math works well for reinforcing mathematics skills because the program immediately identifies incorrect responses by objective and provides correct answers. However, the program does not identify any misunderstandings about the particular concepts (Yamagata, 2001).

Lind and Lubas (as cited in *Teachers Take Revolutionary Approach*, 1999) conducted a study on the effects of *Accelerated Math* at Sudley Elementary School in Manassas, Virginia. Virginia set the passing rate for math at 70% for individual students and schools. Math scores in the district had been average but there had been no upward movement for many years. During the 1997-1998 school year, *Accelerated Math* was in its pilot year. After using the program as a pilot for two years, Lind and Lubas installed the program for full math use in 1999. Lubas said, "All I do is teach. I haven't taken work home to grade for two years. I push one button and 50 individualized tests are run off over objectives the students have mastered" (p. 111). Lind and Lubas relied almost exclusively on *Accelerated Math*. The fifth graders went from the 50th percentile to the 90th percentile (on normative testing) in just nine months. The teachers frequently mentioned "time on appropriate practice" (p. 112) as a key component of the program's success. Each student could work on his or her individual functioning level rather than meet a requirement that all students work on the same material. Lind commented that the program did not teach--teachers teach. However, they noted that the program gave teachers the information they needed to teach effectively. In June 1999, math test scores were compared between the six classes that used *Accelerated Math* and the three classes that did not use the program. The classes that did not use the program dropped from the 63rd percentile to the 60th, whereas *Accelerated Math* classes increased from the 75th to the 85th percentile. The school administrator planned to require all teachers to use the program during the 1999-2000 school year (*Teachers Take Revolutionary Approach*).

As reported by the School Renaissance Institute (2000), *Accelerated Math* pilot software was installed in nine pilot locations during the 1997-1998 school year. Some of the teachers chose not to use the program for the full year and there were various degrees of implementation among the other teachers who used the program all year. All pilot teachers were provided with the same training and equipment. Each pilot teacher chose how to implement the program into his or her classroom. Some chose to supplement their traditional methods of instruction with *Accelerated Math* whereas other teachers adopted *Accelerated Math* as their primary management and instructional tool. Most of the teachers continued to use the textbooks. The study involved students in grades four, five, and six. Students in the treatment group using *Accelerated Math* were on task more often and mastering objectives faster than the control classes. Teachers were able to work one-on-one with students who struggled. The institute noted that other variables besides the intervention might have contributed to the success of the study. Different tests were used for the pretest and posttest. The control and treatment groups were not equal. Also, the pretest achievement score in math for the control group was at the 35th percentile compared to the 56th percentile for the treatment group (School Renaissance Institute).

Ysseldyke, Spicuzza, Kosciolek, and Boys (2003) examined the effects of implementing *Accelerated Math* on students' achievement. A treatment group of 157 students in grades four and five used the intervention program (*Accelerated Math*) in conjunction with the standard curriculum provided by the textbook. The 157 students were enrolled in eight classes at three schools in a large urban school district. The study took place during 1999. The performance of the treatment group was compared to that of the fourth- and fifth-grade students in the district (N=6,385). Teachers were trained to use the software program during December 1998. The students in the control group received only the standard curriculum using the textbook. All students took the Northwest Achievement Levels Test (NALT) and results were measured in NCEs. The average math achievement gains on the NALT over a one-year span for all students in the district (N=6,385) were 2.56 NCEs. The students who participated in the *Accelerated Math* intervention (N=157) gained 6.58 NCEs in the same period. In addition, an analysis of covariance (ANCOVA) was calculated on the difference between means for posttest scores for the two groups while controlling for variance caused by the pretest score. The ANCOVA showed that the difference was statistically significant, $F1$ (1, 6,537) = 24.53, $p<0.000$, with an effect size of 0.40. Therefore, results indicated that the implementation of the program to the treatment group resulted in an increase in students' achievement. They found that students using the *Accelerated Math* program demonstrated greater mathematics achievement gains than students in the control group (Ysseldyke, Spicuzza, Kosciolek, & Boys).

Teelucksingh, Ysseldyke, Spicuzza, and Ginsburg-Block (2001) conducted a study to determine the extent to which English Language Learning (ELL) students who used the *Accelerated Math* program performed when compared to a similar group of ELL students who did not use the program. The study took place during the 1998-1999 school year at four sites involving 26 students. These fourth- and fifth-grade students were primarily Hispanic (N=17) and the majority was economically disadvantaged (N=22). The control group (N=74) was also comprised of students in grades four and five. The demographics and other variables for the control group were similar to the intervention group. A pretest-posttest analysis was conducted using standardized test scores. Students in the intervention group gained an average of 6.57 NCEs compared to an average of 2.79 NCEs for the control group. The students in the intervention group used *Accelerated Math* as a supplement to the standard curriculum. The intervention had positive effects on the academic gain (Teelucksingh et al., 2001).

Spicuzza et al. (2001) examined the extent to which the addition of *Accelerated Math* improved students' math achievement. The purpose of the study was to compare the achievement of students who used the program with students who did not. Their study involved four elementary schools in a large urban school district in 1999. Eight teachers volunteered to implement the program. The study involved 137 students in the treatment group. The results indicated that students who participated in *Accelerated Math* demonstrated more growth in math achievement than did students in the control group. As with most previous studies, the program was used as a supplement to the other instructional materials--not a replacement. The mean for the treatment group was 51.25 compared to a mean of 46.58 for the control group. The students using the intervention program scored significantly higher than the control group on the standardized tests (Spicuzza et al.).

Ysseldyke, Spicuzza, Kosciolek, Teelucksingh, Boys, et al. (2003) examined the effects of adding *Accelerated Math* to students' achievement. Even though previous research demonstrated an improvement in students' performance, the authors cited several research questions remaining on the effectiveness of computerized curriculum-based instructional management systems. For example, most previous studies have been conducted for limited periods. In addition, more research needed to be done involving students with diverse instructional needs. The study was conducted in 2000 and included 397 students in the intervention, or treatment group. These students were enrolled in grades three, four, and five. Approximately 75% of the students were nonCaucasian and 67% were economically disadvantaged. The control group consisted of 484 students. This study was unique in that each classroom was classified according to the degree of intervention. In other words, students were classified by the number of objectives mastered. As with previous studies, each classroom teacher was provided training. Each student in the intervention was allowed to work at his or her pace. The method of intervention varied by the teacher. Students were not randomly assigned to the groups. ANCOVA was used with pretest scores as the covariate and posttest scores as the dependent variable. The results from standardized tests indicated a positive effect of the *Accelerated Math* treatment. Students enrolled in classrooms classified as “high degree of intervention” demonstrated more growth than did students who partially used the program or did not use it at all ($F\ (2,459) = 4.126$, $p<0.02$, d=0.13). The researchers found no difference in scores between partial participants and nonparticipants (Ysseldyke, Spicuzza, Kosciolek, Teelucksingh, Boys, et al.).

As part of Renaissance Independent Research Reports, Leffler (2001) conducted a study to determine the effects *Accelerated Math* had on a group of students. The population consisted of a group of 22 students in one classroom who used the program for two consecutive years from

1999 through 2001. The class included a wide variety of students. The 22 students improved, on average, by 2.5 years. The class improved from an average grade equivalent of 4.7 to an average grade equivalent of 7.2 (Leffler).

Gaeddert (2001) conducted a quasi-experimental study at Buhler High School in Buhler, Kansas. The researcher evaluated the effectiveness of *Accelerated Math* in high school math classes. The three-and-a-half month study involved 50 students in the intervention classes (*Accelerated Math*) and 53 students in the control (traditional instruction) classes. The students in the treatment classes progressed at their own rate through the objectives. Instruction was primarily individualized with some very small group instruction. Pretest and posttest analyses were conducted using the SAT 9 test. Students in both groups scored about the same. However, the treatment or intervention classes experienced more improvement than the control classes. *Accelerated Math* classes gained 12 percentile points whereas students in the control classes gained 3.8 percentile points. In addition, by use of parent surveys, it was noted that parents with children in *Accelerated Math* indicated more positive attitudes toward math than did parents with children in the control group. The intervention group showed significant gains in achievement than the control group. Changes in both students' and parents' attitudes were observed (Gaeddert).

Teelucksingh (2002) also examined the effects of *Accelerated Math* on math performance. The study involved 301 students from grades three and five. Most of the students were economically disadvantaged (78%). Three groups of students were selected for the study: (a) students in *Accelerated Math* and receiving teacher consultation (N=116), (b) students using *Accelerated Math* only (N=95), and (c) students who were not enrolled in *Accelerated Math* and received no consultation (N=90). The students using *Accelerated Math* (M=59.34) significantly outperformed the students not receiving the *Accelerated Math* intervention (M=55.85). Significant differences were found between students when examining the number of objects that had been mastered (Teelucksingh). However, the addition of teachers' consultation had no noticeable effect on students' performance.

Zumwalt (2001) conducted a study during the 1999-2000 school year involving 350 eighth-grade students. The time between pretest and posttest was 25 weeks. Students were categorized according to one of three groups: (a) students who received traditional instruction (N=94), (b) students who received *Accelerated Math* instruction (N=162), and (c) students instructed using other CAI programs (N=94). The Iowa Test of Basic Skills was used as the measurement instrument. The researcher found that students using *Accelerated Math* scored significantly higher than students using traditional instruction or other CAI strategies. Zumwalt reported:

> Since Analysis of Variance (ANOVA) indicated a significant difference in achievement scores between the teaching strategies, a Tukey HSD post-hoc test was conducted to identify the most effective teaching strategy. The Tukey HSD indicated a significant difference existed between the traditional instruction group (M = 18.70) and the *Accelerated Math* group (M = 29.26) at the 0.05 level. (p. 53)

Students from the bottom quartile had the greatest gains while students in the top quartile experienced minimal gains. Even though the students using *Accelerated Math* showed significant gains, the research revealed that not all computer-aided instruction was beneficial (Zumwalt).

Smith (2002) conducted a study examining the effects of *Accelerated Math* on students' achievement. The study consisted of 204 students. Five classes were designated as the control group. The control group continued to receive traditional instruction consisting of lecture, model, and practice. However, the treatment group received the intervention of *Accelerated Math* lessons and individualized instruction. The demographics of the control and treatment groups were similar. A pretest was given to each group. Four classes participated in the treatment program for 10 weeks while five classes continued with the traditional classroom instruction. Students in the treatment group were continuously encouraged to progress at their own pace. Posttesting was done at the end of 10 weeks. The results demonstrated that students in the traditional math classes with a mean grade equivalent gain of 2.199 outperformed the students enrolled in *Accelerated Math*. The treatment group had a mean grade equivalent gain of 1.300. Therefore, students in the control group using traditional mathematics instruction experienced greater gains than students enrolled in the treatment group using *Accelerated Math*. The researcher went on to suggest that using a longitudinal study involving the intervention program for a longer period might provide different results (Smith, 2002).

Ysseldyke and Tardrew (2002) conducted a large-scale research study involving 2,202 students in 125 classrooms across 24 states. The study focused on the effects of a curriculum-based instructional management system on academic achievement. *Accelerated Math* was the instructional management system used as intervention. The results were very positive for students in grades three through six. In those grades, *Accelerated Math* students gained significantly more than did the students in the control group. The levels of success using the intervention were universal across all ability levels from gifted (NCE gain difference = 7.1; t = 2.218; $p = 0.029$) to low achieving students (NCE gain difference = 7.7; t = 3.781; $p = 0.001$). For two other critical subgroups, economically disadvantaged and ELL, the results were similar. The researchers concluded that the academic achievement was closely associated with the degree of intervention. Surveys were conducted at the end of the study. Teachers' surveys indicated that teachers in the intervention group spent less time doing paperwork and more time providing individualized instruction. Surveys indicated that students in the intervention group were more positive about math than were those in the control group (Ysseldyke & Tardrew).

Brem (2003) conducted a study to determine how students using *Accelerated Math* compared to a control group in the same school using the standard mathematics curriculum. Students were not randomly assigned to the groups. Both the intervention and control groups participated in pretest and posttest assessments. There were no gains based on being in the intervention group as compared to the control group. However, significant gains were evident when categorizing students based on their degree of intervention (or the degree of the use of the program). Students who attempted more problems had greater gains on the SAT 9 [F (4,234)=8.24, p<0.001] than students who used the program less or who did not use the program at all. There was also a positive correlation to the mastery level within the intervention program. Students mastering more objectives had greater gains. Students using *Accelerated Math* had greater gains when their exposure to the program was high (Brem).

In 2003, a two-group comparison approach was used on a study involving Title I students. The pretest-posttest study hypothesized that Title I students using *Accelerated Math* as intervention would score higher than would students who received no intervention other than regular instruction. The duration of the intervention was five months. Analysis of covariance (ANCOVA) was used to compare the gain in math achievement for Title I students while controlling for pretest results. The R-squared value using posttest NCEs was 0.438. The study showed a significant difference between the groups (p<0.0001). Students in the treatment group gained 7.9 NCEs compared to 0.3 NCE for the control group. The difference in gain of 7.6 NCEs with an effect size (Cohen's d) of 0.5 was significant. Implementation of the *Accelerated Math* program enhanced the math achievement of Title I students (Ysseldyke et al., 2004).

Summary

Most of the researchers' studies strongly supported the use of *Accelerated Math* as a means of increasing students' achievement. However, as noted by Smith (2002), limited research exists pertaining to the effects of sustained intervention of *Accelerated Math* on academic achievement. First, questions exist pertaining to the methodologies of some previous research. Limited longitudinal and independent research exists that involves experimental or quasi-experimental studies. Second, the various degrees of implementation need to be examined in future research studies. For example, some teachers use the program as a supplement to traditional instruction while others use it as a replacement to traditional instructional supplies.

Third, the differences in demographics between the control and treatment groups should be minimal. This research study addresses these three concerns.

A substantial amount of research has been conducted in the areas of mathematics achievement, computer-assisted instruction, and curriculum-based management. Researchers have documented the effectiveness of factors such as individualized instruction, matching assignments to the students' skill level, adequate time to practice math, corrective student feedback, and monitoring students' progress (Kosciolek, 2003). In addition, previous research has documented that computer-assisted instruction, integrated learning system, and computerized-management systems have a positive effect on mathematics achievement.

However, there have also been limitations in previous studies (Fuchs & Fuchs, 1998; Smith, 2002; Teelucksingh, 2002). Much of the previous research has been limited to the methodology of studies (e.g., unclear definition of implementation, poor methodological designs, very short implementations of the intervention, and differences in demographics between the control and treatment groups). Additional research needs to be conducted on alternate ways to provide support to teachers using computer-assisted instruction (Teelucksingh). Studying the effects of *Accelerated Math*, a computerized-based learning information management system, on students' achievement will assist in addressing these issues. This scientific-based research program will be constructive in finding alternate modes of instruction for the advancement of students' achievement. Considering the sanctions associated with NCLB, school districts no longer consider this task to be an option. Educators are constantly seeking ways to improve the quality of education. With high-stakes testing playing a major role in today's education, administrators, principals, and teachers are looking for more effective instructional methods.

Accountability continues to be an important part of public education as state and national governments develop policies. As the government continues to emphasize the importance of meeting minimum standards as defined in NCLB, alternate instructional techniques and programs will become increasingly important to maximize academic achievement. Many of the limitations earmarked in this review of literature were avoided in this study. In this study, Summitt County Schools' *TerraNova* scores in mathematics were used to establish a relationship between *Accelerated Math*, a computer-based informational management and learning system, and students' academic achievement. The majority of the literature reviewed was from independent sources with only two research studies included from the program's parent company.

CHAPTER 3

RESEARCH METHODOLOGY

The purpose of this study was to examine the effects of *Accelerated Math*, a computer-based learning information management system, on students' achievement as measured by the *TerraNova*. The Summitt County school district implemented the *Accelerated Math* program in grades six through eight in some of the classrooms of its four elementary schools during the 2003-2004 school year. This chapter describes the methodology used in this study. It is organized into the following sections: research design, population, instrumentation, description of Summitt County's implementation of the program, a description of *Accelerated Math* courseware, data collection, and data analysis.

Research Design

Participants in this study were part of a multiple-grade project that was conducted at four elementary schools in a small rural school district from August 2001 through May 2004. This study proposed to contribute information about improvement in math achievement by analyzing the effectiveness of the intervention of *Accelerated Math*, a computerized integration learning and management system. The study examined the effectiveness of the recently implemented math courseware in grades six through eight at four elementary schools in Summitt County. NRT and CRT scores were analyzed to determine the effectiveness of using *Accelerated Math*. In addition, the study examined the relationship between demographics and the intervention. Statistical analyses were conducted on variables such as socioeconomic status, race, special education status, and limited English proficiency to determine if the intervention had any effect on the math scores of these groups. These groups play a major role in determining if schools meet NCLB requirements.

This study was a quasi-experimental design using a nonequivalent control group design. The design is similar to the pretest/posttest control group design. The difference is that nonequivalent control group design involves assignment of intact groups to treatments whereas the pretest-posttest control group design is truly experimental and involves the random assignment of individuals to groups. In most cases, especially with public education, it is not feasible to conduct pure experiments. True experimental research involves the random assignment of students to groups. With public schools, as with this research study, classrooms instead of students are usually assigned to treatments. According to Gay and Airasion (2002):

> The inability to randomly assign students to treatments adds validity threats such as regression and interactions between selection, maturation, and testing. The more similar the intact groups are, the stronger the study, so the researcher should make every effort to use groups that are as equivalent as possible. (p. 378)

The groups came from the same school system as intact groups with similar qualities. However, if differences between the groups on any of the major variables existed, analysis of covariance (ANCOVA) was used to statistically equate the groups. One advantage of ANCOVA is that because classes are selected with students already assigned to that group, possible effects from those prearrangements are minimized (Gay & Airasion). Analysis of covariance holds constant differences in pretest scores. The differences in posttest scores may be attributable not only to the treatment but also to initial differences in pretest scores. In order to control the pre-existing differences, the effect of the covariate has to be removed.

The treatment group consisted of individuals who had taken the *TerraNova* as a pretest during 2002 and 2003, who received the intervention *Accelerated Math*, and who then took the 2004 *TerraNova* as a posttest. The control group took the *TerraNova* during 2002, 2003, and 2004 but did not receive the *Accelerated Math* intervention.

Isaac and Michael (as cited in Kirk, 2003) emphasized the importance of evaluating educational programs so educators could “make rational choices between alternative practices, to validate educational improvements, and to build a stable foundation of effective practices as a safeguard against faddish but inferior innovations" (p. 40). As researchers, we must determine if the program produces more of a desired outcome than would have happened without the program. In other words, we must decide if the intervention program results in greater student academic gains.

