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Efficacy of a Summer Intervention to Improve GATEWAY Mathematics Examination Scores

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COLLEGE OF EDUCATION

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Arthur Wesley Jackson

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Walden University
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Abstract

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M.M., Southwestern Baptist Theological Seminary, 1976

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Abstract

Less than 50% of students from an inner-city high school in a southeastern US state who took the GATEWAY mathematics exam (2001-2007) earned a passing score on the first attempt, prompting teachers at the school to begin a summer intervention program based on Bandura's Self Efficacy Theory, to help them succeed on a subsequent reexamination. The program featured (a) extended learning time, (b) mastery learning, (c) direct instruction, (d) single-sex grouping, and (e) teacher collaboration. A survey of recent scholarly literature indicated that these 5 characteristics positively impact student learning and performance. The goal was to increase student understanding of fundamental mathematics concepts and by doing so increase their confidence in their ability to do well on standardized assessments. To test the efficacy of this intervention, this study used a quasi-experimental pre-post comparison group design to compare five academic indicators—GATEWAY exam scores, grade point averages, attendance, failed classes, and final averages in future mathematics courses—for students who participated in summer intervention programs (treatment group) with outcome data from students who did not participate (control group). A multivariate analysis of covariance (MANCOVA) was used to determine whether there was a significant difference in outcomes between students in the treatment and control groups. Findings revealed an overall significant effect of the summer intervention program on the five academic indicators ($F = 5.024$, $p < 0.001$). Univariate F tests indicated that only student GATEWAY scores were affected by participation in the summer intervention program. This study contributes to social change by providing evidence that short-term intervention programs may help struggling students pass high stakes tests such as the GATEWAY examination.

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Section 1: The Problem

The Tennessee State Board of Education stipulated that students, beginning with those entering the ninth grade in the 2001-2002 school year, pass examinations in three subject areas—language arts, mathematics, and science—in order to earn a regular high school diploma (Tennessee Department of Education, 2008). These GATEWAY tests, as they were named, are administered three times annually to accommodate students who complete work in fall, spring, and summer courses. The tests are given at no other time. If students fail to pass a GATEWAY test, they must retake it during a subsequent test administration.

At Taylor High School (a pseudonym), located in southeast Tennessee, only 40.4% of students taking the GATEWAY passed the mathematics exam given in May 2001 (Tennessee Department of Education, 2001). The percentage of students that did not achieve a passing score remained high for the following three years (62.3% in 2002, 61.0% in 2003, and 63.0% in 2004). It was this local problem that this study addresses.

Background of the Study

On April 26, 1983, a commission appointed by T. H. Bell, Secretary of Education in the Reagan administration, released A *Nation at Risk,* an ominous report that found serious deficiencies in the United States educational system. The report identified major achievement gaps between students of different ethnic backgrounds and different socioeconomic levels. The report then stated, "All, regardless of race or class or economic status, are entitled to a fair chance and to the tools for developing their individual powers of mind and spirit to the utmost" (National Commission of Excellence in Education, 1983).

The No Child Left Behind Act [NCLB], (2002) magnified the demands on public high schools to furnish a curriculum that enhances student achievement (Harris, 2007). A major premise of NCLB (2002) was that all students are expected to learn at high levels. In order to provide an accountability system to measure achievement, NCLB (2002) mandated that each state adopt a standardized testing process with established pass/fail scales. Every district and each school is evaluated by whether they meet Annual Yearly Progress (AYP) indicators in the areas of test participation, attendance, test scores, and graduation rate. Schools that fail to make AYP face progressive consequences and sanctions that could eventually result in state takeover of a school. Leaders in state educational departments began to examine their existing curriculum in order to make the modifications needed to meet the standards imposed by the federal government.

NCLB (2002) required each state to submit assessment documents that would demonstrate that learning was indeed taking place. Some states, such as Georgia, chose to use a single test that students must pass in order to graduate with a regular diploma (Georgia Department of Education, n.d.). Other states, such as Tennessee, required students to earn passing scores on one or more end-of-course tests that are given as the final exam in their classes (Tennessee Department of Education, n.d.).

Problem Statement

As noted earlier, deficiencies became evident at Taylor High School, where only 40.4% of students taking the GATEWAY passed the mathematics exam in 2001, only 37.7% passed in 2002, and only 39% passed in 2003 (Tennessee Department of Education, 2001). Taylor High School has a population of approximately 1,150 students in Grades 9-12, of whom 97.1% are African American, and of whom 87.9% are economically disadvantaged. Perry Middle School and Anderson Middle School (pseudonyms) serve as feeder schools to the high school. Perry Middle School has a 95.4% African American student population and 97.2% of its students are classified as economically disadvantaged. Anderson Middle School has a 98.4% African American student population and 98.6% of its students are classified as economically disadvantaged (Tennessee Department of Education, 2008).

Evidence of low student achievement in the two feeder schools became apparent after the implementation of high-stakes testing in May 2001. Both Perry Middle School and Anderson Middle School scored “deficient” based on scores on the Tennessee Comprehensive Assessment Program (TCAP) assessment, one of the indicators used by NCLB (2002) benchmarks at the middle school level to determine whether school makes AYP (TNDOE, 2001). The three elementary schools that served as feeder schools to the middle schools also scored “deficient” based on their TCAP mathematics test results.

Student inability to perform well on high-stakes tests at Taylor High School was also a common pattern found at state and national levels. Many critics argue that efforts by government agencies to improve public education by generating massive amounts of legislation to address standards, testing, and accountability have been unsuccessful in impacting the individual classroom (Ladwig, 2007). Laws designed to improve educational outcomes did not automatically produce increases in achievement. Many students who are required to take high-stakes tests lack understanding of basic mathematics proficiencies (e.g., arithmetic operations with whole numbers, fractions, and percents) that are prerequisites for success in future higher level coursework (Cawley, Parmar, Foley, Salmon, & Roy, 2001). Many mathematics curricula are sequential from one school year to the next and rely on students' acquisition of skills and concepts from earlier courses. When students are deficient in these prerequisite skills, progress in higher-level mathematics classes is impeded. For example, students who have not memorized their multiplication facts or who are unable to write the multiples of counting numbers from one to ten struggle when they attempt to do factoring within a high school algebra class.

Recent government assessment findings revealed that, despite significant academic increases from 1990 to 2007, 29% of all students tested below basic mathematical skill levels. Concern about American students' inability to compete with students in other industrialized countries and within a global economy still abound (Kerachsky, 2010; MediaCorp Press LTD, 2010; U.S. Department of Education, 2010). The average reading and mathematics scores were higher in 2008 than in the early 1970s for fourth and eighth grade students, yet the scores for 17-year-old students were relatively unchanged over the same time span (National Assessment of Educational Progress (NAEP), 2008). Additionally, the achievement gap between European American and African American students has remained at the same level as it was in 1990, although both groups have demonstrated significant increases in reading and mathematics scores (National Assessment of Educational Progress [NAEP], 2008).

Many students struggle to attain the minimum passing levels created by states. NCLB (2002) requires individual states to establish accountability systems to ensure the academic achievement of students. Their accountability system assigns penalties based on student performance on standardized tests (Nichols, Glass, & Berliner, 2006). Schools that fail to meet all NCLB (2002) indicators are classified as “target” schools. Students who attend a target school are given an option to transfer to another school within the district that met their AYP requirements.

The Trends in International Mathematics and Science Study (TIMSS) revealed that 20 foreign countries were ranked higher than fourth and eighth grade students from the United States in mathematical skills (National Center for Education Statistics, 1999). Although American fourth grade students have shown small improvements over time, there has been a lack of significant change in eighth grade mathematics scores overall from 1999 to 2007. Similarly, public schools containing a student body categorized by poverty failed to demonstrate detectable changes in performance (National Center for Educational Statistics, 2007).