In this study, achievement test scores were obtained from the school system and comparisons were made between the control and treatment groups. Initially, the research was to include statistical analysis to determine the relationship of the treatment on mathematics achievement for both race/ethnicity and LEP. However, demographics showed that 0.37 % of the population to be LEP and 1.05 % to be nonCaucasian. Given those demographics, I question whether the results would be valid or reliable. Therefore, these variables will not be included in the research. The following questions were developed to serve as a guide for completing the study:

1. To what extent, if any, is there a difference between the *TerraNova* math test scores of students who did and did not participate in the *Accelerated Math* program?
2. To what extent, if any, is there a difference between the *TerraNova* math test scores of male and female students who did and did not participate in the *Accelerated Math* program?
3. To what extent, if any, is there a difference between the *TerraNova* math test scores of students from different schools who did and did not participate in the *Accelerated Math* program?
4. To what extent, if any, is there a difference between the *TerraNova* math test scores of special education and nonspecial education students who did and did not participate in the *Accelerated Math* program?
5. To what extent, if any, is there a difference between the *TerraNova* math test scores of students of different socioeconomic status who did and did not participate in the *Accelerated Math* program?

6. To what extent, if any, is there a difference between the *TerraNova* math test scores of students of different ability groups who did and did not participate in the *Accelerated Math* program?
7. To what extent, if any, is there a difference between the *TerraNova* math test scores of students of different degrees of implementation of the *Accelerated Math* program?
8. To what extent, if any, is there a difference between the *TerraNova* math test scores of students in different grades who did and did not participate in the *Accelerated Math* program?
9. To what extent, if any, is there a difference between the *TerraNova* math test scores of students with different teachers who did and did not participate in the *Accelerated Math* program?

From the research questions, the following hypotheses were tested:

$Ho1_1$: There is no difference in the performance of students who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* based on the 2004 *TerraNova* CRT scores.

$Ho1_2$: There is no difference in the performance of students (based on value-added scores) who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* on the 2004 *TerraNova* while controlling for the 2002 and 2003 test results.

$Ho2_1$: There is no difference between the performance of males and females on the 2004 *TerraNova* CRT scores.

$Ho2_2$: There is no difference between the performance of males and females (based on value-added scores) on the 2004 *TerraNova* while controlling for the 2002 and 2003 *TerraNova*.

$Ho2_3$: Based on CRT scores, there is no difference in the performance of students by gender who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* on the 2004 *TerraNova* test results.

$Ho2_4$: Based on value-added scores, there is no difference in the performance of students by gender who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* on the 2004 *TerraNova* while controlling for the 2002 and 2003 test results.

$Ho3_1$: There is no difference in performance by school on the 2004 *TerraNova* CRT scores.

$Ho3_2$: There is no difference in performance by school (based on value-added scores) on the 2004 *TerraNova* while controlling for the 2002 and 2003 *TerraNova* test results.

$Ho3_3$: There is no difference in school performance of students who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* based on the 2004 *TerraNova* CRT scores.

$Ho3_4$: Based on value-added scores, there is no difference in school performance of students who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* on the 2004 *TerraNova* while controlling for the 2002 and 2003 *TerraNova* test results.

$Ho4_1$: There is no relationship between special education status and scores on the 2004 *TerraNova* CRT scores.

$Ho4_2$: There is no relationship between special education status and scores on the 2004 *TerraNova* test while controlling for the 2002 and 2003 *TerraNova* as determined by value-added scores.

$Ho4_3$: There is no relationship between the use of *Accelerated Math* and mathematics achievement by special education status based on 2004 *TerraNova* CRT test results.

$Ho4_4$: Based on value-added scores, there is no relationship between the use of *Accelerated Math* and mathematics achievement by special education status on the 2004 *TerraNova* test while controlling for the 2002 and 2003 *TerraNova*.

$Ho5_1$: There is no relationship between socioeconomic status and scores on the 2004 *TerraNova* test based on CRT scores.

$Ho5_2$: Based on value-added scores, there is no relationship between socioeconomic status and scores on the 2004 *TerraNova* test while controlling for the 2002 and 2003 *TerraNova*.

$Ho5_3$: There is no relationship between the use of *Accelerated Math* and mathematics achievement by socioeconomic status based on the 2004 *TerraNova* CRT scores.

$Ho5_4$: There is no relationship between the use of *Accelerated Math* and mathematics achievement by socioeconomic status based on value-added scores from the 2004 *TerraNova* test while controlling for the 2002 and 2003 *TerraNova*.

$Ho6_1$: There is no difference in the performance of students on the CRT portion of the 2004 *TerraNova* test in the five different quintiles (1^{st}, 2^{nd}, 3^{rd}, 4^{th}, and 5^{th} quintiles).

$Ho6_2$: There is no difference in the performance of students on the 2004 *TerraNova* test in the five different quintiles (1^{st}, 2^{nd}, 3^{rd}, 4^{th}, and 5^{th} quintiles) based on value-added scores while controlling for the 2002 and 2003 *TerraNova*.

$Ho6_3$: There is no difference in the performance of students on the CRT portion of the 2004 *TerraNova* test in the five different quintiles (1^{st}, 2^{nd}, 3^{rd}, 4^{th}, and 5^{th} quintiles) after participating in the *Accelerated Math*.

$Ho6_4$: Based on value-added scores, there is no difference in the performance of students on the 2004 *TerraNova* test in the five different quintiles (1^{st}, 2^{nd}, 3^{rd}, 4^{th}, and 5^{th} quintiles) after participating in the *Accelerated Math* while controlling for the 2002 and 2003 *TerraNova*.

$Ho7_1$: There is no relationship between the degree of implementation of the treatment and mathematics achievement on the 2004 *TerraNova* CRT scores.

$Ho7_2$: There is no relationship between the degree of implementation of the treatment and mathematics achievement on the 2004 *TerraNova* value-added scores while controlling for the 2002 and 2003 scores.

$Ho8_1$: There is no difference in the performance of sixth-, seventh-, and eighth-grade students on the 2004 *TerraNova* CRT scores.

$Ho8_2$: There is no difference in the performance of sixth-, seventh-, and eighth-grade students on the 2004 *TerraNova* value-added scores while controlling for the 2002 and 2003 *TerraNova* math scores.

$Ho8_3$: There is no difference in the performance of sixth-, seventh-, and eighth-grade students who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* based on the 2004 *TerraNova* CRT scores.

$Ho8_4$: Based on value-added scores, there is no difference in the performance of sixth-, seventh-, and eighth-grade students who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* on the 2004 *TerraNova* while controlling for the 2002 and 2003 *TerraNova* test results.

$Ho9_1$: There is no relationship between the use of *Accelerated Math* and mathematics achievement by teacher based on the 2004 *TerraNova* CRT scores.

$Ho9_2$: There is no relationship between the use of *Accelerated Math* and mathematics achievement by teacher based on the 2004 *TerraNova* value-added scores while controlling for the 2002 and 2003 *TerraNova* test results.

Population

The population consisted of all the sixth-, seventh-, and eighth-grade students who attended an elementary school in a small rural school system in East Tennessee for three consecutive years beginning in the 2001-2002 school year and who took the *TerraNova* all three years. Of the 702 students enrolled in the sixth, seventh, and eighth grades during the 2001-2002 school year, only 542 were enrolled in the school system for three consecutive years and took the *TerraNova* math subtests each year. Students who were retained were excluded from the study. Consequently, 160 students were eliminated from the study. All of the classes were departmentalized. All of the teachers in the study taught only math classes. In Summitt County, no self-contained classes existed above the fifth grade. In addition, all classes in the study were single-grade classrooms.

The population consisted of 542 students who participated in *Accelerated Math* instruction as well as those who participated in traditional math instruction. Because achievement test scores could be obtained for all students, the entire population of 542 students was included in the research. With such a large N value, type I and II errors were minimized. Realizing that statistical analysis will result in small *p*-values, the effect size could play a significant role in determining relationships between the treatment and the effect.

Instrumentation

The instrument used was the *TerraNova* test, published by CTB/McGraw-Hill (1997) and used by the Tennessee Department of Education for assessment purposes for students in grades three through eight each year as part of the state mandated Tennessee Comprehensive Assessment Program (TCAP). The test uses multiple-choice questions and has established time limits. It provides both norm-referenced and criterion-referenced information. Scores are provided for 11 subtests in the form of National Percentiles (NP), Normal Curve Equivalent (NCE) scores, Grade Equivalent (GE), and Scale Scores. The Tennessee Department of Education (1999) provides value-added scores for grades four through eight in reading, language arts, mathematics, science, and social studies. The test format is similar to the one used by the National Assessment of Educational Progress (Tennessee Department of Education, 1999).

In addition to providing the aforementioned norm-referenced test data, criterion-referenced test data are also provided by the *TerraNova* test. The criterion-referenced test portion provides students and educators with three primary pieces of information for each part: (a) number of correct questions answered, (b) percentage of questions answered correctly, and (c) the proficiency status (below proficient, proficient, and advanced). The criterion-referenced portion of the test is used to determine if students meet a minimum specified level of performance.

The latest national norm for the *TerraNova* is from 1996. CTB/McGraw-Hill (2000) reported that the use of statistics has indicated the *TerraNova* test as reliable and valid, stating:

> Validity refers to the appropriateness, meaningfulness, and usefulness of the specific inferences made from test scores. Test validation is not a static concept. It is an ongoing

> process. The test is designed to move students toward proficiency. Its content is strongly aligned with state and national standards, instructional practices, and curricula nationwide. Reliability is an index of the consistency of test results. A reliable test is one that produces scores that are relatively stable if the test is administered repeatedly under similar conditions. (p. 13)

The company has matched the test content to the curriculum for the *TerraNova* test as part of a statewide testing program. In addition, the company claims a high degree of content, criterion, and constructive validity. In addition, they have designed the *TerraNova* to ensure the highest degree of reliability. The *TerraNova* math test includes objectives based on the NCTM standards, as well as on state curriculum documents and the framework of the NAEP (CTB/McGraw-Hill, 2000).

Description of Summitt County Schools' Implementation

During the spring of 2002, the Summitt County school system began a system wide technology endeavor involving the use of *Accelerated Math* in elementary and middle schools. The school system provided teachers with computers, printers, and optical mark scanners. The school system's technology department installed the program on the schools' servers and provided the program in a networked environment.

A three-hour initial training session was conducted during the implementation phase. The training took place at the end of a school day. All math teachers were provided initial training. Follow-up training and ongoing support was provided by the school system and was conducted during the 2003-2004 school year. New math teachers were provided with training and equipment to enable them to use the program if they desired.

The school system did not mandate the use of the program; however, it was encouraged. Of the 11 faculty members teaching math in grades six, seven, and eight, 7 chose to use the program and 4 chose to use traditional methods of instruction. Of the seven teachers who voluntarily participated in the intervention, each was provided an optional optical mark scanner to expedite the scoring of practice exercises and tests.

Once teachers were familiar with the program, they began enrolling students, diagnosing students' functioning level in math, assigning exercises, providing feedback, and monitoring reports. A substantial investment has been made by Summitt County schools in implementing the program in all of its elementary and middle schools. The school system is constantly seeking ways to improve instruction. It is hopeful that this study might provide information on the effectiveness of *Accelerated Math*.

Teacher Quality

Teacher quality is a key component of NCLB. All "core academic" teachers must be highly qualified by 2005-2006. According to Seivers (2004), "The core subjects include English, reading or language arts, mathematics, science (biology, chemistry, earth science, physics, and physical science), foreign languages (French, German, Latin, and Spanish), civics and government, economics, arts (visual arts and music), history, and geography" (p. 1). All core academic teachers must have a bachelor's degree, teacher's license, and meet content requirements for the appropriate grade/subject area in which they are teaching. The requirements for teacher licensure in Tennessee are separate from the federal requirement for highly qualified status. It is possible to be licensed and not meet the highly qualified requirements of the NCLB Act. Likewise, it is possible to be highly qualified without being a licensed teacher in Tennessee. New elementary teachers (kindergarten through sixth grade) must past the Praxis test and secondary teachers (7^{th} through 12^{th} grade) must demonstrate content knowledge in all core academic subjects they are teaching. The new middle/high school teachers can demonstrate content area knowledge by the following options: (a) academic major or graduate degree in the content area; (b) coursework equivalent of an academic major (24 semester hours of which 6 hours can be in methodology); (c) pass a test such as Praxis; or (d) advanced certification such as National Board Certification (*No Child Left Behind*, 2004).

Existing teachers can demonstrate they are highly qualified in the same manner as new teachers or use the Highly Objective Uniform State Standard of Evaluation (HOUSSE) option. The evaluation route for existing teachers contains three options: (a) framework for evaluation and professional growth, (b) teacher effect data, and (c) professional matrix. Tennessee has completed development of the specific criteria for two HOUSSE options and is still developing the criteria for the "framework for evaluation and professional growth" method (Tennessee Department of Education, 2004).

Seivers (2004) stated, "The professional matrix enables teachers to accumulate points for a variety of professional activities and accomplishments related to the content area and teaching skills as a means to achieve highly qualified status" (p. 5). Using a 100 point scale, teachers may earn points in the following areas: experience in the specific content area, career ladder, positive evaluations, college coursework, years of experience, professional leadership, and staff development. The matrix includes maximum point limits for each of the broad categories. The professional matrix was approved by the State Board of Education on August 22, 2003 (Seivers).

Teacher effect data is a statistical means of estimating the teacher's impact or lack thereof on students' achievement. It has been a component of the Tennessee Value-Added Assessment System (TVAAS) since 1996. "The analysis of teacher effect data uses three-year average gain comparisons: teacher vs. norm, teacher vs. state, and teacher vs. system as an estimated measure of the teacher's effect on student achievement" (Seivers, 2004, p. 5). The estimated average gain comparisons are reported as above the mean, below the mean, or not detectably different (NDD) from the mean. NDD comparison scores are within two standard errors of the mean that provides a 95% level of statistical confidence. The teacher effect option was also approved by the State Board of Education on August 22, 2003 (Seivers).

School districts must notify Title I parents of their rights to request the qualifications of their child's teachers. Highly qualified status can be obtained for grades kindergarten through 6, 7 through 8, or 9 through 12. For example, a teacher may be highly qualified to teach sixth grade math but not in seventh grade. Summitt County has reported to the Tennessee Department of Education that 242 of the 248 teachers employed are highly qualified, including all 11 math teachers currently teaching in grades six through eight.

Of the four sixth-grade math teachers involved in the research, all are highly qualified in grades kindergarten through six. Three of these teachers chose to use the intervention program whereas one chose the control group. It should be noted that these four teachers are not “highly qualified” in middle/high school math. Three of the four teachers obtained their highly qualified status by using the matrix option and the other one took the Praxis test. The teacher who opted to take the Praxis test had two years of experience whereas each of the three teachers using the matrix option had over 20 years of experience. In summation, the sixth-grade teacher who used the traditional mathematics method had over 20 years experience and achieved kindergarten through sixth grade highly qualified status from the matrix. Of the three sixth-grade teachers who used *Accelerated Math*, two had over 20 years of experience and obtained highly qualified status from the professional matrix. However, the other sixth-grade teacher using the intervention program had two years of experience and passed the Praxis test to become highly qualified.

Of the seven math teachers in grades seven through eight, five were highly qualified in grades 7 through 8 math and two were highly qualified in grades 7 through 12 math. One of the grade 7 through 12 highly qualified teachers used *Accelerated Math* whereas the other did not. Three of the seven teachers involved in the research achieved highly qualified status from coursework equivalent to a major, three from teacher effect data, and two from the professional matrix. All three methods of achieving highly qualified status were represented in both the treatment and control groups of the research. The characteristics of the teachers participating in the treatment and control groups appeared to be similar. The treatment group consisted of only highly qualified teachers with that status being achieved from a combination of coursework equivalent to a major, teacher effect data, and the professional matrix. The same can be said of the control group. None of the teachers participating in the research had achieved National Board Certification. In addition, none of the 11 teachers had an advanced degree in mathematics.

Description of Accelerated Math Courseware

Accelerated Math is a task-level computerized learning information management system designed to: (a) provide information to allow teachers to individualize math instruction, (b) allow students to work in their zone of proximal development, (c) support NCTM and state standards, (d) increase time on task (or academic learning time), (e) generate reports for teachers, and (f) provide immediate feedback to students (School Renaissance Institute, 2000). This scientifically-based research program effortlessly monitors each student's progress. With this program, students are not required to advance at the same speed. In addition, teachers can offer instruction that is tailored to the student's ability without the abundance of paperwork. Because *Accelerated Math* is classified as scientifically-based research under NCLB, it qualifies for funding under federal programs (Renaissance Learning, 2004).

With its random generator, the program is capable of generating an endless supply of unique problems for each student. Because the program is linked to numerous states, the school has the option of purchasing the version matched to the state standards in which the school is located. School Renaissance Institute (2000) provided the flowchart for *Accelerated Math* as shown in Figure 1.