In general, the increasing educational standards movement fueled by NCLB (2002) requirements led to the growth of summer programs (Borman, 2001). Evidence in the literature suggests that students lose one month of grade-level skills from the end of one school year to the beginning of the next school year (H. Cooper, 2001; H. Cooper, Nye, Charlton, Lindsay, & Greathouse, 1996). Two landmark studies tracked the achievement results of students over multiple years and found significant gaps in summer learning between students from economically advantaged families and those from lower income families (Ginsburg & et al., 1981; Heyns, 1978). A major reason for the gap might be that summer learning activities that cost money (e.g., travel, tutoring, summer camp, and museum visits) are not readily available to students from economically disadvantaged families (Entwisle & Alexander, 1992).

Research findings maintain that summer learning loss impacts socioeconomically disadvantaged students to a greater extent than economically advantaged students. It became crucial that effective programs be implemented to bridge the learning gap. To address this problem, a faculty colleague and I implemented an intervention program in Summer 2001 to provide extended learning opportunities for low socioeconomic students to be successful in passing their GATEWAY exams. The summer intervention program continued each summer from 2001 until 2009. My colleague served as an instructor in the summer sessions from 2001 to 2009 and I served as an instructor from 2001 to 2008.

Purposes of the Study

The purposes of this research study were to (a) determine the effectiveness of this three-weeks summer intervention program (independent variable) in improving student achievement of Algebra 1 course standards (dependent variable), as measured by the GATEWAY Exam and (b) determine the effectiveness of the program (independent variable) in improving student achievement in subsequent math courses, in improving overall student academic achievement, and in improving student attendance (dependent variables).

Theoretical Base

The theoretical basis for this study was rooted in self-efficacy theory formalized by Bandura in 1986. Teachers at the local high school believed that many students performed poorly on the GATEWAY mathematics exam not because they lack ability, but because they lack confidence and do not believe they can succeed. One of the goals established during the implementation of the summer intervention program was that students would gain increased understanding of fundamental mathematic concepts and, in so doing, would increase their confidence in their ability to do well on standardized assessments.

Recent research findings have found a positive association between students' belief about their own academic abilities and their willingness to demonstrate persistence when attempting or completing new or difficult tasks (Skaalvik, 2002). Student self-efficacy was a stronger predictor of mathematical achievement than general mental ability (T. Stevens, Olivarez, Lan, & Tallent-Runnels, 2004). Bandura, a psychologist best known for his development and work with social development theory, defined self-efficacy as "the belief in one's capabilities to organize and execute the courses of action required to manage prospective situations" (Bandura, 1995, p. 2). He contended that students with higher self-efficacy perceived difficult tasks as challenges to be mastered while students with lower self-efficacy perceived the same tasks as unattainable and as something to be avoided. According to Bandura, four factors contribute to students' self-efficacy and their ability to achieve in school: (a) mastery experiences, (b) vicarious experiences, (c) social persuasions, and (d) physiological factors (Bandura, 1997).

Mastery experiences, where students have been successful at a particular skill or effort in the past, are the most powerful contributor to increase self-efficacy to the degree that students will believe they can be successful at the same skill in the future (Bandura, 1997). On the other hand, failure while attempting a particular skill or task lowers self-efficacy and often causes students to avoid future tasks with apprehension or with minimal or no effort. Failure to be successful leads students to perceive a task to be more difficult than it is (Pajares, 2009). When students perceive that success is unattainable, they usually enter a cycle of disappointing academic performances, which in turn continues to decrease their self-efficacy (Margolis & McCabe, 2006).

A second factor that affects self-efficacy is vicarious experiences, which is defined as the impact of others' successes and failures on one's own beliefs. When students observe other students succeeding at a difficult task, that experience often strengthens their own belief about their ability to also accomplish that task (D. H. Schunk, 1991). Conversely, when students observe other students failing on a difficult task, they are less likely to believe in their own ability in accomplishing the same task.

A third factor that can influence student levels of self-efficacy is social persuasion, defined as verbal or written communication from others about student effort and achievement. Teacher encouragement of student work or effort after the student had been successful on a learning task was shown to increase that student's confidence to do subsequent tasks, although such verbal recognition did not appear to cause an increase in self-efficacy as much as an individual's own successes or vicarious experiences (Pogue & AhYun, 2006).

Finally, physiological factors have been shown to influence self-efficacy beliefs. Physical symptoms (e.g., dry mouth, sweaty palms, or a rapid heartbeat) indicate nervousness and can contribute to a decrease in a person's self-confidence about whether he or she will be successful on a future performance task (Bandura, 1986). Feeling confident or relaxed before beginning a difficult task may increase student self-efficacy while improving performance on the task itself.

Research also suggests that school personnel such as teachers and administrators played a significant role in increasing student self-efficacy. Students who were given timely feedback that included praise about their abilities rather than their effort developed higher self-efficacy and greater academic achievement (Zimmerman & Schunk, 1989). In addition, teacher feedback about goals that addressed specific performance standards was more likely to increase student self-efficacy than teacher feedback containing general goals. For example, setting an explicit goal for students to show mastery of multiplying polynomials would likely lead to a more significant increase in self-efficacy than just encouraging them *to do better* or commenting that they are doing *good work*. Decades earlier, Erikson stated,

> Children cannot be fooled by empty praise and condescending encouragement. They may have to accept artificial bolstering of their self-esteem in lieu of something better, but their ego identity gains real strength only from wholehearted and consistent recognition of real accomplishment—that is, achievement that has meaning in their culture. (Erikson, 1950, pp. 236-237)

Schunk and Pajares (2002) suggested that teachers establish specific, short-term goals that are challenging, yet reachable for students. Goals that are perceived as too easy will communicate to the student that the teacher doubts their ability to perform them, whereas goals that are too difficult will lower self-efficacy. Teachers who give frequent, focused feedback on student progress towards established goals by comparing present work with past performances by the same student, and by encouraging students to keep trying, increase student beliefs that they have the capability to be successful in their efforts. Teachers can establish a positive learning environment that will help reduce the stress and anxiety that often accompanies high-stakes testing situations (Pogue & AhYun, 2006).

Research Questions and Hypotheses

The focus of this study was to determine the effect of an academic intervention (i.e., summer intervention involvement versus Algebra 1 course completion) on five academic indicators (GATEWAY test scores, attendance, future mathematics course averages, number of courses passed, and GPAs). To address this focus, the following research questions and hypotheses guided the study:

RQ1: What is the relationship between academic intervention (i.e., summer intervention involvement versus Algebra 1 course completion) and student achievement, as measured by GATEWAY math scores?

H_O1: There is no significant difference in student achievement, as measured by GATEWAY mathematics scores, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

H_A1: There is a significant difference in student achievement, as measured by GATEWAY mathematics scores, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

RQ2: What is the relationship between academic intervention (i.e., summer intervention involvement versus Algebra 1 course completion) and student academic performance, as measured by the number of absences for the next regular school semester?

H_O2: There is no significant difference in student academic performance, as measured by the number of absences for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

H_A2: There is a significant difference in student academic performance, as measured by the number of absences for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

RQ3: What is the relationship between academic intervention (i.e., summer intervention involvement versus Algebra 1 course completion) and student academic performance, as measured by the number of absences for the next regular school semester?

H_O3: There is no significant difference in student academic performance, as measured by the final mathematics grade earned for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

H_A3: There is a significant difference in student academic performance, as measured by the final mathematics grade earned for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

RQ4: What is the relationship between academic intervention (i.e., summer intervention involvement versus Algebra 1 course completion) and student academic performance, as measured by the number of courses passed for the next regular school semester?

H_O4: There is no significant difference in student academic performance, as measured by the number of courses passed for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

H_A4: There is a significant difference in student academic performance, as measured by the number of course passed for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

RQ5: What is the relationship between academic intervention (i.e., summer intervention involvement versus Algebra 1 course completion) and student academic performance, as measured by GPAs for the next regular school semester?

H_O5: There is no significant difference in student academic performance, as measured by GPAs for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

H_A5: There is a significant difference in student academic performance, as measured by GPAs for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

Quantitative Approach

A quantitative approach was chosen because each dependent variable—test score, grade point average, number of absence, number of failed classes, and final average in subsequent mathematics courses—could be conceptualized through precise measurements. A quantitative approach is best when (a) the research problem calls for the identification of factors that influence an outcome or (b) an intervention is being assessed for its effect on an outcome (Creswell, 2009). Quantitative studies use deductive reasoning and universally accepted statistical tests to analyze data (Atieno, 2009).

Because I was instrumental in the implementation and operation of the summer intervention program, a quantitative approach provided the best way to eliminate or greatly reduce personal biases. Some bias was likely present through my interests, choice of variables, and selection of research questions. Yet the correct use of appropriate sampling strategies, data protocols, and statistics tests can minimize biases or eliminate them entirely. A more detailed discussion of research methods used can be found in section 3.

Definition of Terms

The following terms were operationally defined for the study:

Achievement gap: The disparity in school performance as related to race and ethnicity usually distinguished by test scores, grades, and course selections (Ware, Richardson, & Kim, 2000).

At-risk students: Students who “lack confidence and success in their academic endeavors. They often exhibit negative behavior patterns and steadily remove themselves, mentally and physically, from school” (Cuddapah, Masci, Smallwood, & Holland, 2008, p. 261).

Criterion-referenced (content-referenced) tests: An assessment instrument that allows for interpretation in reference to the specific content mastered by the student (Gregory, 2004).

Economically disadvantaged student: A student who is a member of a household that meets the income eligibility guidelines for free or reduced-price meals (less than or equal to 185% of Federal Poverty Guidelines) under the National School Lunch Program (NSLP).

Gateway exam: One of the three tests—biology, mathematics, and language arts—that students must pass in order to earn a Tennessee regular high school diploma (Tennessee Department of Education, 2008).

Self-efficacy: "People's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances. It is concerned not with the skills one has but with judgments of what can do with whatever skills one possesses" (Bandura, 1986, p. 391).

Significance of the Study

The study is significant for three reasons. First, the study addresses issues that currently dominate national media coverage (Mathis, 2010; Thomas, 2010; Williams, 2010) about the need to improve performance in public schools. Second, the longitudinal design of the study allows the observation of significant trends and substantiates conclusions. Finally, the study will explore the benefits of a summer program designed to meet the needs of lower-income students by identifying curriculum and instructional strategies that might contribute to increased student achievement and outcomes. Indications of significant increases in student achievement scores and other performance indicators would promote social change among students who previously experienced failure in earlier mathematics endeavors. Hopefully, students will gain confidence in their own ability to understand mathematical concepts and perform related skills.

Assumptions

The following assumptions were present in this study. First, I assumed that teachers and coaches who worked during the program were proficient in their understanding of mathematics standards and dedicated to helping students succeed.

I assumed that students gave good effort during the program and tried their best on the GATEWAY exam. I assumed that student data obtained from the Tennessee Department of Education were reliable and accurate. Last, I assumed the quizzes, pretests, and posttests students took provided a valid assessment of student ability on GATEWAY standards at the time of their administration during the program.

Limitations

The following limitations were present in this study. First, participation in the summer program was on a volunteer basis for both students and teachers. Performance outcomes from students who volunteered for the program may differ from results from performance outcomes from students who were required to attend the program. Additionally, quality of instruction was limited to the individual skill levels and efforts of the teachers who chose to work in the program. Second, although any student who previously failed the GATEWAY mathematics exam was permitted to attend the summer program, only students who earned a raw score of 25 or above were formally invited. Teachers reasoned that scores lower than 25 revealed a very low cognitive level and believed students would benefit more by repeating the class during the regular school year. Last, students may have received remediation or encouragement from other sources that may have affected their achievement scores.

Delimitations

This study was delimited to students who previously failed the Tennessee GATEWAY mathematics exam on their first attempt and who were enrolled at the school in the study during the period from the fall semester of 2002 to the spring semester of 2007. The study was limited to one urban high school where many students failed their high-stakes test on the first attempt. Therefore, generalization of results from the study cannot be made to other populations with different ethnic or socio-economic levels.

Summary and Transition Statement

In this section, I outlined a problem worthy of study, where a majority of students at a local high school failed to pass an exam required for graduation. I also provided a theoretical base to suggest causes for the lack of adequate student performance on academic indicators such as attendance, effort, and test scores. Finally, I identified research questions and hypotheses that will guide the study as well as assumptions, limitations and delimitations to be considered. The following paragraphs detail the organization and major content for the remaining sections of the study.

In Section 2, I present an exhaustive survey of historical and current relevant literature in two parts. The first part centers on major themes that emerged to suggest plausible reasons why students demonstrate poor academic performance in school settings. The second part consists of a thorough literature review that focuses on direct instruction, mastery learning, single-sex grouping, and teacher collaboration as possible factors of the summer intervention program that could have contributed to student mathematics achievement.

In section 3, I describe the methodology used in the study, beginning with a detailed discussion of the research design and approach. Descriptions of the setting, sample, instrumentation and materials, data collection process, and data analysis methodologies with rationales are then outlined. The section concludes with a summary of measures taken to protect the rights of participants in the study.

In section 4, I report the major findings related to the research question and hypotheses addressed in the study. The section begins with a discussion of procedures that were taken to address concerns about violations of MANCOVA assumptions during data analysis. Descriptive statistics, MANCOVA and univariate tests are reported and interpreted.

In section 5, I present a summary of the findings and conclusions of the study. The key questions are whether participation in a summer intervention program increased student academic achievement on GATEWAY test scores and whether participation in the program contributed to improved student attendance and improved performance in later school coursework. This section also contains recommendations for future research.

Section 2: Review of the Literature

In this research study, I examined a summer intervention program that was implemented to help students pass a high-stakes mathematics test. An exhaustive review of historical and current research was conducted. In part 1 of this review, I explore several factors that impact student achievement. Emphasis was given to studies that explored the factors associated with student motivation in learning. In part 2, I explore studies related to the five major organizational characteristics of the summer intervention program.

Strategies for Searching of Literature

Literature searches were done through electronic research databases available through Walden University and University of Tennessee at Chattanooga online library resources. Databases that were used extensively included the following: Academic OneFile, Academic Search Premier/Complete, Education: A SAGE Full-Text Collection, Education Research Complete, Educational Resource Information Center (ERIC), JSTOR, ProQuest Dissertations and Theses, and Wilson Web. Appropriate keywords were used to search for factors that contributed to student academic effort and performance included *achievement gap*, *at-risk students*, *dropouts/dropout prevention*, *high-stakes testing*, *low achievement*, *mathematics achievement*, *parental support*, *motivation*, *self-efficacy*, and *student attitudes*. Keywords that were used to search for literature that addressed the major characteristics of the summer intervention program included *coaching*, *direct instruction*, *mastery learning*, *teacher collaboration*, *single-sex education*, and *summer programs*.

Factors That Affect Student Achievement

This first part of the literature review is divided into four sections. Each section presents a major theme that emerged during the search that suggests reasons why students are either motivated or unmotivated to learn. This summary of selected literature addresses the relationship between (a) self-efficacy and achievement, (b) motivation and achievement, (c) parental support and achievement, and (d) classroom engagement and achievement.