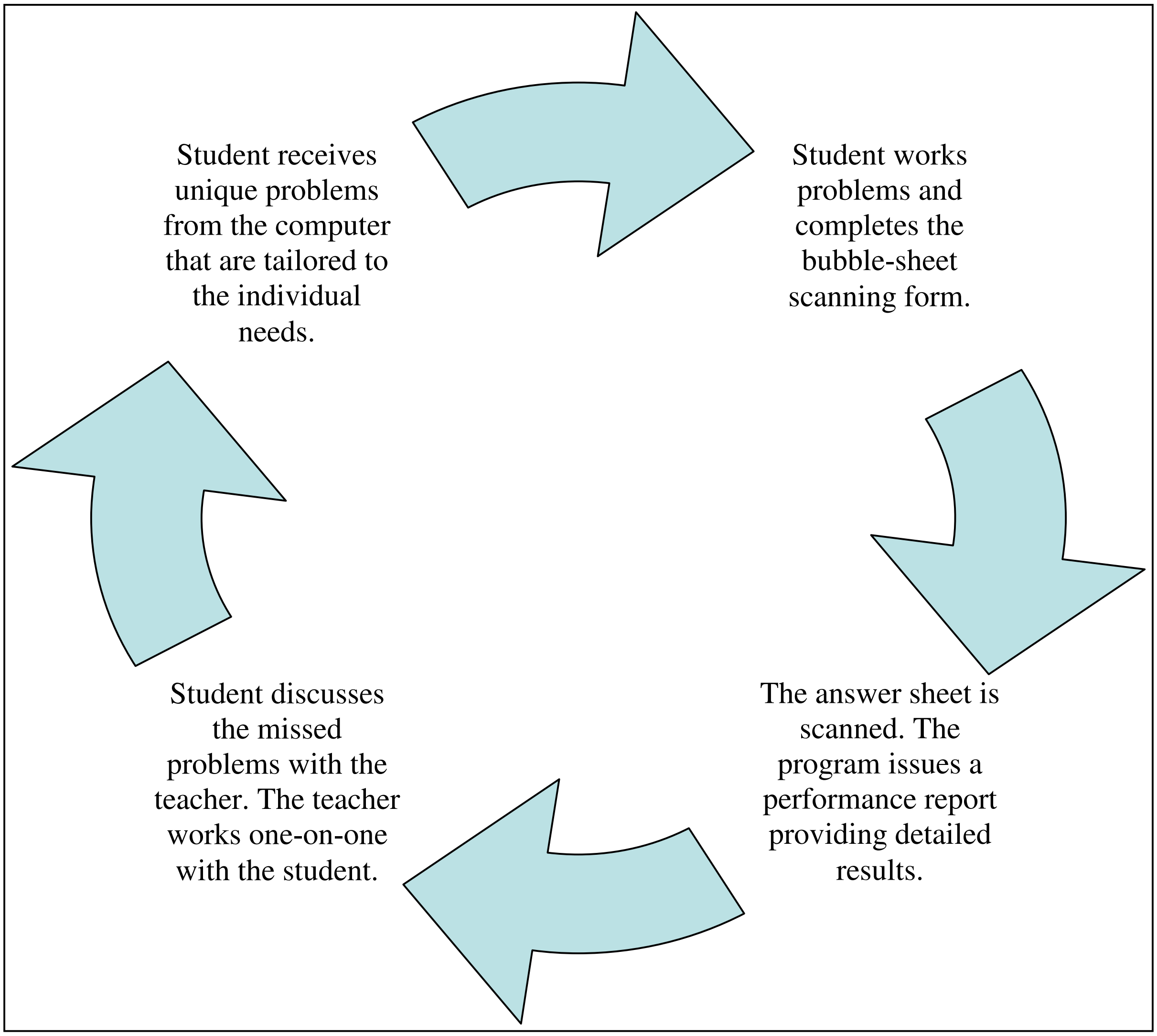

Figure 1. *Accelerated Math* Flow Chart

The program keeps track of all students' work and alerts the teacher to the objectives for which the students are ready to test (School Renaissance Institute, 2000). The initial mastery is set by the program at 80%. However, the teacher has the opportunity to change the mastery level to any correct percentage. A sample *Accelerated Math* student daily report (TOPS report) as provided by Renaissance Learning (2004) is shown in Appendix D. Many other reports can be generated by the software program.

Data Collection

Approval was obtained from the Institutional Review Board (IRB) at East Tennessee State University prior to collecting any data. Written permission was granted by the director of Summitt County Schools for the use of archival data from the school system. The data consisted of demographics and *TerraNova* math scores for students in the sixth, seventh, and eighth grades during 2003-2004. In addition, the math scores were obtained for the previous two years for those students. Students were eliminated from the study who did not take the *TerraNova* for three consecutive years from 2001-2002 through 2003-2004.

The data were provided by the director of testing and special programs for Summitt County Schools. The data provided did not identify students in any way. Any identifiable information including names, social security numbers, and birth dates were removed prior to the researcher obtaining the data. The school system provided a unique I.D. number for each student that was used to track students for the purpose of this study. The researcher had no knowledge of the students' identities. In addition, teachers had unique numbers assigned to protect their identities. Data were entered into the Microsoft Excel software program and then transferred to the SPSS statistical package.

Based on the 2004 *TerraNova* test results, the data consisted of the composite math score (scale score) and NCE scores on the NRT portion of the test. The gain was calculated from the 2003 and 2004 scale scores so the value-added score could be calculated. In addition, the percentage correct and proficiency status was used from the CRT portion of the math subtest. This provided both NRT and CRT for analysis.

Data Analysis

Descriptive statistics were used to provide a profile for the population. The data set came from the *TerraNova* Comprehensive Tests of Basic Skills (CTB/McGraw-Hill, 1997). The Statistical Program for Social Sciences (SPSS) was used to analyze the data. Inferential statistics were used to determine effects and relationships among variables. The inferential statistics included *t* tests, analysis of variance (ANOVA), and analysis of covariance (ANCOVA). The majority of the statistical analysis was performed using ANCOVA.

ANCOVA holds constant differences in pretest scores (or differences in any covariance scores). In other words, if there were pretest differences between the groups, then one could hold constant those differences by looking at the predicted posttest scores at any particular pretest score. The differences in posttest scores might be attributable not only to the treatment but also to initial differences in pretest scores. In order to control the pre-existing differences, the effect of the covariate (pretest) had to be removed from the posttest scores by using the regression method.

Sixth-, seventh-, and eighth-grade math scores from the *TerraNova* were analyzed. All statistical analysis was conducted using a predetermined alpha of 0.05. This preset alpha was used to determine the statistical significance. The effect size was also calculated to determine the impact of the intervention.

CHAPTER 4

ANALYSIS OF DATA

As a result of government intervention in the form of more rigorous accountability measures, schools are relying on proven programs to increase standardized test scores (Scanlon, 1998). The purpose of this study was to examine the relationship between the use of *Accelerated Math*, a computerized instructional management system, and traditional instruction on mathematics achievement as measured by the *TerraNova*. The scores of the students who participated in *Accelerated Math* were compared with those who did not participate using the *TerraNova* test by gender, ability groups, special education status, school, teacher, socioeconomic status, and degree of implementation.

The students participating in the study were sixth-, seventh-, and eighth-grade students who were enrolled in Summitt County Schools during the 2003-2004 and who took the *TerraNova* for three consecutive years between 2002 and 2004. Of the 702 students who were sixth, seventh, and eighth graders during 2003-2004, 160 were excluded because they did not take the *TerraNova* all three years of the study. The resulting population was 542. This chapter contains an analysis of data collected from 11 teachers and four elementary schools.

Nine research questions were constructed to guide the investigation. The data were used to test 30 null hypotheses. Computer data analysis was performed using the Statistical Package for the Social Sciences (SPSS). Demographic characteristics of the population included gender, race, grade, special education status, socioeconomic status, and participation in the intervention. Table 2 shows the demographic profile of the sample.

Table 2

Demographic Profile of the Sample

Characteristic	*F*	%
Gender		
Female	267	49.3
Male	275	50.7
Total	542	100.0
Race		
Caucasian	539	99.4
Asian	1	0.2
African American	1	0.2
Hispanic	1	0.2
Total	542	100.0
Grade 2004		
6th	181	33.4
7th	178	32.8
8th	183	33.8
Total	542	100.0
Special Education		
Non-Special Education	478	88.2
Special Education	64	11.8
Total	542	100.0

Table 2 continued

Characteristic	*F*	%
Socioeconomic Status		
Paid	256	47.2
Free/Reduced	286	52.8
Total	542	100.0
Participation in AM		
No	188	34.7
Yes	354	65.3
Total	542	100.0

As shown in Table 2, 354 students were taught using the intervention--Accelerated Math. Some of these students used the mathematics program as a supplement whereas others used the intervention as a replacement to traditional instruction. Slightly more than half of the population was classified as low socioeconomic status based on free/reduced lunch status. Initially, I planned to use Limited English Proficiency (LEP) and race as two variables in the analysis because they are included in NCLB accountability measures. However, the population included less than one percent nonCaucasian and no LEP students; therefore, these two demographic characteristics were not included in the analysis.

The data consisted of both CRT and NRT components. The CRT data contain raw scores, scale scores, and proficiency levels. However, the NRT component is more complicated. In 2004, the Tennessee Department of Education changed the way value-added was calculated. Prior to 2004, value-added was calculated by taking the net gain/loss in scale scores from the previous to the current year divided by the USA norm. This value was multiplied by 100 to convert the decimal to a percent. The value-added scores were converted to a letter grade by the Tennessee Department of Education. A value-added score greater than 115 was an A, 105-114 was a B, 95-104 was a C, 85-94 was a D, and anything less than 85 was an F.

In 2004, the process of determining value-added in Tennessee changed. Tennessee statute authorizes the commissioner of education to set state growth standards for grades four through eight. The state growth in 1998 was used as the growth standard in 2004 for grades four thorough eight. Elementary and middle schools in Tennessee show progress on CRT tests in "State NCE Scores." The state NCE scores are based on 1998 growth standards. All previous *TerraNova* NRT scores were mapped to CRT scores using concordance tables. The Tennessee Department of Education used the equipercentile method for single group design to map the scores. The state growth standard replaced the USA norm. Results greater than zero indicate more progress than the growth standard or the state average in 1998. Therefore, value-added scores greater than zero represent gain greater than Tennessee's average in 1998. These changes reflected a shift from Tennessee's previous accountability system to the federal system as a result of NCLB. The change necessitated a transition between the two different types of tests (Park, 2005). As a result, the tests were equated using the NRT - CRT - NCE concordance tables for the sixth, seventh, and eighth grades (see Appendices E, F, and G, respectively).

To provide history about the transition from NRT to CRT scores in Tennessee, Tennessee state law required NRT scores be used for value-added. However, NCLB required the use of CRT scores. This resulted in double testing in 2004 to satisfy both Tennessee and NCLB requirements. The conversion of NRT to CRT equated scores avoids double testing. Concordance was used to map the scores from one scale to another. Concordance refers to the process in which methods are used to link scores on tests that are built to different specifications. Concordance can be used when tests are measuring similar construct and scores are highly correlated (Park, 2005).

Equipercentile scaling and linear scaling are two basic statistical methods used to produce concordance tables. The equipercentile method sets equal the scores on each test having the same percentile ranks. For example, the score at the 65^{th} percentile on the *TerraNova* NRT score distribution would correspond to the score at the 65^{th} percentile of the *TerraNova* CRT score distribution. However, equity cannot be achieved even for scores measuring the same thing unless the two scores are parallel. If equity cannot be achieved for measuring the same thing, it likewise cannot be achieved for scores measuring different things. Scores are referred to as closely equable if they are parallel (Hanson et al., 2001).

Concordance tables may be based on equating or scaling. To support scaling, the correlation must be high. If the correlation is too low, then concordance becomes merely a predictor. Researchers refer to a "reduction of uncertainty" as $1 – \sqrt{(1-r^2)}$, where r is the correlation. Tennessee uses a 50% reduction of uncertainty. Therefore, the correlation must be a minimum of 0.866 between the scores being mapped to reduce the uncertainty by at least 50%. "If a predictor cannot reduce uncertainty by at least 50%, it is unlikely that it can serve as a valid surrogate for the score you want to predict" (Dorans, 2000, p. 3). Four prerequisites for equating include: (a) the two tests must measure the same construct, (b) the equating must achieve equity, (c) the equating transformation should be symmetric, and (d) the transformation should be invariant across subpopulations (Dorans).

The Tennessee Department of Education deemed their correlations are at least 0.866. The lowest correlation was 0.880 in third grade mathematics. Therefore, all NRT scores mapped to CRT state NCE scores satisfy the 50% reduction in uncertainty (Park, 2005).

All questions used either analysis of variance (ANOVA), analysis of covariance (ANCOVA), or *t* test for independent samples. The data consisted of two large independent samples from a population that was normally distributed and contained interval measurements. The population variances were unknown but assumed equal. Therefore, the two sample standard deviations were "pooled" to estimate the population standard deviation. Throughout this research, statistical analyses consisted of both value-added scores from NRT test items and CRT proficiency scores. Because value-added scores were available for three years, ANCOVA was used to hold constant differences in pretest scores. In other words, if there were any pretest differences between the groups, one could hold constant those differences by using ANCOVA given that the control and experimental groups had similar characteristics. In order to control for pre-existing differences, the effect of the covariate (pretest) must be removed from the posttest scores by using the regression method. ANCOVA combines the features of simple linear regression with one-way analysis of variance. To satisfy NCLB requirements, Tennessee implemented a CRT component of the *TerraNova* for the first time in 2004. Prior to 2004, CRT scores were not available for Tennessee students.

An effect size is the difference between two means (treatment group minus control group) divided by the standard deviation of the two conditions. Whereas statistical tests of significance provide the likelihood that the results occurred by chance, effect-size measurements provide the relative magnitude of the treatment. The effect-size provides the size of the experimental effect. Although various methods exist for calculating effect sizes, Cohen's *d* was used because of its popularity and the effect size suggestions. Cohen suggested that effect sizes of 0.20 are small, 0.50 are medium, and 0.80 are large (Cohen, 1992).

The researcher looked for differences in CRT proficiency scores in mathematics on the 2004 *TerraNova* while controlling for the 2002 and 2003 *TerraNova*. In addition, the researched looked at the relationship between value-added mathematics scores and the use of *Accelerated Math*.

Research Question 1

To what extent, if any, is there a difference between the *TerraNova* math test scores of students who did and did not participate in the *Accelerated Math* program?

From Research Question 1, the following hypotheses were developed and tested:

$Ho1_1$: There is no difference in the performance of students who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* based on the 2004 *TerraNova* CRT scores (H_0: $\mu_1 = \mu_2$).

$Ho1_2$: There is no difference in the performance of students (based on value-added scores) who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* on the 2004 *TerraNova* while controlling for the 2002 and 2003 test results (H_0: $\mu_1 = \mu_2$).

A *t* test for independent samples was used to test $Ho1_1$. Assuming both populations were approximately normal with equal variances, the *t* test determined if there was a difference in the mean proficiency score of students who participated in *Accelerated Math* and students who did not participate in the intervention. Based on $\alpha = 0.05$ and 540 degrees of freedom (df), the critical value for *t* is +/- 1.970 for a two-tailed test. As shown in Table 3, students not participating in the *Accelerated Math* program had a significantly higher CRT proficiency score than students participating in the intervention program. Because the calculated value of *t* (3.413) is greater than the critical value of *t* (1.970), the null hypothesis $Ho1_1$ was rejected and the alternate hypothesis (H_A: $\mu_1 \neq \mu_2$) was supported by the data. By rejecting the null hypothesis, it was concluded that the means of the two groups were significantly different. The mean proficiency score of the experimental group (M = 35.19) was lower than the control group (M = 38.78). In addition, a small negative effect-size reflects that the control group scored higher than the intervention or treatment group (Cohen's *d* = -0.371).

Table 3

Comparison of Mathematics Proficiency Scores of Students Who Received the Intervention Accelerated Math and Those Students Who Did Not Receive the Intervention Accelerated Math

Subtest	*N*	*M*	*SD*	*t*	*p*
CRT Proficiency Scores					
Participation	354	35.19	11.159	3.413	.001
Non-participation	188	38.78	12.533		

For $Ho1_2$, analysis of covariance (ANCOVA) was conducted to determine if significant differences existed in value-added scores of students after some students received *Accelerated Math* training and others did not. This hypothesis analyzed differences in 2004 value-added scores in mathematics while controlling for 2002 and 2003 mathematics value-added scores. Table 4 shows the results of this analysis.

Table 4

Comparison of Mathematics Value-Added Scores of Students Who Received the Intervention Accelerated Math and Those Students Who Did Not Receive the Intervention Accelerated Math

Subtest	Intervention	*N*	*Adj. M*	*M*	*SD*	*F*	*p*
Value-Added Scores							
	Participation	188	-2.458a	-2.03	11.988	10.363	.001
	Non-participation	354	0.766a	-0.03	12.531		

The results shown in table 4 indicate that students participating in the intervention program had a lower value-added score than students in the control group (F = 10.363, p=0.001). Because the calculated F value (10.363) was greater than the critical F value (3.88), the null hypothesis (H_0: $\mu_1 = \mu_2$) was rejected. Students not participating in the *Accelerated Math* program had a higher value-added gain than did students participating in the intervention program. In other words, students participating in the intervention program had lower value-added scores than students in the control group. In addition, because p (.001) < .05, the difference was significant. As for the effect size, a small negative effect-size (Cohen's d = -0.16) reflects that the control group scored higher than the intervention or treatment group. The negative effect-size reflects the lower scores for the intervention group.

Research Question 2

To what extent, if any, is there a difference between the *TerraNova* math test scores of male and female students who did and did not participate in the *Accelerated Math* program?

From Research Question 2, the following hypotheses were developed and tested:

$Ho2_1$: There is no difference between the performance of males and females on the 2004 *TerraNova* CRT scores.

$Ho2_2$: There is no difference between the performance of males and females (based on value-added scores) on the 2004 *TerraNova* while controlling for the 2002 and 2003 *TerraNova*.

$Ho2_3$: Based on CRT scores, there is no difference in the performance of students by gender who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* on the 2004 *TerraNova* test results.

$Ho2_4$: Based on value-added scores, there is no difference in the performance of students by gender who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* on the 2004 *TerraNova* while controlling for the 2002 and 2003 test results.

A *t* test for independent samples was used to test $Ho2_1$. Using $\alpha = 0.05$ and $df = 540$, the critical value for *t* is +/- 1.970 for a two-tailed test. As shown in Table 5, the calculated value of *t* (1.183) was less than the critical value of *t* (1.970). Therefore, the researcher failed to reject the null hypothesis ($Ho2_1$) and concluded that there was no significant difference in mean proficiency scores between males and females. In addition, the *p* value (0.237) was greater than the predetermined alpha of 0.05.

Table 5

Comparison of Mathematics Proficiency Scores by Gender

Subtest	*N*	*M*	*SD*	*t*	*P*
CRT Proficiency Scores					
Males	275	35.84	12.014	1.183	.237
Females	267	37.04	11.542		

For $Ho2_2$, analysis of covariance (ANCOVA) was conducted to determine if significant differences existed in 2004 value-added mathematics scores by gender while controlling for 2002 and 2003 value-added scores. Table 6 shows the results of this analysis. Because the *F* value (0.008) was less than the critical value, I failed to reject the null hypothesis and concluded that there was no significant difference in the 2004 value-added scores by gender. The *p* value (0.928) was larger than the preset alpha of 0.005.

Table 6

Comparison of Mathematics Value-Added Scores by Gender

Subtest	*N*	*Adj. M*	*M*	*SD*	*F*	*p*
Value-Added Scores						
Males	275	-1.297a	-1.64	13.014	0.008	.928
Females	267	-1.383a	-1.03	11.328		

For $Ho2_{3,}$ analysis of covariance (ANCOVA) was conducted to determine if there was a gender by intervention interaction. The statistical analysis was conducted to determine if a significant difference existed in the performance of students by gender who participated in *Accelerated Math* and students who did not participate in the intervention based on 2004 proficiency test scores from the *TerraNova*. Table 7 presents the results of gender by participation (participation in *Accelerated Math*) interaction with the 2004 *TerraNova* mathematics proficiency scores. Because the *F* value was less than the critical value, I failed to reject the null hypothesis and concluded that there was no intervention interaction by gender and participation in the *Accelerated Math* program (F =1.829, p = 0.177).

Table 7

Comparison of Means by Gender and Its Interaction With the Intervention (Participation in Accelerated Math) in Mathematics Proficiency Scores

Intervention	*Gender*	*N*	*Adj. M*	*M*	*SD*	*F*	*p*
Proficiency Scores							
No AM	Male	91	37.264	37.26	13.042	1.829	.177
	Female	97	40.206	40.21	11.928		
AM	Male	184	35.141	35.14	11.443		
	Female	170	35.235	35.24	10.947		

For $Ho2_{4,}$ ANCOVA was conducted to determine if there was a gender by intervention interaction in value-added scores. As shown in Table 8, there was no significant difference in interaction between gender and participation in *Accelerated Math* (F = 2.413, p = 0.121). Therefore, I failed to reject the null hypothesis.

Table 8

Comparison of Means by Gender and Its Interaction With the Intervention (Participation in Accelerated Math) in Mathematics Value-Added Scores

Intervention	*Gender*	*N*	*Adj. M*	*M*	*SD*	*F*	*p*
Value-Added Scores							
No AM	Male	91	-.163a	-1.56	12.984	2.413	.121
	Female	97	1.633a	1.40	11.981		
AM	Male	184	-1.838a	-1.68	13.063		
	Female	170	-3.127a	-2.41	10.729		

Research Question 3

To what extent, if any, is there a difference between the *TerraNova* math test scores of students from different schools who did and did not participate in the *Accelerated Math* program?

From Research Question 3, the following four hypotheses were developed and tested:

$Ho3_1$: There is no difference in performance by school on the 2004 *TerraNova* CRT scores.

$Ho3_2$: There is no difference in performance by school (based on value-added scores) on the 2004 *TerraNova* while controlling for the 2002 and 2003 *TerraNova* test results.

$Ho3_3$: There is no difference in school performance of students who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* based on the 2004 *TerraNova* CRT scores.

$Ho3_4$: Based on value-added scores, there is no difference in school performance of students who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* on the 2004 *TerraNova* while controlling for the 2002 and 2003 *TerraNova* test results.

Analysis of variance (ANOVA) was used to test $Ho3_1$ because it allows statistical analysis involving more than two groups. As shown in Table 9, there was a significant difference in the 2004 mathematics proficiency score by school ($F = 11.698$, $p = .000$*). The calculated value of F was greater than the critical value of F (2.642) based on an alpha of 0.05. Therefore, I rejected the null hypothesis ($Ho3_1$) that stated $\mu_1 = \mu_2 = \mu_3 ... = \mu_k$ and concluded that at least one school mean was significantly different from one other school mean. There was a significant difference in the performance of students at the four elementary schools in the Summitt County School System.

Table 9

Comparison of Mean Proficiency Scores of the Four Elementary Schools in the Summitt County School System in Mathematics

Intervention	*School*	*N*	*M*	*SD*	*F*	*P*
Proficiency Scores						
	School 1	174	35.85	10.647	11.698	.000*
	School 2	135	38.44	12.226		
	School 3	144	32.50	10.889		
	School 4	89	40.90	12.601		

Because a significant F was obtained, post hoc tests were used to determine which schools differed significantly from one another. Many types of post hoc tests were available from which to select. One of the most important ways that post hoc tests differ is in the degree to which they control the probability that a family of tests will produce Type I errors. The Scheffe method was selected as the post hoc test of choice because it is most conservative with respect to Type I errors. The Scheffe post hoc tests were applied to determine which pairs were different. Table 10 provides the results of post hoc tests examining the differences between the four elementary schools using Scheffe tests on the mathematics proficiency scores.

Table 10

Results of Scheffe Tests to Provide Post Hoc Analysis Comparing School Performance on the 2004 Mathematics Proficiency Scores

Intervention	(I) School	(J) School	M Diff. (I-J)	P
Proficiency Scores				
	School 1	School 2	-2.59	.276
		School 3	3.35	.082
		School 4	-5.05*	.010
	School 2	School 1	2.59	.276
		School 3	5.94*	.000
		School 4	-2.46	.480
	School 3	School 1	-3.35	.082
		School 2	-5.94*	.000
		School 4	-8.40*	.000
	School 4	School 1	5.05*	.010
		School 2	2.46	.480
		School 3	8.40*	.000

* The mean difference is significant at the .05 level.

In comparison of the pairs, school 2 scored significantly higher than school 3. In addition, school 4 scored significantly higher in mathematics proficiency than both school 1 and school 3.

For $Ho3_2$, ANCOVA was conducted to determine if significant differences existed in 2004 value-added mathematics scores by school while controlling for 2002 and 2003 value-added scores. As shown in Table 11, there was a significant difference in the 2004 mathematics value-added score by school ($F = 17.038$, $p = .000$). Because the calculated value of *F* was greater than the critical value of *F* based on an alpha of 0.05, the null hypothesis was rejected ($Ho3_2$) and it was concluded that at least one school's mean value-added score was significantly different from one other school mean.

Table 11

Comparison of Mathematics Value-Added Scores by School

School	*N*	*Adj. M*	*M*	*SD*	*F*	*P*
Value-Added Scores						
School 1	174	-3.577a	-3.33	12.512	17.038	.000
School 2	135	3.303a	2.94	10.782		
School 3	144	-4.564a	-3.67	11.924		
School 4	89	1.211a	-.16	12.396		

Because a significant *F* was obtained, post hoc tests were used to determine which schools differed significantly from one another. Table 12 provides the results of Scheffe post hoc tests examining the differences between the four elementary schools on the mathematics value-added scores.

Table 12

Results of Scheffe Tests to Provide Post Hoc Analysis Comparing School Performance on the 2004 Mathematics Value-Added Scores

Intervention	(I) School	(J) School	M Diff. (I-J)	P
Value-Added Scores				
	School 1	School 2	-6.27*	.000
		School 3	.34	.996
		School 4	-3.18	.244
	School 2	School 1	6.27*	.000
		School 3	6.61*	.000
		School 4	3.10	.307
	School 3	School 1	-.34	.996
		School 2	-6.61*	.000
		School 4	-3.52	.190
	School 4	School 1	3.18	.244
		School 2	-3.10	.307
		School 3	3.52	.190

* The mean difference is significant at the .05 level.

In comparison of the pairs, school 2 had significantly higher value-added scores than school 1 and school 3 on 2004 value-added mathematics scores.

For $Ho3_3$, ANCOVA was conducted to determine if there was a difference in school performance of students who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* based on the 2004 *TerraNova* CRT scores. The statistical analysis was conducted to determine if there was a school by intervention interaction. Table 13 presents the results of the school by intervention interaction (participation in *Accelerated Math*) with the 2004 *TerraNova* mathematics proficiency scores. As shown in Table 13, there was a significant difference in the interaction of school and participation in the *Accelerated Math* program (F = 19.191, p = .000). Because the F value was greater than the critical value, the null hypothesis ($Ho3_3$) was rejected and it was concluded that there was a significant difference in the interaction of school and participation in the intervention by students on the 2004 proficiency scores.

Table 13

Comparison of Means by School and Its Interaction with the Intervention (Participation in Accelerated Math) in Mathematics Proficiency Scores

Intervention	*School*	*N*	*M*	*Adj. M*	*SD*	*F*	*P*
Proficiency Scores							
No AM	School 1	59	41.34	41.339	12.001	19.191	.000
	School 2	50	45.96	45.960	10.635		
	School 3	53	30.74	30.736	10.187		
	School 4	26	35.58	35.577	11.697		
AM	School 1	115	33.03	33.035	8.670		
	School 2	85	34.01	34.012	10.908		
	School 3	91	33.53	33.527	11.205		
	School 4	63	43.10	43.095	12.387		

Because a significant *F* was obtained, post hoc tests were used to determine which schools differed significantly from one another. Table 14 provides the results of Scheffe post hoc tests examining the differences in school performance and its interaction with the intervention (participation in *Accelerated Math*) in mathematics proficiency scores.

Table 14

Results of Scheffe Tests to Provide Post Hoc Analysis Comparing School Performance and Its Interaction With the Intervention (Participation in Accelerated Math) on the 2004 Mathematics Proficiency Subtest

Intervention	(I) School	(J) School	M Diff. (I-J)	P
Proficiency Scores				
	School 1	School 2	-2.59	.225
		School 3	3.35	.056
		School 4	-5.05*	.005
	School 2	School 1	2.59	.225
		School 3	5.94*	.000
		School 4	-2.46	.425
	School 3	School 1	-3.35	.056
		School 2	-5.94*	.000
		School 4	-8.40*	.000
	School 4	School 1	5.05*	.005
		School 2	2.46	.425
		School 3	8.40*	.000

* The mean difference is significant at the .05 level.

In comparison of the pairs, school 2 scored significantly higher than school 3. In addition, school 4 had higher mean proficiency scores than school 1 and school 3.

For $Ho3_{4,}$ ANCOVA was conducted to determine if there was a difference in school performance of students who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* based on the 2004 *TerraNova* value-added scores while controlling for 2002 and 2003 value-added scores. The statistical analysis was conducted to determine if there was a school by intervention (comparing students who received *Accelerated Math* instruction and students who did not receive the modified instruction) interaction. As shown in Table 15, there was a significant difference in the interaction of school and participation in the *Accelerated Math* program (F = 8.498, p = .000). Because the F value was greater than the critical value, null hypothesis ($Ho3_4$) was rejected and it was concluded that there was a significant difference in the interaction of school and participation in the intervention by students on value-added scores.

Table 15

Comparison of Means by School and Its Interaction with the Intervention (Participation in Accelerated Math) in Mathematics Value-Added Scores

Intervention	*School*	*N*	*M*	*Adj. M*	*SD*	*F*	*P*
Value-Added Scores							
No AM	School 1	59	2.86	3.092a	11.789	8.498	.000
	School 2	50	1.84	4.365a	9.911		
	School 3	53	-6.49	-5.196a	12.420		
	School 4	26	2.96	1.119a	14.636		

Table 15 (continued)

Intervention	*School*	*N*	*M*	*Adj. M*	*SD*	*F*	*P*
AM	School 1	115	-6.51	-7.002a	11.695		
	School 2	85	3.59	2.694a	11.270		
	School 3	91	-2.03	-4.236a	11.375		
	School 4	63	-1.44	1.290a	11.223		

Because a significant *F* was obtained, post hoc tests were used to determine which schools differed significantly from one another. Table 16 provides the results of Bonferroni post hoc tests examining the differences in school performance and its interaction with the intervention (participation in *Accelerated Math*) in mathematics value-added scores.

Table 16

Results of Bonferroni Tests to Provide Post Hoc Analysis Comparing School Performance and Its Interaction With the Intervention (Participation in Accelerated Math) on the 2004 Mathematics Value-Added Scores

Intervention	(I) School	(J) School	M Diff. (I-J)	P
Value-Added Scores				
	School 1	School 2	-5.485*	.000
		School 3	2.761	.145
		School 4	-3.159	.185

Table 16 (continued)

Intervention	(I) School	(J) School	M Diff. (I-J)	P
	School 2	School 1	5.485*	.000
		School 3	8.246*	.000
		School 4	2.326	.751
	School 3	School 1	-2.761	.145
		School 2	-8.246*	.000
		School 4	-5.920*	.001
	School 4	School 1	3.159	.185
		School 2	-2.326	.751
		School 3	5.920*	.001

* The mean difference is significant at the .05 level.

In comparison of the pairs, school 2 scored significantly higher than school 1 and school 3. In addition, school 4 had higher mean value-added scores than school 3.

Research Question 4

To what extent, if any, is there a difference between the *TerraNova* math test scores of special education and nonspecial education students who did and did not participate in the *Accelerated Math* program?

From Research Question 4, the following four hypotheses were developed and tested:

$Ho4_1$: There is no relationship between special education status and scores on the 2004 *TerraNova* CRT scores.

$Ho4_2$: There is no relationship between special education status and scores on the 2004 *TerraNova* test while controlling for the 2002 and 2003 *TerraNova* as determined by value-added scores.

$Ho4_3$: There is no relationship between the use of *Accelerated Math* and mathematics achievement by special education status based on 2004 *TerraNova* CRT test results.

$Ho4_4$: Based on value-added scores, there is no relationship between the use of *Accelerated Math* and mathematics achievement by special education status on the 2004 *TerraNova* test while controlling for the 2002 and 2003 *TerraNova*.

A *t* test for independent samples was used to test $Ho4_1$. Using $\alpha = 0.05$ and $df = 540$, the critical value for *t* is +/- 1.970 for a two-tailed test. As shown in table 17, the calculated value of *t* (8.570) was greater than the critical value of *t* (1.970). Therefore, the null hypothesis ($Ho4_1$) was rejected and it was concluded that there was a significant difference in mean proficiency score between special education and nonspecial education students.

Table 17

Comparison of Mathematics Proficiency Scores by Special Education Status

Subtest	*N*	*M*	*SD*	*t*	*P*
CRT Proficiency Scores					
Special Education	64	25.30	8.578	8.570	.000
Non-Special Education	478	37.92	11.359		

As shown in table 17, nonspecial education students (M = 37.92) had significantly higher proficiency scores than special education students (M = 25.30), p =.000. In addition, the effect size was large (Cohen's $d = 1.25$).

For $Ho4_2$, ANCOVA was conducted to determine if significant differences existed in 2004 value-added mathematics scores by special education status while controlling for 2002 and 2003 value-added scores. Table 18 shows the results of this analysis. Because the *F* value (0.157) was less than the critical value, I failed to reject the null hypothesis and concluded that there was no significant difference in the 2004 value-added scores by gender. The *p* value (0.692) was larger than the preset alpha of 0.05.

Table 18

Comparison of Mathematics Value-Added Scores by Special Education Status

Subtest	*N*	*Adj. M*	*M*	*SD*	*F*	*p*
Value-Added Scores						
Special Education	64	-.822a	-1.64	12.918	0.157	.692
Non-Special Education	478	-1.409a	-1.47	12.115		

For $Ho4_3$, ANCOVA was conducted to determine if there was a difference in the performance of students by special education status who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* based on the 2004 *TerraNova* CRT scores. The statistical analysis was conducted to determine if there was a special education by intervention interaction. Table 19 presents the results of the special education status by intervention interaction (participation in *Accelerated Math*) with the 2004 *TerraNova* mathematics proficiency scores. As shown in Table 19, there was no significant difference in the interaction of special education status and participation in the *Accelerated Math* program (F = 0.333, p = .564). Therefore, I failed to reject the null hypothesis ($Ho4_3$).

Table 19

Comparison of Means by Special Education Status and Its Interaction With the Intervention (Participation in Accelerated Math) in Mathematics Proficiency Scores

Intervention	*Special Education Status*	*N*	*Adj. M*	*M*	*SD*	*F*	*p*
Proficiency Scores							
No AM	No Sp. Ed.	153	41.497	41.50	11.655	.333	.564
	Sp. Ed.	35	26.914	26.91	8.856		
AM	No Sp. Ed.	325	36.243	36.24	10.833		
	Sp. Ed.	29	23.345	23.34	7.943		

For $Ho4_4$, ANCOVA was conducted to determine if there was a special education status by intervention interaction in value-added scores. As shown in table 20, there was no significant difference in interaction between special education and participation in *Accelerated Math* (F = 0.099, p = 0.753). Therefore, I failed to reject the null hypothesis.

Table 20

Comparison of Means by Special Education Status and Its Interaction With the Intervention (Participation in Accelerated Math) in Mathematics Value-Added Scores

Intervention	*Special Education Status*	*N*	*Adj. M*	*M*	*SD*	*F*	*p*
Value-Added Scores							
No AM	No Sp. Ed.	153	.881a	-.02	12.151	.099	.753
	Sp. Ed.	35	.270a	-.09	14.269		
AM	No Sp. Ed.	325	-2.485a	-2.15	12.056		
	Sp. Ed.	29	-2.159a	-.69	11.314		

Research Question 5

To what extent, if any, is there a difference between the *TerraNova* math test scores of students of different socioeconomic status who did and did not participate in the *Accelerated Math* program?

From Research Question 5, the following four hypotheses were developed and tested:

$Ho5_1$: There is no relationship between socioeconomic status and scores on the 2004 *TerraNova* test based on mathematics CRT scores.

$Ho5_2$: Based on value-added scores, there is no relationship between socioeconomic status and scores on the 2004 *TerraNova* test while controlling for the 2002 and 2003 *TerraNova*.

$Ho5_3$: There is no relationship between the use of *Accelerated Math* and mathematics achievement by socioeconomic status based on the 2004 *TerraNova* CRT scores.

$Ho5_4$: There is no relationship between the use of *Accelerated Math* and mathematics achievement by socioeconomic status based on value-added scores from the 2004 *TerraNova* test while controlling for the 2002 and 2003 *TerraNova.*

A *t* test for independent samples was used to test $Ho5_1$. Using α = 0.05 and *df* = 540, the critical value for *t* is +/- 1.970 for a two-tailed test. As shown in table 21, the calculated value of *t* (5.524) was greater than the critical value of *t* (1.970). Therefore, the null hypothesis ($Ho5_1$) was rejected and it was concluded that there was a significant difference in mean proficiency scores by socioeconomic status.

Table 21

Comparison of Mathematics Proficiency Scores by Socioeconomic Status

Subtest	*N*	*M*	*SD*	*t*	*P*
CRT Proficiency Scores					
Paid	256	39.31	11.650	5.524	.000
Free/Reduced	286	33.86	11.324		

As shown in table 21, students paying for meals (M = 39.31) had significantly higher proficiency scores than students receiving free/reduced priced meals (M = 33.86), *p*=.000. In addition, the effect size was medium (Cohen's *d* = .47).

For $Ho5_{2,}$ ANCOVA was conducted to determine if significant differences existed in 2004 value-added mathematics scores by socioeconomic status while controlling for 2002 and 2003 value-added scores. Table 22 shows the results of this analysis. Because the *F* value (3.668) was less than the critical value, I failed to reject the null hypothesis and concluded that there was no significant difference in the 2004 value-added scores by socioeconomic status. The *p* value (0.056) was larger than the preset alpha of 0.05.