Self-efficacy and Achievement

Bandura's (1977) seminal research with *social cognitive theory* held that one's self-efficacy and eventual cognitive learning are always influenced by outside psychological factors that act to alter their level and intensity. Bandura also pointed out that people often choose to avoid what they perceive to be intimidating situations, especially if they believe those situations go beyond their ability to cope. Bandura further hypothesized that a person's self-efficacy establishes "whether coping behavior will be initiated, how much effort will be expended, and how long it will be sustained in the face of obstacles and aversive experiences" (p. 192).

Students frequently judge their own abilities by contrasting their accomplishments with those of other students. There is a strong correlation between a students' perceived self-efficacy and the amount of effort given to a difficult task. Students who do not believe in their own abilities or possess self-doubt often significantly reduce proficient use of previously learned skills by redirecting attention from the task at hand to focus on concerns over their weaknesses and shortcomings (Bandura, 1986). These concerns about one's perceived weaknesses often create stress and may cause students to perform inadequately, even when they understand subject matter. Self-efficacy predicted motivation and achievement among children categorized as low, average, or high in their mathematical ability (Collins, 1982). Students were given several word problems to solve and told that they could rework any problem that they missed. Results indicated that students from the low and average ability groups with high efficacy worked on unsolvable problems longer than did low-efficacy students.

Four hundred twenty-seven students of diverse ethnic backgrounds—72% Latino, 13% African American, 5% Asian American, 5% Caucasian, 2% Native American, and 3% who described themselves as "Other"—were surveyed to predict how their self-efficacy beliefs affected their grades, attendance, and perceived amount of physical and psychological distress (Close & Solberg, 2008). The researchers found that the students with more confidence in their abilities received higher grades, maintained better school attendance, and reported less distress. Conversely, they also stated that higher levels of distress were predictive of lower achievement.

Research has consistently found that students with learning disabilities (LD) hold lower self-efficacy perceptions about their academic abilities than students without LD (Gans, Kenny, & Ghany, 2003; Lackaye, Margalit, Ziv, & Ziman, 2006). Yet some students with learning disabilities (LD) and with relatively poor academic performance often exhibit positive self-beliefs about their academic abilities. Klassen (2008), who compared 133 adolescents' perception of their spelling and writing skills with their actual performance, found that students with LD sometimes overrated their actual performance. In a similar study that involved multiple interviews with 28 students with LD and seven specialist LD teachers, students viewed themselves with low self-efficacy while teachers considered students' perceptions about academic tasks as exaggerated (Clayson, 2005). This tendency to overestimate one's academic ability often contributes to a lack of preparation for academic tasks. Steinmayr and Spinath (2009) explored several motivation concepts to discover their ability to predict subsequent academic performance. Using a sample of 342 11th and 12th grade students, the authors performed hierarchical regression and relative weights analyses with student mathematics and German grades as dependent variables while using motivational constructs and intelligence as independent variables. They found that, controlling for prior achievement, students' self-belief about their competency in the subject areas contributed to subsequent performance.

Motivation and Achievement

Maehr (1984), a leading theorist in the study of human motivation, persuaded educators to stop thinking of students as either motivated or unmotivated. He maintained that all students have reasons to behave as they do, even if that behavior conflicts with what they are asked to do. He contended that students invest themselves differently because they construct their own interpretation of learning situations and the role they have in it. Further, Maehr maintained that students will arrive at their own interpretation, or *personal investment*, by evaluating three elements: (a) their awareness of the possibilities for action in the situation, (b) their self-confidence about their abilities to affect and work successfully within the situation, and (c) their perceptions of the goals that guide action in the situation.

LaSierra High School in Riverside California conducted a 6-week intervention program for rising ninth graders to promote positive motivation towards learning, address academic weaknesses, and build on existing student strengths and skills. According to the author, the program had a significant impact in improving the positive academic behavior of students (Austin, 2006). Others researchers have examined the factors associated with student success. Daniels and Arapostathis (2005), for example, interviewed and observed students in an alternative high school to determine what factors they viewed as principal contributors to their school successes and failures. The students indicated relation building with teachers, interest in school assignments, and confidence in their ability to perform the assignments as key elements in their levels of engagement.

Faircloth and Hamm (2005) used survey data from a sample of 5,495 students in Grades 9 -12 from seven ethnically-diverse high schools to investigate the relationship between students' sense of *belonging* (encompassing relationships with teachers and peers, extracurricular involvement, and perceived ethnic-based discrimination), their motivation to make effort in the classroom, and their academic success. The authors found all four measures of "belonging" to be significant for European American and Latino students but with potential variability in perspectives among other ethnic groups. They also found a strong correlation between the belonging construct and academic success across all groups. A similar study, which included 143 predominantly Puerto Rican and Mexican seniors from a large, urban high school (Sanchez, Colon, & Esparza, 2005), reported that students' sense of school belonging significantly impacted their grade point averages, absenteeism, motivation, effort, and educational aspirations and expectations. Though there was a difference in the relationship of sense of belonging and its ability to predict GPA between girls and boys, regression analyses failed to explain the gap.

Some students lack motivation because they lack trust in the ability of educational structures to provide outcomes that will affect them and have meaning on a personal level. A study that included 75 African American male students attending a Southern California high school examined the relationship between academic outcome expectations, academic outcome value, and cultural mistrust (Irving & Hudley, 2005). The researchers found a significant inverse relationship between cultural mistrust and outcome value. Additionally, cultural mistrust and academic outcome value were significant predictors of academic outcome expectations.

Research indicated that classroom instructional practices sometimes contribute to student boredom and lack of motivation. Fisher (2009) observed students in 15 classrooms for a total of 2,475 minutes to monitor teacher strategies and student involvement. Fisher observed that, in a majority of classrooms, students were involved in activities where they either listened or waited. Fisher further noted limited times of engagement with peers in small-group settings.

Although a majority of researchers reported that motivational variables contribute positively to student achievement (e.g., test scores), other studies suggest that the relationship is inconsistent. A 2-year, cross-sectional investigation of eighth and ninth grade students, largely African American, in a Midwestern school district was conducted to determine the relationship between motivation and GPA (Long, Monoi, Harper, Knoblauch, & Murphy, 2007). Using regression analysis of students' self-reported levels of three motivational variables (learning goals, self-efficacy beliefs, and GPA), they found that the predictive value of the three variables on academic achievement differed across the two grade levels. They concluded that students' motivation beliefs and self-efficacy develop as a result of their educational experiences that can either be positive or negative. Factors that may impede the relationship between motivation and achievement might include poor resources, ineffective teachers, or poor physical facilities.

Nelson and DeBacker (2008) used Maehr's theory of personal investment as their theoretical framework to explore connections among student-perceived peer relationships and academic motivation. A sample of 253 middle school and high school students currently enrolled in science classes was asked to complete a questionnaire that measured their beliefs about their personal achievement, classroom climate, achievement goals, social goals, self-efficacy, and the personal attributes that they thought a *best friend* would possess. The authors found that students who perceive being valued and respected by their peers were more likely to adapt their achievement motivation.

Lack of Parental or Other Significant Adult Support and Achievement

Many students who struggle in school come from homes where one or both parents play little or no role in providing support for them. The Social and Health Assessment (SAHA) surveyed 652 predominantly minority, inner-city rising ninth graders to explore the relationship between their self-perceived feelings of school attachment and family involvement to predict negative behaviors during their high school experience one year later. Researchers found that the students' self-perceived detachment from school and reduced involvement with parental authorities were associated with negative outcomes while perceived teacher support was associated with lower levels of violent activities and higher levels of academic motivation (Frey, Ruchkin, Martin, Schwab, & Mary, 2009).