Table 22

Comparison of Mathematics Value-Added Scores by Socioeconomic Status

Subtest	*N*	*Adj. M*	*M*	*SD*	*F*	*p*
Value-Added Scores						
Paid	256	-.376a	-.50	12.564	3.668	.056
Free/Reduced	286	-2.202a	-2.09	11.847		

For $Ho5_3$, ANCOVA was conducted to determine if there was a difference in the performance of students by socioeconomic status who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* based on the 2004 *TerraNova* CRT scores. Table 23 presents the results of the socioeconomic status by intervention interaction (participation in *Accelerated Math*) with the 2004 *TerraNova* mathematics proficiency scores. As shown in table 23, there was a significant difference in the interaction of socioeconomic status and participation in the *Accelerated Math* program ($F = 4.711$, $p = .030$). Therefore, the null hypothesis ($Ho5_3$) was rejected and it was concluded that there was an intervention interaction (participation in *Accelerated Math*) with proficiency scores.

Table 23

Comparison of Means by Socioeconomic Status and Its Interaction with the Intervention (Participation in Accelerated Math) in Mathematics Proficiency Scores

Intervention	*Socioeconomic Status*	*N*	*Adj. M*	*M*	*SD*	*F*	*p*
Proficiency Scores							
No AM	Paid	94	42.894	42.89	11.451	4.711	.030
	Free/Reduced	94	34.670	34.67	12.269		
AM	Paid	162	37.235	37.23	11.287		
	Free/Reduced	192	33.458	33.46	10.842		

For $Ho5_{4,}$ ANCOVA was conducted to determine if there was a socioeconomic status by intervention interaction in value-added scores. As shown in table 24, there was no significant difference in interaction between socioeconomic status and the intervention - participation in *Accelerated Math* (F = 0.270, p = 0.604). Therefore, I failed to reject the null hypothesis.

Table 24

Comparison of Means by Socioeconomic Status and Its Interaction With the Intervention (Participation in Accelerated Math) in Mathematics Value-Added Scores

Intervention	*Socioeconomic Status*	*N*	*Adj. M*	*M*	*SD*	*F*	*p*
Value-Added Scores							
No AM	Paid	94		1.27	11.997	.270	.604
	Free/Reduced	94		-1.33	12.977		
AM	Paid	162		-1.53	12.805		
	Free/Reduced	192		-2.46	11.269		

Research Question 6

To what extent, if any, is there a difference between the *TerraNova* math test scores of students of different ability groups who did and did not participate in the *Accelerated Math* program?

From Research Question 6, the following four hypotheses were developed and tested:

$Ho6_1$: There is no difference in the performance of students on the CRT portion of the 2004 *TerraNova* test in the five different quintiles (1^{st}, 2^{nd}, 3^{rd}, 4^{th}, and 5^{th} quintiles).

$Ho6_2$: There is no difference in the performance of students on the 2004 *TerraNova* test in the five different quintiles (1^{st}, 2^{nd}, 3^{rd}, 4^{th}, and 5^{th} quintiles) based on value-added scores while controlling for the 2002 and 2003 *TerraNova*.

$Ho6_3$: There is no difference in the performance of students on the CRT portion of the 2004 *TerraNova* test in the five different quintiles (1st, 2nd, 3rd, 4th, and 5th quintiles) after participating in the *Accelerated Math*.

$Ho6_4$: Based on value-added scores, there is no difference in the performance of students on the 2004 *TerraNova* test in the five different quintiles (1st, 2nd, 3rd, 4th, and 5th quintiles) after participating in the *Accelerated Math* while controlling for the 2002 and 2003 *TerraNova*.

ANOVA was used to test $Ho6_1$ because it allows statistical analysis involving more than two groups. As shown in table 25, there was a significant difference in the 2004 mathematics proficiency score by ability group ($F = 256.882$, $p = .000$). Because the calculated value of F was greater than the critical value, the null hypothesis ($Ho6_1$) that stated $\mu_1 = \mu_2 = \mu_3 \ldots = \mu_k$ was rejected and it was concluded that at least one ability group scored significantly higher than one other ability group. There was a significant difference in the performance of students by ability group. The ability grouping was based on a two-year average of "State NCEs" as determined by the Tennessee Department of Education.

Table 25

Comparison of Mathematics Proficiency Scores by Ability Group

Intervention	*Ability Group*	*N*	*M*	*SD*	*F*	*P*
Proficiency Scores						
	1st Quintile	112	22.57	6.801	256.882	.000*
	2nd Quintile	117	30.77	6.169		
	3rd Quintile	120	37.61	6.238		
	4th Quintile	105	44.51	8.175		
	5th Quintile	88	50.36	7.330		

Because a significant *F* was obtained, post hoc tests were used to determine which ability groups differed significantly from one another. The Scheffe method was selected as the post hoc test of choice since it is most conservative with respect to Type I errors. The Scheffe post hoc tests were applied to determine which pairs were different. Table 26 provides the results of post hoc tests examining the differences between the five ability groups using Scheffe tests on the mathematics proficiency scores. As expected all differences between ability groups were significant.

Table 26

Results of Scheffe Tests to Provide Post Hoc Analysis Comparing Ability Group Performance on the 2004 Mathematics Proficiency Scores

Intervention	(I) Ability Group	(J) Ability Group	M Diff. (I-J)	P
Proficiency Scores				
	1st Quintile	2nd Quintile	-8.20*	.000
		3rd Quintile	-15.04*	.000
		4th Quintile	-21.94*	.000
		5th Quintile	-27.79*	.000
	2nd Quintile	1st Quintile	8.20*	.000
		3rd Quintile	-6.84*	.000
		4th Quintile	-13.75*	.000
		5th Quintile	-19.59*	.000

Table 26 (continued

Intervention	(I) Ability Group	(J) Ability Group	M Diff. (I-J)	P
	3rd Quintile	1st Quintile	15.04*	.000
		2nd Quintile	6.84*	.000
		4th Quintile	-6.91*	.000
		5th Quintile	-12.76*	.000
	4th Quintile	1st Quintile	21.94*	.000
		2nd Quintile	13.75*	.000
		3rd Quintile	6.91*	.000
		5th Quintile	-5.85*	.000
	5th Quintile	1st Quintile	27.79*	.000
		2nd Quintile	19.59*	.000
		3rd Quintile	12.76*	.000
		4th Quintile	5.85*	.000

The mean difference is significant at the .05 level.

In comparison of the pairs, quintile 5 had the greatest mean score followed by quintile 4, quintile 3, quintile 2, and quintile 1, consecutively. All differences were significant.

For $Ho6_{2,}$ ANCOVA was conducted to determine if significant differences existed in 2004 value-added mathematics scores by ability group while controlling for 2002 and 2003 value-added scores. As shown in table 27, there was a significant difference in the 2004 mathematics value-added score by ability group ($F = 5.413$, $p = .000$). Because the calculated value of *F* was greater than the critical value of *F* based on an alpha of 0.05, the null hypothesis ($Ho6_2$) was rejected and it was concluded that at least one quintile's mean value-added score was significantly different from one other quintile's mean value-added score.

Table 27

Comparison of Mathematics Value-Added Scores by Ability Group

School	*N*	*Adj. M*	*M*	*SD*	*F*	*P*
Value-Added Scores						
1st Quintile	112	-4.276a	-3.70	13.631	5.413	.000
2nd Quintile	117	-2.438a	-1.57	9.886		
3rd Quintile	120	-.487a	-.28	12.140		
4th Quintile	105	1.832a	.97	10.916		
5th Quintile	88	-.516a	-2.24	14.101		

Because a significant *F* was obtained, post hoc tests were used to determine which quintiles differed significantly from one another. Table 28 provides the results of the Bonferroni pairwise comparisons examining the differences between the mean value-added scores of the five quintiles.

Table 28

Results of Bonferroni Tests to Provide Post Hoc Analysis Comparing Ability Group Performance on the 2004 Mathematics Value-Added Scores

Intervention	(I) Ability Group	(J) Ability Group	M Diff. (I-J)	P
Value-Added Scores				
	1st Quintile	2nd Quintile	-2.288	1.000
		3rd Quintile	-4.239*	.033
		4th Quintile	-6.558*	.000
		5th Quintile	-4.210	.077
	2nd Quintile	1st Quintile	2.288	1.000
		3rd Quintile	-1.950	1.000
		4th Quintile	-4.270*	.040
		5th Quintile	-1.922	1.000
	3rd Quintile	1st Quintile	4.239*	.033
		2nd Quintile	1.950	1.000
		4th Quintile	-2.319	1.000
		5th Quintile	.028	1.000
	4th Quintile	1st Quintile	6.558*	.000
		2nd Quintile	4.270*	.040
		3rd Quintile	2.319	1.000
		5th Quintile	2.348	1.000

Table 28 (continued)

Intervention	(I) Ability Group	(J) Ability Group	M Diff. (I-J)	P
	5th Quintile	1st Quintile	4.210	.077
		2nd Quintile	1.922	1.000
		3rd Quintile	-.028	1.000
		4th Quintile	-2.348	1.000

* The mean difference is significant at the .05 level.

In comparison of the pairs, the third quintile scored significantly higher than the 1st quintile. The fourth quintile scored significantly higher than both the first and second quintile.

For $Ho6_3$, ANCOVA was conducted to determine if there was a difference in the performance of students by ability groups who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* based on the 2004 *TerraNova* CRT scores. Table 29 presents the results of the ability group by intervention interaction (participation in *Accelerated Math*) with the 2004 *TerraNova* mathematics proficiency scores. As shown in table 29, there was a no significant difference in the interaction of ability groups and participation in the *Accelerated Math* program ($F = 1.129$, $p = .342$). Therefore, I failed to reject the null hypothesis ($Ho6_3$) and concluded that there was no significant difference in the performance of students in the mathematics CRT portion of the 2004 *TerraNova* by ability group comparing students who received the intervention (participation in *Accelerated Math*) and students who did not participate in the intervention.

Table 29

Comparison of Means by Ability Groups and Its Interaction With the Intervention (Participation in Accelerated Math) in Mathematics Proficiency Scores

Intervention	*Ability Group*	*N*	*Adj. M*	*M*	*SD*	*F*	*p*
Proficiency Scores							
No AM	1st Quintile	42	23.738	23.74	6.188	1.129	.342
	2nd Quintile	41	33.220	33.22	6.650		
	3rd Quintile	31	42.000	42.00	6.261		
	4th Quintile	44	46.523	46.52	9.500		
	5th Quintile	30	52.767	52.77	6.892		
AM	1st Quintile	70	21.871	21.87	7.093		
	2nd Quintile	76	29.447	29.45	5.498		
	3rd Quintile	89	36.079	36.08	5.486		
	4th Quintile	61	43.066	43.07	6.787		
	5th Quintile	58	49.121	49.12	7.296		

For $Ho6_4$, ANCOVA was conducted to determine if there was a difference in the performance of students by ability groups who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* based on the 2004 *TerraNova* value-added scores. Table 30 presents the results of the ability group by intervention interaction (participation in *Accelerated Math*) with the 2004 *TerraNova* mathematics value-added scores. As shown in table 30, there was a no significant difference in the interaction of ability groups and participation in the *Accelerated Math* program ($F = 1.287$, $p = .274$). Therefore, I failed to reject the null hypothesis ($Ho6_4$) and concluded that there was no significant difference in the performance of students in the mathematics value-added portion of the 2004 *TerraNova* by ability group, comparing students who received the intervention (participation in *Accelerated Math*) and students who did not participate in the intervention.

Table 30

Comparison of Means by Ability Groups and Its Interaction With the Intervention (Participation in Accelerated Math) in Mathematics Value-Added Scores

Intervention	*Ability Group*	*N*	*Adj. M*	*M*	*SD*	*F*	*p*
Value-Added Scores							
No AM	1st Quintile	42	-2.190a	-2.24	13.047	1.287	.274
	2nd Quintile	41	.728a	1.20	10.383		
	3rd Quintile	31	3.947a	2.23	12.077		
	4th Quintile	44	2.372a	.70	12.485		
	5th Quintile	30	-.369a	-2.03	14.885		
AM	1st Quintile	70	-6.327a	-4.57	13.989		
	2nd Quintile	76	-4.186a	-3.07	9.339		
	3rd Quintile	89	-2.039a	-1.15	12.108		
	4th Quintile	61	1.501a	1.16	9.733		
	5th Quintile	58	-.492a	-2.34	13.810		

Research Question 7

To what extent, if any, is there a difference between the *TerraNova* math test scores of students of different degrees of implementation of the *Accelerated Math* program?

From Research Question 7, the following hypotheses were developed and tested:

$Ho7_1$: There is no relationship between the degree of implementation of the treatment and mathematics achievement on the 2004 *TerraNova* CRT scores.

$Ho7_2$: There is no relationship between the degree of implementation of the treatment and mathematics achievement on the 2004 *TerraNova* value-added scores while controlling for the 2002 and 2003 scores.

ANOVA was used to test $Ho7_1$ because the hypothesis involved one independent variable consisting of three groups and one dependent variable. As shown in table 31, there was a significant difference in the 2004 mathematics proficiency score by degree of implementation ($F = 7.579$, $p = .001$). Because the calculated value of F was greater than the critical value, the null hypothesis ($Ho7_1$) that stated $\mu_1 = \mu_2 = \mu_3$ was rejected and it was concluded that at least one degree of implementation scored higher than did another. There was a significant difference in the performance of students by the degree of implementation of the intervention.

Table 31

Comparison of Mathematics Proficiency Scores by Degree of Implementation of the Intervention

Intervention	*Degree of Implementation*	*N*	*M*	*SD*	*F*	*P*
Proficiency Scores						
	Did not use AM	188	38.78	12.533	7.579	.000*
	Used AM as supplement	210	34.23	10.248		
	Used AM exclusively	144	36.58	12.346		

Because a significant *F* was obtained, post hoc tests were used to determine which degree of implementation had the greatest mean. The Scheffe method was selected as the post hoc test of choice because of its conservative characteristics. The Scheffe post hoc tests were applied to determine which pairs were different. Table 32 provides the results of post hoc tests examining the differences between the degrees of implementation using Scheffe tests on the mathematics proficiency scores.

Table 32

Results of Scheffe Post Hoc Analysis Comparing the Performance of 2004 Mathematics Proficiency Scores by the Degree of Implementation

Intervention	(I) Degree of Implementation	(J) Degree of Implementation	M Diff. (I-J)	P
Proficiency Scores	Did not use AM	Used AM as supplement	4.55*	.001
		Used AM exclusively	2.21	.233
	Used AM as supplement	Did not use AM	-4.55*	.001
		Used AM exclusively	-2.34	.179
	Used AM exclusively	Did not use AM	-2.21	.233
		Used AM as supplement	2.34	.179

* The mean difference is significant at the .05 level.

In comparison of the pairs, the control group that did not use *Accelerated Math* (AM) had a significantly higher mean proficiency score than the group that used *Accelerated Math* as a supplement.

ANCOVA was used to test $Ho7_2$ because the 2002 and 2003 value-added scores were covariates to control for small group differences. As shown in table 33, there was a significant difference in the 2004 mathematics value-added score by degree of implementation ($F = 5.188$, $p = .006$). Because the calculated value of *F* was greater than the critical value, the null hypothesis ($Ho7_1$) that stated $\mu_1 = \mu_2 = \mu_3$ was rejected and it was concluded that at least one degree of implementation group scored higher than did another. There was a significant difference in the performance of students by the degree of implementation of the intervention.

Table 33

Comparison of Mathematics Value-Added Scores by Degree of Implementation of the Intervention

Intervention	*Degree of Implementation*	*N*	*M*	*SD*	*F*	*P*
Value-Added Scores						
	Did not use AM	188	-.03	12.531	5.188	.006
	Used AM as supplement	210	-2.60	12.382		
	Used AM exclusively	144	-1.20	11.381		

Because the difference in mean scores was significant, post hoc tests were used to determine which degree of implementation achieved significantly higher scores. The Bonferroni pairwise comparison was applied to determine which pairs were different. Table 34 provides the results of post hoc tests examining the differences between the degrees of implementation on the mathematics value-added scores.

Table 34

Results of Bonferroni Post Hoc Analysis Comparing the Performance of 2004 Mathematics Value-Added Scores by the Degree of Implementation

Intervention	(I) Degree of Implementation	(J) Degree of Implementation	M Diff. (I-J)	P
Value-Added Scores				
	Did not use AM	Used AM as supplement	3.311*	.009
		Used AM exclusively	3.097*	.037
	Used AM as supplement	Did not use AM	-3.311*	.009
		Used AM exclusively	-.214	1.000
	Used AM exclusively	Did not use AM	-3.097*	.037
		Used AM as supplement	.214	1.000

* Based on estimated marginal means.

In comparison of the pairs, the control group that did not use *Accelerated Math* had a significantly higher mean value-added score than the group that used *Accelerated Math* as a supplement and the group that used the intervention exclusively.

Research Question 8

To what extent, if any, is there a difference between the *TerraNova* math test scores of students in different grades who did and did not participate in the *Accelerated Math* program?

From Research Question 8, the following hypotheses were developed and tested:

$Ho8_1$: There is no difference in the performance of sixth-, seventh-, and eighth-grade students on the 2004 *TerraNova* CRT scores.

$Ho8_2$: There is no difference in the performance of sixth-, seventh-, and eighth-grade students on the 2004 *TerraNova* value-added scores while controlling for the 2002 and 2003 *TerraNova* math scores.

$Ho8_3$: There is no difference in the performance of sixth-, seventh-, and eighth-grade students who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* based on the 2004 *TerraNova* CRT scores.

$Ho8_4$: Based on value-added scores, there is no difference in the performance of sixth-, seventh-, and eighth-grade students who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* on the 2004 *TerraNova* while controlling for the 2002 and 2003 *TerraNova* test results.

ANOVA was used to test $Ho8_1$ because the hypothesis involved one independent variable consisting of three groups and one dependent variable. As shown in Table 35, there was a significant difference in the 2004 mathematics proficiency score by grade ($F = 37.119$, $p = .000$). Because the calculated value of F was greater than the critical value, the null hypothesis ($Ho7_1$) that stated $\mu_1 = \mu_2 = \mu_3$ was rejected and it was concluded that at least one grade scored higher than another grade.

Table 35

Comparison of Mathematics Proficiency Scores by Grade

Intervention	*Grade*	*N*	*M*	*SD*	*F*	*P*
Proficiency Scores						
	6^{th} Grade	181	33.93	10.055	37.119	.000
	7^{th} Grade	178	33.10	10.044		
	8^{th} Grade	183	42.15	12.843		

Because a significant *F* was obtained, post hoc tests were used to determine which grade had the greatest mean proficiency score. The Scheffe post hoc tests were applied to determine which pairs were different. Table 36 provides the results of post hoc tests examining the differences between the degrees of implementation using Scheffe tests on the mathematics proficiency scores.

Table 36

Results of Scheffe Post Hoc Analysis Comparing the Performance of 2004 Mathematics Proficiency Scores by Grade

Intervention	(I) Grade	(J) Grade	M Diff. (I-J)	P
Proficiency Scores				
	6^{th} Grade	7^{th} Grade	.84	.773
		8^{th} Grade	-8.22*	.000
	7^{th} Grade	6^{th} Grade	-.84	.773
		8^{th} Grade	-9.06*	.000
	8^{th} Grade	6^{th} Grade	8.22*	.000
		7^{th} Grade	9.06*	.000

* The mean difference is significant at the .05 level.

In comparison of the pairs, the 8^{th} grade had significantly higher mean proficiency scores than the 6^{th} or 7^{th} grades.

ANCOVA was used to test $Ho8_2$ because the 2002 and 2003 value-added scores were used as covariates to control for small group differences. As shown in table 37, there was a significant difference in the 2004 mathematics value-added score by grade (F = 5.865, p = .003). Because the calculated value of F was greater than the critical value, the null hypothesis ($Ho8_2$) that stated $\mu_1 = \mu_2 = \mu_3$ was rejected and it was concluded that at least one grade scored higher than another did.

Table 37

Comparison of Mathematics Value-Added Scores by Grade

Intervention	*Grade*	*N*	*M*	*SD*	*F*	*P*
Value-Added Scores						
	6^{th} Grade	181	-3.98	13.229	5.865	.003
	7^{th} Grade	178	-.19	11.132		
	8^{th} Grade	183	.16	11.777		

Because the difference in mean scores was significant, post hoc tests were used to determine which grade(s) achieved significantly higher scores. The Bonferroni pairwise comparison was applied to determine which pairs were different. Table 38 provides the results of post hoc tests examining the differences between grades on the mathematics value-added scores.

Table 38

Results of Bonferroni Post Hoc Analysis Comparing the Performance of 2004 Mathematics Value-Added Scores by Grade

Intervention	(I) Grade	(J) Grade	M Diff. (I-J)	P
Value-Added Scores				
	6^{th} Grade	7^{th} Grade	.042	1.000
		8^{th} Grade	-3.481*	.009

Table 38 (continued)

Intervention	(I) Grade	(J) Grade	M Diff. (I-J)	P
	7th Grade	6th Grade	-.042	1.000
		8th Grade	-3.523*	.012
	8th Grade	6th Grade	3.481*	.009
		7th Grade	3.523*	.012

* The mean difference is significant at the .05 level.

In comparison of the pairs, the 8th grade had significantly higher mean value-added scores than the 6th or 7th grades.

For $Ho8_3$, ANCOVA was conducted to determine if there was a difference in the performance of students by grade level who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* based on the 2004 *TerraNova* CRT scores. Table 39 presents the results of the grade by intervention interaction (participation in *Accelerated Math*) with the 2004 *TerraNova* mathematics proficiency scores. As shown in Table 39, there was a significant difference in the interaction of grade level and participation in the *Accelerated Math* program ($F = 5.802$, $p = .003$). Therefore, the null hypothesis ($Ho8_3$) was rejected and it was concluded that there was a significant difference in the performance of students in the mathematics CRT portion of the 2004 *TerraNova* by grade level, comparing students who received the intervention (participation in *Accelerated Math*) and students who did not participate in the intervention.

Table 39

Comparison of Means by Grade Level and Its Interaction with the Intervention (Participation in Accelerated Math) in Mathematics Proficiency Scores

Intervention	*Grade*	*N*	*Adj. M*	*M*	*SD*	*F*	*P*
Proficiency Scores							
No AM	6th Grade	53	30.736	30.74	10.187	5.802	.003
	7th Grade	26	35.577	35.58	11.697		
	8th Grade	109	43.459	43.46	11.576		
AM	6th Grade	128	35.258	35.26	9.735		
	7th Grade	152	32.671	32.67	9.714		
	8th Grade	74	40.230	40.23	14.377		

Because the difference in mean scores was significant, the Scheffe post hoc test was used to determine which grade(s) achieved significantly higher scores. Table 40 provides the results of post hoc tests examining the differences between grades on the mathematics proficiency scores.

Table 40

Results of Scheffe Post Hoc Analysis Comparing the Performance of 2004 Mathematics Proficiency Scores by Grade

Intervention	(I) Grade	(J) Grade	M Diff. (I-J)	P
Proficiency Scores				
	6^{th} Grade	7^{th} Grade	.84	.770
		8^{th} Grade	-8.22*	.000
	7^{th} Grade	6^{th} Grade	-.84	.770
		8^{th} Grade	-9.06*	.000
	8^{th} Grade	6^{th} Grade	8.22*	.000
		7^{th} Grade	9.06*	.000

* The mean difference is significant at the .05 level.

In comparison of the pairs, the 8^{th} grade had significantly higher mean proficiency scores than the 6^{th} or 7^{th} grades when evaluating the intervention (participation in *Accelerated Math*) interaction with mathematics proficiency scores.

For $Ho8_4$, ANCOVA was conducted to determine if there was a difference in the performance of students by grade level who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* based on the 2004 *TerraNova* value-added scores. Table 41 presents the results of the intervention (participation in *Accelerated Math*) interaction with grade of the 2004 *TerraNova* mathematics value-added scores. There was a significant difference in the interaction of grade level and participation in the *Accelerated Math* program ($F = 10.438$, $p = .000$). Therefore, the null hypothesis ($Ho8_4$) was rejected and it was concluded that there was a significant difference in the performance of students in the mathematics value-added scores on the 2004 *TerraNova* by grade level, comparing students who received the intervention (participation in *Accelerated Math*) and students who did not participate in the intervention.

Table 41

Comparison of Means by Grade Level and Its Interaction With the Intervention (Participation in Accelerated Math) in Mathematics Value-Added Scores

Intervention	*Grade*	*N*	*Adj. M*	*M*	*SD*	*F*	*P*
Value-Added Scores							
No AM	6th Grade	53	-5.295a	-6.49	12.420	10.438	.003
	7th Grade	26	1.418a	2.96	14.636		
	8th Grade	109	3.655a	2.39	10.930		
AM	6th Grade	128	-1.277a	-2.95	13.459		
	7th Grade	152	-3.053a	-.73	10.382		
	8th Grade	74	-3.422a	-3.14	12.272		

Because the difference in mean scores was significant, the Bonferroni post hoc test was used to determine which grade(s) achieved significantly higher scores than other grades. Table 42 provides the results of post hoc tests examining the differences between grades on the mathematics value-added scores.

Table 42

Results of Bonferroni Post Hoc Analysis Comparing the Performance of 2004 Mathematics Value-Added Scores by Grade

Intervention	(I) Grade	(J) Grade	M Diff. (I-J)	P
Value-Added Scores				
	6th Grade	7th Grade	-2.469	.311
		8th Grade	-3.402*	.015
	7th Grade	6th Grade	2.469	.311
		8th Grade	-.934	1.000
	8th Grade	6th Grade	3.402*	.015
		7th Grade	.934	1.000

* The mean difference is significant at the .05 level.

In comparison of the pairs, the 8th grade had significantly higher mean value-added scores than the 6th grade when evaluating the intervention (participation in *Accelerated Math*) interaction with grade level.

Research Question 9

To what extent, if any, is there a difference between the *TerraNova* math test scores of students with different teachers who did and did not participate in the *Accelerated Math* program?

From Research Question 9, the following hypotheses were developed and tested:

$Ho9_1$: There is no relationship between the use of *Accelerated Math* and mathematics achievement by teacher based on the 2004 *TerraNova* CRT scores.

$Ho9_2$: There is no relationship between the use of *Accelerated Math* and mathematics achievement by teacher based on the 2004 *TerraNova* value-added scores while controlling for the 2002 and 2003 *TerraNova* test results

For $Ho9_1$, ANOVA was conducted to determine if there was a difference in the performance of students by teacher who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* based on the 2004 *TerraNova* proficiency scores. The independent variable – teacher – is a mutually exclusive category. It is impossible for a teacher to both participate in *Accelerated Math* and also not participate in the intervention. Therefore, ANOVA must be used to determine the association between the teacher and mathematics performance on 2004 proficiency scores. Table 43 presents the results of the teacher association with the 2004 *TerraNova* mathematics proficiency scores. There was a significant difference in the mean proficiency score by teacher (F = 12.604, p = .000). Therefore, the null hypothesis ($Ho9_1$) was rejected and it was concluded that there was a significant difference in the proficiency scores of students from different teachers.

Table 43

Comparison of Mean Proficiency Scores by Teacher

Subtest	*Teacher*	*N*	*M*	*SD*	*F*	*P*	*Scheffe PostHoc Comparison*
Proficiency Scores							
	1	47	37.74	11.199	12.604	.000	<6,7
	2	56	34.45	9.045			<6,7
	3	25	38.04	7.971			
	4	59	41.34	12.001			>5,9,11
	5	59	31.69	8.150			<4,6,7
	6	50	45.96	10.635			>1,2,5,9,10,11
	7	38	46.42	13.685			>1,2,5,9,10,11
	8	26	35.58	11.697			
	9	91	33.53	11.205			<4,6,7
	10	38	33.11	10.616			<6,7
	11	53	30.74	10.187			<4,6,7

Because the difference in mean scores was significant, the Scheffe post hoc test was used to determine which teachers achieved significantly higher scores. As shown in Table 43, teachers 6 and 7 had significantly higher means than most of the other teachers. Teacher 6 did not participate in the intervention whereas teacher 7 did participate in *Accelerated Math*.

For $Ho9_2$, ANCOVA was conducted to determine if there was a difference in the performance of students by teacher who participated in *Accelerated Math* and students who did not participate in *Accelerated Math* based on the 2004 *TerraNova* value-added scores. Table 44 presents the results of the teacher association with the 2004 *TerraNova* mathematics value-added scores while controlling for 2002 and 2003 scores. There was a significant difference in the mean value-added score by teacher (F = 9.552, p = .000). Therefore, the null hypothesis (Ho9_2) was rejected and it was concluded that there was a significant difference in the value-added scores of students from different teachers.

Table 44

Comparison of Mean Value-Added Scores by Teacher

Subtest	*Teacher*	*N*	*M*	*SD*	*F*	*P*	*Bonferroni PostHoc Comparison*
Value-Added Scores							
	1	47	3.09	12.131	9.552	.000	>2,5,9,11
	2	56	-8.34	13.309			< ALL
	3	25	-2.20	11.442			>2,5,11
	4	59	2.86	11.789			>2,5,9,11
	5	59	-4.78	9.726			<1,3,4,6,8,10
	6	50	1.84	9.911			>2,5,9,11
	7	38	-.95	11.203			
	8	26	2.96	14.636			>5
	9	91	-2.03	11.375			<1,4,6,10
	10	38	4.21	10.230			>2,5,9,11
	11	53	-6.49	12.420			<1,3,4,6,10

Because the difference in mean scores was significant, the Bonferroni post hoc test was used to determine which teachers achieved significantly higher scores. As shown in Table 44, teacher 2 had significantly lower value-added scores than any of the other teachers. Teacher 2 used the intervention as a supplement.

Summary

This chapter included an analysis of data. In Chapter 5, the findings are summarized and interpreted and from the analysis, conclusions are made. In addition, limitations and recommendations for practice and further consideration are given.

CHAPTER 5

FINDINGS, CONCLUSIONS, LIMITATIONS, AND RECOMMENDATIONS

The purpose of this study was to examine the relationship of students' participation in *Accelerated Math* to students' performance on the *TerraNova* of sixth- through eighth-grade students at the four elementary schools in the Summitt County school system. The analysis focused on the NRT and CRT mathematics portions of the 2004 *TerraNova*. The scores of the students who participated in *Accelerated Math* were compared with those who did not participate using the *TerraNova* test by gender, ability groups, special education status, school, teacher, socioeconomic status, and degree of implementation. A summary of the findings, conclusions, and recommendations for further research and for practice follow.

Summary of the Study

In recent years, technology has played a greater role in the education of students. One such role has been the use of computerized instructional management systems. Numerous variations of these computerized instructional systems have been classified as Computer Assisted Instruction (CAI), and Integrated Learning Systems (ILS) over the past few years. The effectiveness of these computer programs has been documented in numerous research studies. The results of these studies are mixed. Previous research pertaining to *Accelerated Math*, the intervention of this study, has been limited. The validity and reliability of much of the research has been questioned. In addition, many of the *Accelerated Math* studies cannot be generalized to the current population of this study because of the unique demographic characteristics.

The review of literature documented the various concepts related to computerized instructional management systems including immediate corrective student feedback, record keeping for teachers, related instructional factors, individualized instruction, mastery, curriculum alignment, accountability, and students' achievement. The use of technology in schools has played a major role in the evolution of these concepts. Definitions of the terms were presented along with a description of the advantages and disadvantages of technology. Most of the research studies documented in the literature review section pertained to *Accelerated Math*, the program of intervention in this study. However, because of student demographics consisting of unique characteristics in race and socioeconomic status, the generalization of those studies to this population was limited. Although most of the research documented the effectiveness of the intervention program, educators need to be confident that they are making educationally sound and fiscally responsible decisions. Since the passage of NCLB in 2001, educators find themselves seeking scientifically-proven academic programs to assist in increasing students' achievement.

This quasi-experimental control group design study focused on the use of *Accelerated Math*, a computerized instructional management system as both a supplement and replacement to traditional mathematics instruction. The population consisted of 542 students who were enrolled in one of the four elementary schools in the Summitt County School System during the 2003-2004 school year and who took the *TerraNova* for three consecutive years beginning in 2001-2002. Data were collected from the 2001-2002, 2002-2003, and 2003-2004 school years. Students' achievements in the form of proficiency scores and value-added scores were measured using the *TerraNova* data.

Summary of Findings

The analysis focused on nine research questions. The independent variables for the study were gender, school, teacher, special education status, socioeconomic status, grade, ability group, participation in the intervention, and the degree of implementation of the intervention. The dependent variables consisted of *TerraNova* value-added scores (NRT) and proficiency scores (CRT) in mathematics. A combination of *t* test for independent samples, analysis of variance

(ANOVA), and analysis of covariance (ANCOVA) was used to determine the effectiveness of *Accelerated Math* on mathematics achievement. The findings of the study provide answers to the nine research questions. The following restates each research question and provides a summary of the findings related to it.

Research Question 1

To what extent, if any, is there a difference between the *TerraNova* math test scores of students who did and did not participate in the *Accelerated Math* program?

The students participating in the intervention (*Accelerated Math*) scored significantly lower than did students who were not enrolled in the intervention on both the proficiency and value-added sections on the TerraNova. The intervention or treatment group (M = 35.19) had a lower proficiency score than the control group (M = 38.78) with a medium effect size (Cohen's *d* = -0.371). The proficiency score is a measurement of proficiency based on CRT standards. Tennessee has not set a proficiency goal because CRT scores are converted to state NCE values for value-added purposes. However, an average of 30 is considered to be proficient. Proficiency is a primary component of NCLB. Based on a goal of 30, both the treatment and control groups had an average score greater than that goal. Furthermore, the group receiving the intervention (M = -2.458) had a significantly lower adjusted value-added score than the control group (0.766a) with a small effect size (Cohen's *d* = -0.16). As shown in Appendix E, the intervention group achieved a value-added grade of F compared to a grade of B for the control group.

Research Question 2

To what extent, if any, is there a difference between the *TerraNova* math test scores of male and female students who did and did not participate in the *Accelerated Math* program?

The results indicated that there were no significant differences in the 2004 *TerraNova* proficiency scores on the mathematics subtest between males and females. In addition, there were no significant differences in the 2004 *TerraNova* value-added scores on the mathematics subtest between males and females.

Research Question 3

To what extent, if any, is there a difference between the *TerraNova* math test scores of students from different schools who did and did not participate in the *Accelerated Math* program?

The results indicated that there were significant differences in the performance of students in proficiency scores and value-added scores at the four elementary schools. In addition, there were significant differences in the performance of students by school interaction with student's participation in the intervention (participation or nonparticipation in the *Accelerated Math* program). To further examine the differences, post hoc tests were performed.

The Scheffe tests were used to determine which pairs had different proficiency scores. The Scheffe tests revealed that school 2 had significantly higher proficiency scores than school 3. Also, school 4 had significantly higher proficiency scores than did schools 1 and 3. The Scheffe tests revealed that school 2 had significantly higher value-added scores than schools 1 and 3 on the 2004 *TerraNova*.

The Scheffe post hoc tests were conducted to see which schools had significant differences in the performance of students by school interaction with student's participation in the intervention (participation or nonparticipation in the *Accelerated Math* program). When considering the intervention interaction with school, the Scheffe post hoc test indicated that school 2 had higher proficiency scores than school 3. Also, school 4 had higher proficiency scores than did school 1 and 3. The Bonferroni post hoc tests were conducted to see which schools had different value-added scores when considering the intervention interaction with schools. The Bonferroni test was used instead of the Scheffe test whenever ANCOVA is used with covariates since SPSS does not provide the option of using the Scheffe test when covariates are used. The Bonferroni tests revealed that school 2 had significantly higher value-added scores than schools 1 and 3 for the interaction of school with the intervention. In addition, the Bonferroni tests revealed that school 4 had higher value-added scores than school 3.

Research Question 4

To what extent, if any, is there a difference between the *TerraNova* math test scores of special education and nonspecial education students who did and did not participate in the *Accelerated Math* program?

The results indicated that there were significant differences in the performance of students' proficiency scores by special education status. However, there were no significant differences in the performance of students' value-added scores by special education status. There were no significant differences in the performance of students by special education status interaction with student's participation in the intervention (participation or nonparticipation in the *Accelerated Math* program).

To further examine the differences, the Scheffe post hoc tests were performed to compare differences in pairs of students' proficiency scores by special education status. The Scheffe post hoc tests revealed that nonspecial education students (M = 37.92) had significantly higher scores than special education students (M = 25.30). The effect size was large (Cohen's $d = 1.25$).

Research Question 5

To what extent, if any, is there a difference between the *TerraNova* math test scores of students of different socioeconomic status who did and did not participate in the *Accelerated Math* program?

The results indicated that there were significant differences in the performance of students' proficiency scores by socioeconomic status. Students paying for meals (M = 39.31) had significantly higher proficiency scores than student receiving free/reduced meals (M =

33.86) with a medium effect size (Cohen's *d* = 0.47). There were no significant differences in the performance of students' value-added scores by socioeconomic status.