Researchers who conducted a longitudinal study of 168 working and middle class families—parents and their children—found that conflict in the home predicted declines in academic achievement two years later. They also found that lower mathematics grades among families with lower education levels predicted increases in parent-adolescent conflict two years later (Dotterer, Hoffman, Crouter, & McHale, 2008).

Parental influence and encouragement positively impact attendance and mathematical achievement of middle-school students (Filer & Chang, 2008). African American high school students' reading achievement is positively affected by what parents expect their children to accomplish in educational settings (Flowers & Flowers, 2008). Gutman (2006) interviewed parents in African American families ($N = 50$) and surveyed their children to explore the effect of parents' mastery goal orientations and perceived classroom goal structures on their children's self-efficacy and academic achievement. The author found that (a) students who adopted more mastery goals in high school mathematics increased more in both their self-efficacy and grades when compared with their other classmates and (b) students whose parents had high mastery goal expectations for their children increased more in both their self-efficacy and mathematics grades when compared with students whose parents had lower mastery goal expectations for their children.

Somers, Owens, and Piliawsky (2008) surveyed economically disadvantaged African American male and female ninth grade students ($N = 118$) to determine how teachers, parents, classmates, peers, and close friends influenced their educational attitudes such as educational intention, educational behavior, personal control, persistence, and understanding the personal and financial value of educational attainment.

They found that, although moderate and strong correlations between all groups were present, students viewed support from parents, teachers, and peers as most important in affecting their educational attitudes.

Lack of Engagement and Achievement

Many researchers suggest that students in low-poverty schools often fail to receive quality mathematics instruction based on best practice methodologies generally supported by research (McKinney, Chappell, Berry, & Hickman, 2009; McKinney & Frazier, 2006). Still others point to the failure of educational leaders to provide culturally responsive mathematics teaching to motivate learning (Campbell, 1996; Ensign, 2003). Teachers who do not use best practices or who are unskilled in using best practices “are less likely to attempt to reach all students’ learning needs or alter their teaching practices” (Palacios, 2005). Student effort, cooperative efforts with peers, and positive school climate—“cohesion felt by students, teachers, and administrators” (E. Stewart, 2008)—play a pivotal role in increasing student achievement.

Socioeconomic status, race, and ethnicity have long been associated with differences in students’ mathematical ability (National Council of Teachers of Mathematics (NCTM), 1999). But historically, curriculum in high-poverty schools often focuses on practicing basic skills and avoiding tasks that require problem solving and reasoning. This routine instruction, which Haberman (2005) termed the “pedagogy of poverty,” typically follows a set algorithm of lecturing, assigning work, monitoring seat work, reviewing assignments, and giving tests. “Many mathematics students spend much of their time on basic computational skills rather than engaging in mathematically rich problem-solving experiences” (Sutton & Krueger, 2002, p. 26).

McKinney, Chappell, Berry, and Hickman (2009) investigated the pedagogical and instructional mathematics skills of teachers in 99 high-poverty schools to assess instructional practices in their classrooms. They found that participants connected their mathematics instruction to real-world experiences and demonstrated different mathematical concepts. However, their use of lectures, teacher-directed instruction, and drill-and -practice far outweighed their use of manipulatives, abstract mathematical thinking, hands-on activities, and problem-solving strategies.

Characteristics of the Summer Intervention Program

Poor student performance on GATEWAY exams during the school year served as a catalyst for administrators and teachers to provide additional time outside the regular school calendar for students to improve their mathematics skills. It is important to note that the summer intervention program was neither implemented nor designed based on research findings. Rather, teachers made changes in the program based on their observation of what they perceived to be "working" and what they believed could be improved.

The second part of the literature review focused on research studies that explored five factors that characterized the summer intervention program from 2003 to the present: (a) extended learning time, (b) mastery learning, (c) direct instruction, (d) single-sex grouping, and (e) teacher collaboration. The following literature review addresses each of these constructs as possible contributors to the efficacy of the summer intervention program.

Extended Learning Time

Students who lack fundamental mathematics skills struggle with higher-level concepts. After-school and summer programs have been recommended as constructive means to help at-risk students increase achievement in reading and mathematics by providing the extra time necessary for learning and mastery. Woelfel (2005) outlined the Promoting Academically Successful Students (PASS) program for at-risk students at Cerro Villa Middle School in Villa Park, California. The program, operational since 1998, has sequential steps designed to provide additional instructional time for learners and is structured to monitor and encourage their progress. Teachers in the program invited sixth-graders with scores below grade level to attend a Summer School Bridge program to work on deficient skills. At-risk seventh-graders participated in Skills for Success classes that provided individualized instruction. Students who did not maintain a C average met with a counselor for advisement and attended after-school tutorial classes. When students failed two or more classes during a nine-week term, they were placed in an independent learning program. Students who failed two or more classes during the regular school year were required to participate in a summer school/intersession program. If students were still struggling, they were assigned to the Opportunity for Success program, which features small-groups and which targets English, mathematics, history, and social science deficiencies.

Lauer, Akiba, Wilkerson, Apthorp, Snow and Martin-Glenn (2006) examined 35 after-school and summer school program studies to assess their effectiveness in improving student achievement in reading and/or mathematics. The authors required that, as criteria for selection, the programs target students who were at risk for school failure.

They defined at-risk students as those (a) who had low performance on standardized tests, classroom assessments, or teacher assigned grades; or (b) who demonstrated demographic characteristics often associated with lower student achievement and dropping out of school, such as “low socioeconomic status, racial or ethnic minority background, a single-parent family, a mother with low education, and limited proficiency in English.”(p. 286). Each study included a control or comparison group that did not take part in the after-school or summer school program under investigation and whose achievement scores could be compared with students participating in the out-of-school-time program. The researchers concluded that after-school and summer programs demonstrated a positive impact on the achievement of at-risk students in reading and mathematics. They further suggested that additional programs conducted outside the normal school day could positively affect student achievement, even when academic improvement was not the only focus of the program.

Students’ reading levels often predict whether or not a student will be successful in solving word problems. Mallette, Schreiber, Caffey, Carpenter and Hunter (2009) investigated a summer literacy program for 30 at-risk seventh- and eighth-grade students—90% African American, 10% Caucasian—who were scheduled to be retained in the same school grade the following school year because they failed at least three of their four core subjects. The students were transported to a university approximately 50 miles away, where they received extensive tutoring and small group instruction in their areas of deficiency from literacy specialists. The students were informed that they would be promoted to the next grade if they were successful in the program, which took place over a six-week period for three days per week. Pre- and post-test data scores on the

Gates-McGinitie Reading Test were compared using a dependent two-tailed *t* test. The students' normal curve equivalent scores (NCE) were obtained based on their raw scores and grade levels. An effect size was also calculated. The authors reported that 27 of the original 30 students completed the program and were promoted to the next grade level. The other three students were dismissed from the program because of behavior issues. The average NCE reading score on the pre-test was 21.70 and the average score on the post-test was 31.03. A dependent two-tailed *t*-test indicated a significant difference, $p = .001$. The effect size was $d = .43$, which falls in the moderate range (Cohen, 1988). The authors also explored the affective dimensions of the summer literacy program and found that 86% of the students reported that they were doing well in school halfway through the following school year, although the reasons that the students gave were not always academic factors.

Mastery Learning

Benjamin Bloom (1976) stated that although the correlation of pupil performance from grade-to-grade was typically greater than 80%, variation within each grade increased each year. The range between higher-performing students and lower-performing students doubles from second grade to fourth grade, and triples from second grade to sixth grade. He maintained that 90% of student's rank order was fixed by third grade for the rest of their elementary and secondary school experience. Bloom also noted a grade-by-grade decline in student self-concept for students ranked in the lowest 20% compared to a grade-by-grade increase for students ranked in the top 20%, a phenomena he noted was also prevalent in most countries.

Although Bloom acknowledged that home environment to be a crucial component of student success in elementary school, and that changes in those inherited characteristics would not happen quickly, he contended that significant progress could be made over a period of time. He noted that the instructional practices that teachers use in their classrooms exhibit a profound effect on student learning. To reduce variation in student achievement, teachers must configure their instruction to address the diverse learning styles and aptitudes of their students.

Bloom believed that all students can learn at high levels if both the instructional approaches and time were modified to correspond with students' individual learning needs (Guskey, 2007). He examined the work of early pioneers in individualized instruction, particularly Washburne and Morrison, to determine what key components in individualized tutoring could be employed in classroom settings (Morrison, 1926; Washburne, 1922). He observed the process that successful tutors use when working with an individual student. If the student makes a mistake, the tutor first calls attention to the error. Then, the tutor explains, clarifies, and provides corrective practice to ensure that the student understands the concepts being addressed. Bloom noted that this is akin to the procedure academically successful students usually follow when they ask the teacher about questions missed on a test or when they redo problems or tasks they have missed so they will learn the correct way to do them.

Bloom developed a detailed instructional strategy, which he labeled *mastery learning*, that was based on his observation and study of successful learning experiences taking place in individualized settings (Bloom, 1971). These principles can be summarized into four key components. First, curriculum should be organized by major objectives into units that define mastery of the subject. Second, these units are broken into relatively smaller learning sections with fewer objectives. Third, teachers administer a diagnostic test before each unit to identify instructional needs and plan for supplementary instruction to help students' mastery of subject material. Fourth, learning activities must be planned to allow students opportunity to practice and actively engage in learning that will enable them to address the objectives. For example, students who are expected to solve complex mathematical problems must have the chance to practice those skills. Students must be provided corrective feedback and continue to practice until they master the objectives. But, to produce best results, teachers must consider individual student's learning style and design instruction accordingly (Guskey, 2005). Teachers who use mastery learning strategies continually use formative assessments—e.g., quizzes, performance tasks, and oral presentations—to discover the degree to which student learning is taking place. In a mastery-learning classroom, teachers must also provide for the needs of students who master the subject matter when it is first presented. Teachers often use enrichment activities developed for gifted or advanced students to ensure all students are challenged and have opportunities to learn at higher levels.

Mastery learning strategies have the potential to reduce achievement gaps among different groups by reducing the variation in individual student learning outcomes. When teachers vary their instructional methods to address student learning deficiencies, there was often observable a positive increase in student attitude towards learning and increased confidence in their academic abilities (Guskey, 2007).

A high school located in western Tennessee had a student enrollment of 886 in grades 9-12 in 2006. Over 40% of students were economically disadvantaged. Following the lead of other area schools that reported early success with mastery learning models, the mathematics department at the school used a mastery learning curriculum for their Algebra I classes. Chapters were divided into smaller units and students were tested at the end of each unit. In order to achieve mastery, a student had to score 80 or above. Students who scored below 80 were considered incomplete, were given additional instruction and practice to improve their understanding, and were allowed to retake the unit test three times. Reasearchers revealed that students at all levels scored significant gains on statewide standardized tests (B. Zimmerman & M. Dibenedetto, 2008). Interviews with students currently enrolled in an Algebra 1 class indicated a strong preference to learning in a mastery-learning classroom compared to a traditional classroom. A ninth-grade girl stated that she "really liked the approach because it gave me the opportunity to make sure I really understood something before moving on to the next lesson" (p. 214). Engelmann maintained, "When students are taught mastery, they become smarter, acquire information faster, and develop efficient strategies for learning" (Engelmann, 2007, p. 48).

Direct Instruction

Direct instruction is a method of instruction based on meaningful teacher-student interaction and teacher guidance of student learning. Demonstrations, modeling, explicit explanations, and guidance practice characterize this method (Rupley, Blair, & Nichols, 2009). Unlike constructivist approaches, the teacher clearly directs the learning process. The classic model of direct instruction contains five elements: orientation, presentation of material, structured practice, guided practice, and independent practice.

During orientation, teachers introduce the objective or standard to be studied and relate the content of the lesson to prior student knowledge or experiences. Also, teachers talk about procedures that will be followed during the lesson and explain students' responsibilities during those segments. Next, teachers explain new concepts or skills, using explicit oral and visually representations. When explaining a new concept, teachers include attributes, the rule or definition, and numerous examples to illustrate that concept. For skills requiring multiple steps, teachers provide multiple examples while breaking the skill into small increments as much as possible (Reagan, 2008).

Third, teachers lead students through whole-class structured process, giving examples, and asking questions to check for understanding. Special attention is given to review the process steps students will need when they begin to work independently. Fourth, teachers provide guided practice and closely monitor assigned student work while providing praise, prompts, and corrective feedback as needed. The monitoring process allows teachers opportunity to assess if students understand the objective and whether the class has the foundational knowledge for new instruction. If several students struggle with understanding during guided practice, teachers re-teach the concepts and objectives in a whole-class setting (Huitt, 1996).

The final component of a direct instruction lesson begins when students achieve a high accuracy level on their guided practice assignment. Teachers then provide independent practice, during class or homework, to increase retention and mastery of material. Often, practice activities are occasionally planned periodically to review and maintain skill development (Engelmann, 2007).

A survey of the literature found direct instruction to be an effective method in improving student achievement performance, especially for students with learning disabilities or special needs (Beyer, 2008; Maccini, Gagnon, Mulcahy, & Leon, 2006; Ryder, Burton, & Silberg, 2006). An intervention program was implemented for seventh grade students from a rural middle school who had failed the required state mathematics assessment at least twice and who were demonstrating other at-risk characteristics at school (M. M. Flores & Kaylor, 2007). The students participated in 14 Direct Instruction lessons designed to improve their understanding of fractions. A *t* test was used to measure progress on student scores earned on a curriculum-based pre- and post-test. The authors reported significant increases in fraction skills and observable improvement in proper and on-task conduct during the program. In another study researchers compared learning gains made in reading from a large sample of approximately 1400 students at 63 elementary schools to determine what they perceived to be a high rate of variation during the final six months in third grade (Houtveen & van de Grift, 2007). They discovered that learning gains were significantly greater where students had received explicit or direct instruction and teachers demonstrated well-organized instruction compared with classes where teacher worked with students organized by cognitive levels with individualized learning plans.

A study that included a sample of 137 students in 12^{th} grade physics classes compared the jigsaw classroom method of instruction with a traditional direct instruction model. The researchers found direct instruction to be effective among students with higher reported levels of subject self-confidence in physics. On the other hand, the authors discovered that students with lower levels of self-confidence profited from cooperative learning activities rather than direct instruction because they felt more competent within that learning environment (Hanze & Berger, 2007).

Douglas, Burton, and Reese-Durham (2008) investigated whether students who were taught using *multiple intelligence* strategies achieved higher mathematics scores than students taught using a direct instruction model. The participants for the study, eighth grade students ($N = 57$) at a public middle school in North Carolina, were divided into an experimental group where students were taught using MI strategies and a control group where students were taught using direct instruction. A t test for non-independent samples was used to analyze the data. Findings reported a significant difference between the mean of the MI group ($x = 79.06$) and the DI group ($x = 71.24$), $t = 2.06$. The authors concluded that students who were taught using MI strategies achieved higher mathematics test scores than those who were taught using DI.