There were significant differences in the performance of students' proficiency scores by socioeconomic status interaction with student's participation in the intervention (participation or nonparticipation in the *Accelerated Math* program). For students that did not receive the intervention, students paying for meals (M = 42.894) had significantly higher proficiency scores than student receiving free/reduced meals (M = 34.670). For students receiving the intervention, students paying for meals (M =37.235) had significantly higher proficiency scores than student receiving free/reduced meals (M = 33.458). There were no significant differences in the performance of students' value-added scores by socioeconomic status interaction with student's participation in the intervention (participation or nonparticipation in the *Accelerated Math* program).

Research Question 6

To what extent, if any, is there a difference between the *TerraNova* math test scores of students of different ability groups who did and did not participate in the *Accelerated Math* program?

The results indicated that there were significant differences in the performance of students in proficiency scores and value-added scores by ability group. To further examine the differences, post hoc tests were performed. The Scheffe tests were used to determine which pairs had different proficiency scores. As expected, the Scheffe tests revealed significant differences existed between every pair. The fifth quintile had the highest mean proficiency score followed by fourth-, third-, second-, and first-quintiles, respectively. The Bonferroni pairwise comparisons were revealed to determine which pairs had different value-added scores. The Bonferroni post hoc tests revealed that the third quintile scored significantly higher than the first quintile. In addition, the fourth quintile scored significantly higher than both the first and second quintiles.

There were no significant differences in the performance of students' proficiency scores by ability group interaction with student's participation in the intervention (participation or nonparticipation in the *Accelerated Math* program). There were no significant differences in the performance of students' value-added scores by ability group interaction with student's participation in the intervention (participation or nonparticipation in the *Accelerated Math* program).

Research Question 7

To what extent, if any, is there a difference between the *TerraNova* math test scores of students of different degrees of implementation of the *Accelerated Math* program?

The results indicated that there were significant differences in the performance of students in proficiency scores and value-added scores by the degree of implementation of the intervention. To further examine the differences, post hoc tests were performed.

The Scheffe tests were used to determine which pairs had different proficiency scores. The Scheffe tests revealed that the control group (M = 38.78) that did not use *Accelerated Math* had significantly higher proficiency scores than the group that used *Accelerated Math* as a supplement (M = 34.23).

The Bonferroni post hoc tests were conducted to see which schools had significant differences in the performance of students based on value-added scores. The Bonferroni post hoc test indicated that the control group that did not use Accelerated Math (M = -.03) had a significantly higher mean value-added score than the group that used the intervention as a supplement (M = -2.60) and the group that used the intervention exclusively (M = -1.20).

Research Question 8

To what extent, if any, is there a difference between the *TerraNova* math test scores between students in different grades who did and did not participate in the *Accelerated Math* program?

The results indicated that there were significant differences in the performance of students in proficiency scores and value-added scores by grade. In addition, there were significant differences in the performance of students by grade interaction with student's participation in the intervention (participation or nonparticipation in the *Accelerated Math* program). To further examine the differences, post hoc tests were performed.

The Scheffe tests were used to determine which pairs had different proficiency scores. The Scheffe tests revealed that the eighth grade had significantly higher proficiency scores than the sixth or seventh grade. The Bonferroni tests also revealed that the eighth grade had significantly higher value-added scores than did either the sixth or the seventh grade on the 2004 *TerraNova*.

The Scheffe post hoc tests were conducted to see which grades had significant differences in the performance of students by grade interaction with student's participation in the intervention (participation or nonparticipation in the *Accelerated Math* program). When considering the intervention interaction with the grade, the Scheffe post hoc test indicated that the eighth grade had higher proficiency scores than both the sixth and seventh grades. The Bonferroni post hoc tests were conducted to see which schools had different value-added scores when considering the intervention interaction with grades. The Bonferroni test was used instead of the Scheffe test whenever ANCOVA is used with covariates since SPSS does not provide the option of using the Scheffe test when covariates are used. The Bonferroni tests revealed that the eighth grade had significantly higher value-added scores than the sixth grade for the interaction of grade with the intervention.

Research Question 9

To what extent, if any, is there a difference between the *TerraNova* math test scores of students with different teachers who did and did not participate in the *Accelerated Math* program?

The results indicated that there were significant differences in the performance of students in proficiency scores and value-added scores by teacher. To further examine the differences, post hoc tests were performed.

The Scheffe tests were used to determine which pairs had different proficiency scores. The Scheffe tests revealed that teacher 7 (M = 46.42) had significantly higher proficiency scores than six other teachers. Teacher 7 had the highest mean proficiency score among the 11 teachers. The Scheffe tests revealed that teacher 6 (M = 45.96) had significantly higher proficiency scores than six other teachers. Teacher 6 had the second highest mean proficiency score among the 11 teachers. Teacher 7 used the intervention exclusively whereas teacher 6 did not use the intervention.

The Bonferroni post hoc tests were conducted to see which teachers had significant differences in the performance of students based on value-added scores. The Bonferroni post hoc test indicated that teacher 2 (M = -8.34) had a significantly lower mean value-added score than all other teachers. Teacher 2 used the intervention as a supplement.

Conclusions

The study focused on the performance of students who had received the *Accelerated Math* intervention and students who had not received the intervention comparing their academic achievement in proficiency scores and value-added scores on the 2004 *TerraNova*. Students' scores were compared using gender, school, teacher, special education status, socioeconomic status, grade, ability group, participation in the intervention, and the degree of implementation of the intervention. There were no clear indications that the use of *Accelerated Math*, a computerized integrated management system, benefited students as measured by proficiency and value-added scores. In fact, some negative effects may have been associated with the intervention in this study during the 2003-2004 school year. There were six conclusions drawn from this study.

Conclusion #1

The *Accelerated Math* program was studied to determine if a relationship existed for students who received the intervention and students who did not receive the intervention. There appeared to be a negative relationship for students who received the intervention especially with those who received the intervention in the form of a supplement. Students using the intervention had lower proficiency and value-added scores than did students in the control group. All students had higher proficiency scores than the state's average. However, the students participating in the intervention had lower proficiency scores than students not participating in the intervention. Students participating in the intervention had a decrease in value-added scores. Using Tennessee's value-added grade scale, as shown in Appendix D, students participating in the intervention achieved a grade of "F" in growth during the 2003-2004 school year whereas students in the control group had a "B" value-added score. In a time when schools are constantly monitored through the use of annual standardized testing, it is imperative to identify both positive and negative relationships between interventions and students' achievement.

Conclusion 2

The study showed no significant difference in the performance of males and females in either proficiency or value-added scores who took the 2004 *TerraNova*. To further study the gender issue, the research added the examination of participation in the intervention (*Accelerated Math*) and examination of interactions. The results of the gender and its interaction with the intervention revealed that no significant differences in performance existed in proficiency or value-added scores.

Conclusion 3

The study found significant differences in both schools and grades. Schools 2 and 4 had higher scores than schools 1 and 3. When considering the school's interaction with the intervention (participation in *Accelerated Math*), school 4 had the highest student achievement.

The eighth grade outperformed the sixth and seventh grades on both proficiency and value-added scores. The eighth grade also outperformed the other grades when considering grade interaction with the intervention.

Conclusion 4

The study addressed the relationship between special education and performance on the 2004 *TerraNova*. Special education students had lower proficiency scores. However, no significant differences existed in value-added scores by special education status. When examining the special education interaction with the intervention, the study revealed no significant difference in the performance of students in either proficiency or value-added scores.

As expected, the study revealed that the top quintiles scored higher than lower quintiles on proficiency scores. The 3rd and 4th quintiles had higher value-added scores than the other three ability groups. However, when examining the ability group interaction with the intervention, no significant differences existed.

Conclusion 5

When considering socioeconomic status, there were differences in proficiency scores but not in value-added scores. Students who paid full price for meals had higher proficiency scores than did students receiving free or reduced-priced meals. The study also revealed the same results when considering socioeconomic status interaction by intervention. The students paying for meals had higher proficiency scores. There were no differences in value-added scores by socioeconomic status.

Conclusion 6

One of the most revealing aspects of the study pertained to the degree of implementation. When considering proficiency scores, the control group scored higher than the treatment group that used the intervention as a supplement. In addition, the control group had higher value-added scores than did both intervention groups. The students using the traditional methods of instruction had higher value-added scores than did students using the intervention as a supplement and the group using the intervention exclusively.

Conclusion 7

When students' performance was examined by teacher, the study revealed two teachers with very high scores. Teachers 6 and 7 had the highest proficiency scores. Those two teachers had proficiency scores substantially higher than the state's average. Teacher 7 used the intervention exclusively whereas teacher 6 did not use the intervention. These results imply that the teacher may be the most important variable in the study. Teacher 2 had the lowest value-added scores among the group ($M = -8.34$). Teacher 2 used the intervention as a supplement.

Limitations

The study has a couple of limitations that need to be mentioned. First, there are varying degrees of teachers' skills. As noted, one of the most important variables in students' performance was the teacher. Even though all teachers are highly qualified by NCLB standards, the teachers had different levels of mathematics expertise, different degrees of experience teaching mathematics, and other general characteristics unique to each teacher. In addition, not all studies are unbiased. A third limitation is the time on task. Some teachers had 45-minute periods of instruction whereas other teachers had 55-minute periods of instruction.

Recommendations for Practice

Several recommendations for practice can be made as a result of this study. The first would be that the degree of implementation of the program should be monitored. This study did not provide support that the use of *Accelerated Math* can increase mathematics achievement on standardized exams. The fact that many findings of this study were internally inconsistent suggests that other factors played a role in mathematics achievement. Another recommendation would be to target lower grades in the elementary schools. This research study only evaluated the performance of students in grades six through eight. A third recommendation would be to provide the intervention on a voluntary basis for students. Even though the choice to participate in the intervention was on a voluntary basis for teachers, students had no choice of whether or not to use the program. A fourth recommendation is that equal conditions be established. For example, students should be provided the same amount of time of mathematics instruction.

Recommendations for Further Research

Several recommendations for further research were developed as a result of this study. Accelerated Math, along with other computerized instructional programs, is used to increase the academic achievement of students. With the demands of NCLB, educators have no choice but to closely monitor students' achievement. Programs should be evaluated under different conditions. The need for additional research would prompt these recommendations:

1. A longitudinal study of the relationship between the intervention and students' mathematics achievement.

2. Replication of the study to evaluate the relationship between the interaction of numerous independent variables and intervention. The variables should include ability level, gender, special education status, and socioeconomic status.
3. Replication of the study using an experimental design.
4. Replication of the study using the same degree of implementation.
5. Implementation of the program using the same time-on-task among all groups.
6. Replication of the study to evaluate proficiency scores because 2004 was the first year that the CRT subtest was available on the *TerraNova*.
7. Replication of the study taking into account the mastery level and number of objectives mastered by each student participating in the intervention.
8. Replication of the study after providing thorough training on the program.

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APPENDICES

APPENDIX A

TCAP Achievement Test (*TerraNova* Form C) National Norms

National Mean Scale Score by Subject and Grade

	Grade							
Subject	1	2	3	4	5	6	7	8
Reading	579	611	629	640	654	658	664	674
Language	579	609	626	640	653	657	662	670
Mathematics	535	566	608	629	646	664	672	687
Science	569	591	614	636	651	662	674	685
Social Studies	586	609	626	643	651	660	673	679

APPENDIX B

TCAP Achievement Test (*TerraNova* Form C) Norm Gains

Scale Score National Norm Gain by Subject and Grade

	Grade							
Subject	1	2	3	4	5	6	7	8
Reading	-	32	18	11	14	4	6	10
Language	-	30	17	14	13	4	5	8
Mathematics	-	31	42	21	17	18	8	15
Science	-	22	23	22	15	11	12	11
Social Studies	-	23	17	17	8	9	13	6

APPENDIX C

Sample *Accelerated Math* TOPS Report

Accelerated Math®

Practice TOPS Report for Tanya Saunders

Friday, February 13, 2004, 10:36:13 AM

Lincoln Elementary School

Class: 5th Grade	**Teacher: Ms. Powell**	**ID: 24-572**	**Grade: 5**
Printed: 2/13/04, 10:14:31 AM	**Completed:** 2/13/04, 10:36:08 AM	**Problems:** 1-15	**Form:** 1892

Tanya, you answered 11 out of 15 problems correctly, which is 73%.

Incorrect Responses (4)

Objective	Problem	Your Answer	Correct Answer
97. Add like mixed #s	3	C	A
98. WP: Add like fractions & mixed #s	7	A	D
98. WP: Add like fractions & mixed #s	8	B	C
98. WP: Add like fractions & mixed #s	11	A	B

Objectives on this Practice (5)	Results	Overall	Learning Card
97. Add like mixed #s	5/6 (83%)	6/9 (67%)	Orange 76
98. WP: Add like fractions & mixed #s	3/6 (50%)	3/6 (50%)	Orange 76
15.* Multiples of whole #s	1/1 (100%)	1/2 (50%)	Orange 15
16.* Least common multiple	1/1 (100%)	1/1 (100%)	Orange 16
17.* Add 2 whole #s	1/1 (100%)	1/1 (100%)	Orange 17

Summary	Marking Period Results to Date	School Year Results to Date
	57% of marking period complete	59% of marking period complete
Total Testable Objectives:	3	–
Objective Mastery Goal:	33	113
Total Objectives Mastered (% of Goal):	16 (48%)	96 (85%)
Practice Average Percent Correct:	84%	83%
Test Average Percent Correct:	89%	87%
Review Average Percent Correct:	90%	86%

Teacher Signature: ______________________________ Comments:

* Review objectives

APPENDIX D

Tennessee Department of Education Value-Added Grade Scale

TVAAS/Value-Added for Mathematics

Grade	Status	Mean Gain Range
A	Exceptional	> 1.5
B	Exceeds State Growth Standard	0.5 to 1.5
C	Maintains State Growth Standard	-0.5 to 0.4
D	Below State Growth Standard	-1.9 to -0.6
F	Deficient	<-1.9

APPENDIX E

Tennessee 6th Grade NRT – CRT – NCE Concordance Table

Subject	Grade	NRT_Scale_Score_incl_Plus	CRT_Scale_Score	State_NCE_Score_basis_1998
Math	6	484	325	1
Math	6	485	326	1
Math	6	486	327	1
Math	6	487	327	1
Math	6	488	328	1
Math	6	489	328	1
Math	6	490	328	1
Math	6	491	328	1
Math	6	492	328	1
Math	6	493	329	1
Math	6	494	329	1
Math	6	495	329	1
Math	6	496	329	1
Math	6	497	330	1
Math	6	498	330	1
Math	6	499	331	1
Math	6	500	331	1
Math	6	501	331	1
Math	6	502	332	1
Math	6	503	332	1
Math	6	504	332	1
Math	6	505	332	1
Math	6	506	333	1
Math	6	507	333	1
Math	6	508	333	1
Math	6	509	334	1
Math	6	510	334	1
Math	6	511	335	1
Math	6	512	335	1
Math	6	513	336	1

Math	6	514	336	1
Math	6	515	336	1
Math	6	516	337	1
Math	6	517	337	1
Math	6	518	338	1
Math	6	519	338	1
Math	6	520	339	1
Math	6	521	339	1
Math	6	522	340	1
Math	6	523	341	1
Math	6	524	341	1
Math	6	525	342	1
Math	6	526	343	1
Math	6	527	344	1
Math	6	528	345	1
Math	6	529	346	1
Math	6	530	347	1
Math	6	531	347	1
Math	6	532	348	1
Math	6	533	349	1
Math	6	534	350	1
Math	6	535	351	1
Math	6	536	352	1
Math	6	537	353	1
Math	6	538	353	1
Math	6	539	354	1
Math	6	540	355	1
Math	6	541	357	1
Math	6	542	358	1
Math	6	543	360	1
Math	6	544	361	1
Math	6	545	362	1
Math	6	546	364	1
Math	6	547	366	1

Math	6	548	368	1
Math	6	549	369	1
Math	6	550	371	1
Math	6	551	373	1
Math	6	552	375	2
Math	6	553	378	2
Math	6	554	379	2
Math	6	555	382	2
Math	6	556	384	3
Math	6	557	388	3
Math	6	558	390	3
Math	6	559	391	3
Math	6	560	394	4
Math	6	561	395	4
Math	6	562	396	4
Math	6	563	398	5
Math	6	564	399	5
Math	6	565	401	5
Math	6	566	403	5
Math	6	567	405	6
Math	6	568	407	6
Math	6	569	409	6
Math	6	570	411	6
Math	6	571	412	6
Math	6	572	414	7
Math	6	573	415	7
Math	6	574	416	7
Math	6	575	417	8
Math	6	576	418	8
Math	6	577	420	8
Math	6	578	421	8
Math	6	579	423	9
Math	6	580	424	9
Math	6	581	426	9

Math	6	582	427	10
Math	6	583	428	10
Math	6	584	429	10
Math	6	585	430	11
Math	6	586	432	11
Math	6	587	433	11
Math	6	588	434	12
Math	6	589	435	12
Math	6	590	436	13
Math	6	591	439	13
Math	6	592	440	13
Math	6	593	441	14
Math	6	594	442	14
Math	6	595	443	14
Math	6	596	444	15
Math	6	597	445	15
Math	6	598	446	16
Math	6	599	447	16
Math	6	600	448	17
Math	6	601	449	17
Math	6	602	450	18
Math	6	603	450	18
Math	6	604	451	19
Math	6	605	452	19
Math	6	606	454	20
Math	6	607	455	20
Math	6	608	456	21
Math	6	609	457	21
Math	6	610	458	22
Math	6	611	459	22
Math	6	612	460	23
Math	6	613	461	23
Math	6	614	461	23
Math	6	615	462	24

Math	6	616	463	25
Math	6	617	464	25
Math	6	618	465	25
Math	6	619	466	26
Math	6	620	467	26
Math	6	621	468	27
Math	6	622	470	28
Math	6	623	471	28
Math	6	624	471	28
Math	6	625	472	29
Math	6	626	474	30
Math	6	627	474	30
Math	6	628	475	31
Math	6	629	477	31
Math	6	630	478	32
Math	6	631	479	32
Math	6	632	479	32
Math	6	633	480	33
Math	6	634	481	34
Math	6	635	482	34
Math	6	636	484	35
Math	6	637	485	35
Math	6	638	486	36
Math	6	639	487	37
Math	6	640	487	37
Math	6	641	488	37
Math	6	642	489	38
Math	6	643	490	38
Math	6	644	491	39
Math	6	645	492	39
Math	6	646	493	40
Math	6	647	495	40
Math	6	648	496	41
Math	6	649	496	41