Kroesbergen and Van Luit explored the impact of a constructivist intervention for students with mild mental retardation, as compared to DI, to impact student mathematics achievement of 69 mentally retarded students from elementary schools. Participants in the intervention, which focused on multiplication learning, received either a guided constructivist approach or directed instruction for a four-month period. Analysis of multiplication automaticity and ability tests, administered before and after the training period, suggested that students in both learning environments made significant improvement. Although students who received direct instruction made greater gains than students receiving guided instruction, the authors indicated that mentally retarded students can benefit from constructivist instructional methods (Kroesbergen & Van Luit, 2005).

A 4-week intervention program planned for 23 at-risk high school female students integrated science and mathematics concepts by using direct instruction, calculators, projects, and discussion. Although students initially knew very little about mechanical advantage or were unaware of how mathematics is used in applied science, students who participated in the intervention program demonstrated an increased knowledge of mechanical advantage and greater appreciation of how science and mathematics are integrated (Seki & Menon, 2007).

No Child Left Behind's accountability measures amplify the struggles low-performing urban schools constantly encounter in their efforts to increase student achievement results. Instructional strategies that will provide support for these low-performing students in low-performing schools have become the focus of many scholarly studies. Although the majority of surveyed literature suggested the use of direct instruction could increase student achievement for students with learning disabilities or with special needs, other researchers suggest different outcomes. Shippen, Houchins, Calhoon, Furlow and Sartor (2006) investigated the impact of two comprehensive school reform efforts, *Success for All* and direct instruction, on achievement of urban middle school students with disabilities who were two or more years behind grade level in reading. They found that students with disabilities demonstrated little or no gain from either intervention effort and they continued to remain behind. Dean and Kuhn (2007) compared three groups of fourth-grade students (N=15 in each group) in three different instructional settings over a 10-week period to determine their mastery of the control-of-variables strategy essential to the scientific method. The first group worked on assignments that required the control-of variables strategy for successful solution. The second group completed the same activity as the first group after a direct instruction lesson on the control-of-variables strategy. The final group received direct instruction without engagement or practices. The researchers found that all three groups demonstrated understanding of the strategy. More significantly, they concluded that direct instruction did not contribute to quick acquisition of the strategy or promote retention over time.

Single-Sex Grouping

Recent studies point to an increasing gap between male and female students across many indicators of school success. Male students demonstrate higher dropout rates (J. Gray, Peng, Steward, & Thomas, 2004), display more negative behavioral issues which results in a greater percentage of school discipline referrals (Kafer, 2004), and spend less than one-third of the time their female counterparts spend doing homework to prepare for school (National Center for Educational Statistics, 2007). Females now surpass men in their graduation rates in high school and in post-secondary enrollment and subsequent degree completion (Goldin, Katz, & Kuziemko, 2006). A ten-year study of high-school seniors who completed a national survey revealed that male students joked around in class, completed far less assignments, and rarely tried their best at a significantly higher rate than female students, who found their classes to be more meaningful and important to their futures (National Center for Educational Statistics, 2005). Researchers who conducted two similar studies suggested that female students have higher educational aspirations at an earlier stage in their lives than males (Akos, Milsom, & Gilbert, 2007; Blackhurst & Augur, 2008). Using attitudinal data, researchers found that male students place far less importance on education than do female students

(Clark, Oakley, & Adams, 2006) . Blackhurst and Auger argued that the gender gap in educational achievement and attainment is widening and becoming increasingly evident in every social group in the United States.

Most of the single-gender schools in United States in the first half of the 20th century were schools for Caucasian males. Among single-gender schools that existed for females, most served as "finishing schools" rather than preparation for college (Meyer, 2008). Civil rights and feminist movements during the 1960s and 1970s brought pressure upon government leaders to provide equal educational opportunity to all students regardless of race or gender. Many single-sex public and private schools, feeling pressure in the face of political and public opinion, opened their doors to both sexes after 1970. Central High School in Philadelphia, founded in 1838, became coeducational in 1983 (Friend, 2007). Many colleges, including Yale University (in 1969), became coeducational. According to Meyer, over half of the 268 women-only colleges in the United States that were still operating in 1960 had closed by 1980. The decrease in the number of single-sex schools continued at an exponential rate for the next twenty years (Meyer, 2008). By March 2002, only 11 public schools offered single-sex classrooms (National Association for Single Sex Public Education, 2009).

The pendulum began to move in the other direction in June 1996 when the Supreme Court declared the Virginia Military Institute all-male admission policy to be unconstitutional. Although their decision appeared to favor coeducation, all nine justices, notably Ginsburg and Scalia, praised the ability of single-sex education to offer positive educational benefit. The historic rewriting of Title IX in 2006 allowed districts to operate single-sex schools by "providing a rationale", "providing a coeducational class" and “conducting a review every two years“ (Meyer, p. 10). Some school districts, facing mounting pressure to meet accountability requirements mandated by NCLB, began to consider single-sex education as an option to improve student achievement. The number of single-sex schools has increased exponentially in the last decade. According to the National Association of Single Sex Public Education (2009), there are at least 542 schools that contain at least some single-sex learning structures in place. There has been a scarcity of research studies focused on single-sex education in the last thirty years, especially in the United States. As a result, the literature review in the following paragraphs includes many studies from other countries.

Others insist that separating students by gender alone fails to significantly improve achievement. A two-year ethnological study of low-income and minority students attending single-sex schools in California found that schools’ organizational characteristics, positive teacher-student relationships, and ample resources more accurately predicted schools’ success (Hubbard & Datnow, 2005).

Some educators question the benefit of single-sex education as a strategy to produce greater student achievement. Teachers from a coeducational middle school who were responsible for single-sex classes were interviewed and surveyed to measure their perception about the strategy (C. Gray & Wilson, 2006). Although stated goals for creating single-sex classes four years earlier had been to “raise grades” and “boost academic achievement”, researchers maintained that teachers believed academic performance and classroom behavior had declined since its implementation.

Another factor that has sparked an interest in the resurrection of single-sex classes has been perceived “underachievement” of boys relative to girls in the last decade. A study of secondary schools involved in the four-year Raising Boys' Achievement Project found that single-sex classes have the ability to increase the achievement levels of both sexes and promote a beneficial learning environment (M. R. Younger & Warrington, 2006).

Two large groups comprised of 340 girls from eight coeducational and two single-sex schools were surveyed to investigate the influence of coeducational and single-sex school settings on their motivation in mathematics and language arts over a period of three academic years (Chouinard, Vezeau, & Bouffard, 2008). In another study, parents from three independent schools—a coeducational school, a girls' school, and a boys' school—were asked to complete questionnaires (N=225) and participate in semi-structured interviews (N=12) to determine whether or not a school was single-sex or coeducational to be an important factor they considered before enrolling their children. Researchers found that parents believed that single-sex education had academic advantages, especially to girls, while coeducation possessed important social advantages for boys (Jackson & Bisset, 2005).

Some indicators suggest a declining interest in mathematics among girls from low-income or minority groups, especially during middle school. A program was designed for a group of seventh-grade urban girls to learn about research methods, computer skills, mathematics, and descriptive statistics. The participants met on Saturdays for ten weeks and were assisted by university mentors. The authors reported that girls showed greater confidence and increased mathematical achievement after the program (Reid & Roberts, 2006).

Much of the literature surveyed maintained that girls and boys learn in different ways and sometimes prefer one subject in school to another. Zhu (2007) argued that many variables—biological, psychological, and environment factors—contribute to the gender gap in mathematical problem solving favoring males. Across four contemporary theories of achievement motivation—self-efficacy, attribution, expectancy-value, and achievement goal perspectives—female students report greater confidence and interest in language arts and writing while male students report greater confidence and interest in mathematics and science (Meece, Glienke, & Burg, 2006).