Math	6	650	497	42
Math	6	651	498	42
Math	6	652	499	43
Math	6	653	501	43
Math	6	654	502	44
Math	6	655	503	44
Math	6	656	504	45
Math	6	657	505	45
Math	6	658	506	46
Math	6	659	507	46
Math	6	660	508	47
Math	6	661	509	47
Math	6	662	510	48
Math	6	663	511	49
Math	6	664	511	49
Math	6	665	512	50
Math	6	666	513	50
Math	6	667	514	51
Math	6	668	515	51
Math	6	669	516	52
Math	6	670	517	52
Math	6	671	518	53
Math	6	672	519	54
Math	6	673	520	54
Math	6	674	521	55
Math	6	675	523	55
Math	6	676	524	56
Math	6	677	525	57
Math	6	678	525	57
Math	6	679	526	58
Math	6	680	527	58
Math	6	681	528	59
Math	6	682	529	60
Math	6	683	530	60

Math	6	684	531	61
Math	6	685	533	61
Math	6	686	535	62
Math	6	687	536	63
Math	6	688	537	63
Math	6	689	538	64
Math	6	690	538	64
Math	6	691	539	65
Math	6	692	540	66
Math	6	693	541	66
Math	6	694	542	67
Math	6	695	543	67
Math	6	696	544	68
Math	6	697	545	69
Math	6	698	546	69
Math	6	699	547	70
Math	6	700	549	70
Math	6	701	550	71
Math	6	702	550	71
Math	6	703	551	72
Math	6	704	552	73
Math	6	705	553	73
Math	6	706	554	74
Math	6	707	555	75
Math	6	708	557	75
Math	6	709	558	76
Math	6	710	559	76
Math	6	711	560	77
Math	6	712	561	77
Math	6	713	562	78
Math	6	714	563	78
Math	6	715	564	79
Math	6	716	566	79
Math	6	717	567	80

Math	6	718	568	80
Math	6	719	569	81
Math	6	720	570	81
Math	6	721	571	81
Math	6	722	572	82
Math	6	723	573	82
Math	6	724	574	83
Math	6	725	575	83
Math	6	726	576	84
Math	6	727	577	84
Math	6	728	577	84
Math	6	729	578	85
Math	6	730	579	86
Math	6	731	580	86
Math	6	732	582	87
Math	6	733	583	87
Math	6	734	584	88
Math	6	735	584	88
Math	6	736	585	89
Math	6	737	586	89
Math	6	738	587	90
Math	6	739	588	91
Math	6	740	589	91
Math	6	741	590	92
Math	6	742	592	93
Math	6	743	593	93
Math	6	744	594	94
Math	6	745	595	95
Math	6	746	596	95
Math	6	747	597	96
Math	6	748	599	96
Math	6	749	600	97
Math	6	750	601	98
Math	6	751	602	98

Math	6	752	603	99
Math	6	753	603	99
Math	6	754	606	99
Math	6	755	608	99
Math	6	756	610	99
Math	6	757	611	99
Math	6	758	613	99
Math	6	759	613	99
Math	6	760	614	99
Math	6	761	615	99
Math	6	762	615	99
Math	6	763	616	99
Math	6	764	616	99
Math	6	765	618	99
Math	6	766	620	99
Math	6	767	620	99
Math	6	768	622	99
Math	6	769	623	99
Math	6	770	627	99
Math	6	771	628	99
Math	6	772	629	99
Math	6	773	629	99
Math	6	774	629	99
Math	6	775	630	99
Math	6	776	630	99
Math	6	777	630	99
Math	6	778	632	99
Math	6	779	632	99
Math	6	780	633	99
Math	6	781	633	99
Math	6	782	634	99
Math	6	783	638	99
Math	6	784	639	99
Math	6	785	640	99

Math	6	786	642	99
Math	6	787	643	99
Math	6	788	644	99
Math	6	789	646	99
Math	6	790	647	99
Math	6	791	649	99
Math	6	792	651	99
Math	6	793	653	99
Math	6	794	655	99
Math	6	795	657	99
Math	6	796	659	99
Math	6	797	661	99
Math	6	798	663	99
Math	6	799	665	99
Math	6	800	667	99
Math	6	801	669	99
Math	6	802	671	99
Math	6	803	673	99
Math	6	804	675	99
Math	6	805	677	99
Math	6	806	679	99
Math	6	807	681	99
Math	6	808	683	99
Math	6	809	687	99
Math	6	810	689	99
Math	6	811	691	99
Math	6	812	693	99
Math	6	813	695	99
Math	6	814	697	99
Math	6	815	699	99
Math	6	816	701	99

APPENDIX F

Tennessee 7th Grade NRT – CRT – NCE Concordance Table

Subject	Grade	NRT_Scale_Score_incl_Plus	CRT_Scale_Score	State_NCE_Score_basis_1998
Math	7	484	338	1
Math	7	485	339	1
Math	7	486	341	1
Math	7	487	341	1
Math	7	488	342	1
Math	7	489	344	1
Math	7	490	345	1
Math	7	491	347	1
Math	7	492	348	1
Math	7	493	350	1
Math	7	494	351	1
Math	7	495	353	1
Math	7	496	354	1
Math	7	497	356	1
Math	7	498	357	1
Math	7	499	359	1
Math	7	500	360	1
Math	7	501	361	1
Math	7	502	363	1
Math	7	503	364	1
Math	7	504	366	1
Math	7	505	367	1
Math	7	506	368	1
Math	7	507	370	1
Math	7	508	371	1
Math	7	509	372	1
Math	7	510	374	1
Math	7	511	375	1
Math	7	512	376	1
Math	7	513	378	1

Math	7	514	379	1
Math	7	515	380	1
Math	7	516	382	1
Math	7	517	383	1
Math	7	518	384	1
Math	7	519	384	1
Math	7	520	386	1
Math	7	521	387	1
Math	7	522	389	1
Math	7	523	389	1
Math	7	524	389	1
Math	7	525	389	1
Math	7	526	389	1
Math	7	527	389	1
Math	7	528	389	1
Math	7	529	389	1
Math	7	530	389	1
Math	7	531	389	1
Math	7	532	389	1
Math	7	533	389	1
Math	7	534	389	1
Math	7	535	389	1
Math	7	536	389	1
Math	7	537	389	1
Math	7	538	390	1
Math	7	539	390	1
Math	7	540	390	1
Math	7	541	390	1
Math	7	542	391	1
Math	7	543	391	1
Math	7	544	392	1
Math	7	545	393	1
Math	7	546	393	1
Math	7	547	394	1

Math	7	548	395	1
Math	7	549	396	1
Math	7	550	397	1
Math	7	551	397	1
Math	7	552	398	1
Math	7	553	398	1
Math	7	554	399	1
Math	7	555	399	1
Math	7	556	399	1
Math	7	557	400	1
Math	7	558	400	1
Math	7	559	401	1
Math	7	560	402	1
Math	7	561	402	1
Math	7	562	403	1
Math	7	563	404	1
Math	7	564	404	1
Math	7	565	405	2
Math	7	566	406	2
Math	7	567	407	3
Math	7	568	408	3
Math	7	569	409	3
Math	7	570	410	4
Math	7	571	411	4
Math	7	572	412	4
Math	7	573	414	4
Math	7	574	415	5
Math	7	575	417	5
Math	7	576	418	5
Math	7	577	419	6
Math	7	578	420	6
Math	7	579	421	7
Math	7	580	422	7
Math	7	581	423	7

Math	7	582	424	8
Math	7	583	424	8
Math	7	584	425	8
Math	7	585	427	8
Math	7	586	428	9
Math	7	587	430	9
Math	7	588	431	9
Math	7	589	432	10
Math	7	590	433	10
Math	7	591	434	11
Math	7	592	436	11
Math	7	593	437	11
Math	7	594	439	12
Math	7	595	440	12
Math	7	596	441	13
Math	7	597	442	13
Math	7	598	443	13
Math	7	599	444	14
Math	7	600	446	14
Math	7	601	447	15
Math	7	602	448	15
Math	7	603	449	16
Math	7	604	450	16
Math	7	605	452	16
Math	7	606	453	17
Math	7	607	454	17
Math	7	608	455	18
Math	7	609	456	18
Math	7	610	457	19
Math	7	611	458	19
Math	7	612	459	20
Math	7	613	460	20
Math	7	614	461	21
Math	7	615	461	21

Math	7	616	462	22
Math	7	617	463	22
Math	7	618	464	22
Math	7	619	465	23
Math	7	620	466	23
Math	7	621	467	24
Math	7	622	468	24
Math	7	623	469	25
Math	7	624	470	25
Math	7	625	471	26
Math	7	626	472	26
Math	7	627	473	27
Math	7	628	474	27
Math	7	629	475	28
Math	7	630	476	28
Math	7	631	477	29
Math	7	632	478	29
Math	7	633	479	29
Math	7	634	480	30
Math	7	635	481	30
Math	7	636	482	31
Math	7	637	484	31
Math	7	638	485	32
Math	7	639	486	32
Math	7	640	487	33
Math	7	641	488	33
Math	7	642	489	33
Math	7	643	490	34
Math	7	644	491	34
Math	7	645	492	35
Math	7	646	493	35
Math	7	647	493	35
Math	7	648	494	36
Math	7	649	494	36

Math	7	650	495	37
Math	7	651	496	37
Math	7	652	497	38
Math	7	653	498	38
Math	7	654	500	39
Math	7	655	500	39
Math	7	656	501	40
Math	7	657	502	40
Math	7	658	503	40
Math	7	659	504	41
Math	7	660	506	41
Math	7	661	507	42
Math	7	662	508	43
Math	7	663	508	43
Math	7	664	509	43
Math	7	665	510	44
Math	7	666	512	44
Math	7	667	513	45
Math	7	668	514	45
Math	7	669	515	46
Math	7	670	516	46
Math	7	671	517	47
Math	7	672	518	47
Math	7	673	519	48
Math	7	674	520	48
Math	7	675	521	49
Math	7	676	522	49
Math	7	677	523	50
Math	7	678	524	51
Math	7	679	524	51
Math	7	680	525	51
Math	7	681	526	52
Math	7	682	527	52
Math	7	683	529	53

Math	7	684	530	54
Math	7	685	531	54
Math	7	686	532	55
Math	7	687	533	55
Math	7	688	534	56
Math	7	689	535	56
Math	7	690	536	57
Math	7	691	537	57
Math	7	692	538	58
Math	7	693	539	58
Math	7	694	540	59
Math	7	695	542	59
Math	7	696	543	60
Math	7	697	544	61
Math	7	698	545	61
Math	7	699	546	62
Math	7	700	547	62
Math	7	701	548	63
Math	7	702	550	63
Math	7	703	551	64
Math	7	704	552	64
Math	7	705	553	65
Math	7	706	554	65
Math	7	707	555	66
Math	7	708	557	66
Math	7	709	558	67
Math	7	710	559	68
Math	7	711	559	68
Math	7	712	560	68
Math	7	713	561	69
Math	7	714	562	69
Math	7	715	563	70
Math	7	716	565	71
Math	7	717	566	71

Math	7	718	567	72
Math	7	719	568	72
Math	7	720	569	73
Math	7	721	570	73
Math	7	722	571	74
Math	7	723	572	74
Math	7	724	574	75
Math	7	725	575	75
Math	7	726	576	76
Math	7	727	577	76
Math	7	728	579	77
Math	7	729	580	77
Math	7	730	581	78
Math	7	731	582	78
Math	7	732	583	79
Math	7	733	585	79
Math	7	734	586	80
Math	7	735	587	80
Math	7	736	588	80
Math	7	737	589	81
Math	7	738	590	81
Math	7	739	592	82
Math	7	740	593	82
Math	7	741	595	83
Math	7	742	596	83
Math	7	743	597	84
Math	7	744	597	84
Math	7	745	598	84
Math	7	746	599	84
Math	7	747	601	85
Math	7	748	602	85
Math	7	749	603	86
Math	7	750	604	86
Math	7	751	605	87

Math	7	752	606	87
Math	7	753	607	87
Math	7	754	608	88
Math	7	755	610	88
Math	7	756	612	89
Math	7	757	613	89
Math	7	758	614	90
Math	7	759	615	91
Math	7	760	616	91
Math	7	761	617	92
Math	7	762	618	92
Math	7	763	619	93
Math	7	764	620	94
Math	7	765	620	94
Math	7	766	621	95
Math	7	767	621	95
Math	7	768	624	96
Math	7	769	625	97
Math	7	770	626	97
Math	7	771	627	98
Math	7	772	628	99
Math	7	773	631	99
Math	7	774	635	99
Math	7	775	635	99
Math	7	776	635	99
Math	7	777	636	99
Math	7	778	637	99
Math	7	779	638	99
Math	7	780	638	99
Math	7	781	639	99
Math	7	782	639	99
Math	7	783	639	99
Math	7	784	640	99
Math	7	785	641	99

Math	7	786	642	99
Math	7	787	643	99
Math	7	788	648	99
Math	7	789	661	99
Math	7	790	662	99
Math	7	791	663	99
Math	7	792	664	99
Math	7	793	665	99
Math	7	794	667	99
Math	7	795	668	99
Math	7	796	669	99
Math	7	797	670	99
Math	7	798	672	99
Math	7	799	673	99
Math	7	800	674	99
Math	7	801	675	99
Math	7	802	676	99
Math	7	803	677	99
Math	7	804	677	99
Math	7	805	678	99
Math	7	806	679	99
Math	7	807	680	99
Math	7	808	680	99
Math	7	809	681	99
Math	7	810	682	99
Math	7	811	683	99
Math	7	812	683	99
Math	7	813	684	99
Math	7	814	685	99
Math	7	815	686	99
Math	7	816	687	99
Math	7	817	688	99
Math	7	818	689	99
Math	7	819	689	99

Math	7	820	690	99
Math	7	821	691	99
Math	7	822	692	99
Math	7	823	693	99
Math	7	824	694	99
Math	7	825	695	99
Math	7	826	695	99
Math	7	827	696	99
Math	7	828	697	99
Math	7	829	698	99
Math	7	830	699	99
Math	7	831	700	99
Math	7	832	701	99
Math	7	833	701	99
Math	7	834	702	99
Math	7	835	703	99
Math	7	836	704	99
Math	7	837	705	99
Math	7	838	706	99
Math	7	839	707	99
Math	7	840	707	99
Math	7	841	707	99
Math	7	842	708	99
Math	7	843	709	99
Math	7	844	710	99
Math	7	845	711	99
Math	7	846	712	99
Math	7	847	713	99
Math	7	848	713	99
Math	7	849	714	99
Math	7	850	715	99
Math	7	851	716	99
Math	7	852	717	99
Math	7	853	718	99

Math	7	854	719	99
Math	7	855	719	99
Math	7	856	720	99
Math	7	857	721	99
Math	7	858	722	99
Math	7	859	723	99

APPENDIX G

Tennessee 8th Grade NRT – CRT – NCE Concordance Table

Subject	Grade	NRT_Scale_Score_incl_Plus	CRT_Scale_Score	State_NCE_Score_basis_1998
Math	8	506	342	1
Math	8	507	391	1
Math	8	508	395	1
Math	8	509	395	1
Math	8	510	395	1
Math	8	511	395	1
Math	8	512	396	1
Math	8	513	396	1
Math	8	514	396	1
Math	8	515	396	1
Math	8	516	396	1
Math	8	517	396	1
Math	8	518	397	1
Math	8	519	397	1
Math	8	520	397	1
Math	8	521	397	1
Math	8	522	398	1
Math	8	523	398	1
Math	8	524	398	1
Math	8	525	398	1
Math	8	526	399	1
Math	8	527	399	1
Math	8	528	399	1
Math	8	529	399	1
Math	8	530	400	1
Math	8	531	400	1
Math	8	532	401	1
Math	8	533	401	1
Math	8	534	402	1
Math	8	535	402	1

Math	8	536	403	1
Math	8	537	403	1
Math	8	538	403	1
Math	8	539	403	1
Math	8	540	404	1
Math	8	541	404	1
Math	8	542	405	1
Math	8	543	406	1
Math	8	544	406	1
Math	8	545	406	1
Math	8	546	407	1
Math	8	547	407	1
Math	8	548	408	1
Math	8	549	408	1
Math	8	550	409	1
Math	8	551	409	1
Math	8	552	410	1
Math	8	553	410	1
Math	8	554	411	1
Math	8	555	411	1
Math	8	556	411	1
Math	8	557	411	1
Math	8	558	412	1
Math	8	559	413	1
Math	8	560	413	1
Math	8	561	413	1
Math	8	562	414	1
Math	8	563	415	1
Math	8	564	415	1
Math	8	565	416	1
Math	8	566	417	1
Math	8	567	418	1
Math	8	568	418	1

Math	8	569	419	1
Math	8	570	420	2
Math	8	571	421	2
Math	8	572	421	2
Math	8	573	422	3
Math	8	574	422	3
Math	8	575	423	4
Math	8	576	423	4
Math	8	577	424	4
Math	8	578	425	5
Math	8	579	426	5
Math	8	580	426	5
Math	8	581	427	5
Math	8	582	428	6
Math	8	583	429	6
Math	8	584	430	6
Math	8	585	431	6
Math	8	586	432	7
Math	8	587	433	7
Math	8	588	434	7
Math	8	589	435	7
Math	8	590	436	8
Math	8	591	438	8
Math	8	592	438	8
Math	8	593	439	9
Math	8	594	439	9
Math	8	595	440	9
Math	8	596	440	9
Math	8	597	441	10
Math	8	598	441	10
Math	8	599	442	10
Math	8	600	443	11
Math	8	601	444	11

Math	8	602	445	11
Math	8	603	446	12
Math	8	604	447	12
Math	8	605	448	12
Math	8	606	449	13
Math	8	607	450	13
Math	8	608	452	13
Math	8	609	453	14
Math	8	610	454	14
Math	8	611	455	15
Math	8	612	455	15
Math	8	613	456	15
Math	8	614	457	15
Math	8	615	458	16
Math	8	616	458	16
Math	8	617	459	17
Math	8	618	460	17
Math	8	619	461	17
Math	8	620	462	18
Math	8	621	463	18
Math	8	622	464	18
Math	8	623	465	19
Math	8	624	465	19
Math	8	625	466	19
Math	8	626	467	20
Math	8	627	469	20
Math	8	628	469	20
Math	8	629	470	21
Math	8	630	471	21
Math	8	631	472	22
Math	8	632	473	22
Math	8	633	474	22
Math	8	634	475	23

Math	8	635	476	23
Math	8	636	477	23
Math	8	637	478	24
Math	8	638	479	24
Math	8	639	480	24
Math	8	640	481	25
Math	8	641	482	25
Math	8	642	483	25
Math	8	643	484	26
Math	8	644	485	26
Math	8	645	486	26
Math	8	646	487	27
Math	8	647	488	27
Math	8	648	489	28
Math	8	649	490	28
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