Hanratty circulated questionnaires to the Heads of English in all post-primary schools in Northern Ireland to gather their views on the best strategies to teach poetry. Results from analysis of their responses revealed a wide range of methods utilized to affect different learning styles and a strong belief in coeducational settings over single-sex settings in benefiting emotional and intellectual maturity (Hanratty, 2008). A similar study that examined gender differences in academic self-concept for a group of children born in 1958 contained similar findings. Boys again reported greater self-concept in science and mathematics while girls reported the same in English (Sullivan, 2009).

Teacher Collaboration

Findings from international studies revealing significant gaps in achievement scores between American students and students in several other foreign industrialized nations produced intense outcries to determine reasons for the deficiencies and to enact changes to improve American ranking in the global community. Stakeholders placed tremendous pressure on educational leaders at all levels—national, state, district, and local school—to "*fix the problem*".

Reform efforts followed two major pathways. The passage of the No Child Left Behind Act (2002) exemplified a top-down strategy, as legislators and governmental educational leaders established policies and regulations designed to produce a quality product, in this case student achievement. Implementation of newly adopted standards proceeded quickly and smoothly, since state organizational hierarchies were already in place. A second approach, based on *constructivist* principles, centered on placing greater ownership and responsibility on principals and teachers to bring about changes.

Numerous research studies during the 1980s substantiated the advantage of *cooperative learning* to increase student learning and achievement (House, 2006; D. Johnson, Johnson, & Holubec, 1992; Kagan, 1994). The scope of the studies expanded to include how teachers learn from other teachers and how teachers and students learn together in a classroom setting (Lambert, Collay, Dietz, Kent, & Richert, 1997).

Goodlad contended that “teachers controlled firmly the central role of deciding what, where, when and how their students were to learn” (Goodlad, 1984, p. 109). He further suggested that this power led to a culture of student passivity, rote learning, and 70% teacher talk in the classrooms of the country. He led a four-year study where trained investigators talked to teachers, students, administrators, parents and community members in over 1,000 classrooms across the United States to determine what was taking place. Findings revealed that although teachers had some association with colleagues in college courses, in-service classes, workshops, and educational organizational meetings, there exchanges were rather brief and casual. Goodlad stated,

> They rather rarely joined with peers in collaborative endeavors such as district committees or projects. Nor did they visit other schools or receive visitors from

> them very often. There was little in our data to suggest active ongoing exchanges of ideas and practices across schools, between groups of teachers, or between individuals even in the same schools. (p. 187)

Lieberman and Miller (1992) argued that even longtime colleagues lacked the ability to enter each other's professional domain, the individual classroom. Tyrack and Cuban (1995) asserted that "teachers typically have sufficient discretion, once the classroom doors close, to make decisions about pupils that add up over time to de facto policies about instruction, whatever the official regulations." Teachers' production of de facto policies and traditional teacher isolation are still prevalent in many schools today (Ladwig, 2007).

Many authors highlight the possible benefits of teacher collaboration as a viable means of reducing teacher isolation and increasing student learning (Goddard, Goddard, & Tschannen-Moran, 2007; Hearney, 2005; Keck-Centeno, 2008). Others point to a lack of relationship among a student's individual teachers in the school setting as a serious shortcoming in current educational practice (Valli, Croninger, & Walters, 2007). Some of the most intense support in favor of the collaborative movement has been shown by educators, who reported collaborative efforts as highly constructive (Baron, 2005).

Researchers use different terms (e.g., *collaborative culture, collegiality, collaborative schools, joint work, teaming, group instructional practice,* and *professional learning communities*) when discussing collaboration. What these terms usually denote in an educational context is "a sustained effort by teachers to work together interdependently on curriculum, instruction, and assessment to improve student learning" (Howe, 2007, p. 3).

Some authors maintained that *professional learning communities* (PLUs) help teachers work together to better meet the needs of their special education and at-risk students (DuFour, Eaker, & DuFour, 2005; McLaughlin & Talbert, 2006). PLUs are made up of teachers and administrators in a school who continuously seek and share learning, and act on their learning (Astuto, 1993). Tagaris presented a case study that explored the collaborative culture and viewpoints of a team of fifth and sixth grade teachers before and after beginning a PLU. The author found that (a) teachers in a PLC are better able to identify and address students' needs and supply regular interventions to guarantee that students obtain additional time and assistance for learning, (b) collaboration decreases the tendency to refer students to special education, and (c) employment of a PLC permits teachers to take action in response to the needs of every student without exclusively depending on special education placements (Tagaris, 2007). While acknowledging the benefits of professional learning, Easton suggested that PLUs may "go the way of so many other structures, such as block scheduling and small schools, that were instituted without enough attention to how teachers and students would take advantage of those structures" (Easton, 2008, p. 757).

Teachers are impacted by personal relationships (Olsen & Kirtman, 2002) and engaged by collaborative encounters with colleagues (Woods & Weasmer, 2002). But does teacher collaboration have a significant impact on student achievement? An examination of current literature found that many studies indicated a possible relationship between teacher collaboration and its ability to impact student outcomes.

DiPillo investigated a Critical Friends Group (CFGs), a team of teachers who schedule meetings on a regular basis to share teaching strategies and exchange constructive critique with others in the group. The researcher found that, because of their participation with the CFGs, teachers were more likely to make substantial changes in their classroom instructional practices (DiPillo, 2005). Teachers working in teams in selected schools in the Cincinnati area indicated that the use of team formats enhanced school culture, expanded teacher's instructional methods, and produced increased levels of student achievement (Supovitz, 2002). Conversely, a study of six CFGs involving 25 teachers and administrators reported that although CFGs seem to enhance collegial relationships among teachers, they exerted a minimal influence on subject content knowledge (Curry, 2008). A case study of teachers who were organized into grade-level teams at three middle schools in metropolitan Chicago revealed that structured collaboration time was used primarily for scheduling instructional resources and maintaining social cohesion and identities among its members (Grom, 2005). However, the author found that no significant correlation between the degree of teacher collaboration and student achievement results.

Barrett interviewed teachers, administrators, and district personnel at nine elementary schools in Tennessee about the amount of time teachers spent in structured collaboration and its relationship to the success of students in their schools. Responses of a survey from seven high-performing elementary schools and two average-performing schools revealed that all seven of the high-performing school had some kind of required structure in place for collaboration while the two average performing schools did not. Teachers in the high-performing schools cited the time set aside for collaboration as a key element in the success of their students (Barrett, 2006).

Flores explored leadership constructs that led to high achievement in mathematics at a Southern California High School. The school was chosen because of its four-year pattern of sustained improvement in mathematics. Substantial gains were especially evidenced among economically disadvantaged and Hispanic/Latino sub groups. Flores concluded that three significant factors emerged as possible reasons for the improvement. First, the mathematics department revised many of its existing policies and practices to create a uniform approach to instruction and grading. Next, structured teacher collaboration opportunities focused on identifying and removing obstacles to the teaching and learning process. Finally, the department chair provided instructional leadership designed to ensure that all teachers were knowledgeable with the standards students would learn (S. Flores, 2007).

DuFresne studied whether the implementation of the Japanese professional development model called *lesson study* enhanced teacher collaboration time. In this study, eight teachers formed two different study teams. After working together to design a lesson, one member taught while the other members of the team observed. The study teams met later to discuss their observations and then proposed ideas to improve the lesson. Participants remarked that lesson study offered a practical option to add research-based strategies to lesson plans while providing the modeling and feedback necessary to end teacher isolation (DuFresne, 2007). Student achievement and other positive climate changes are increased at the classroom level when small groups of teacher work in collaborative learning communities to focus on improving daily classroom instruction (R. Stewart & Brendefur, 2005).

Goddard et al. (2007) suggested a possible link between teacher perceptions of their degree of collaboration and subsequent student learning. A paired comparison of a teacher survey designed to measure teacher perception and student test scores—using a large sample of 47 elementary schools, 452 teachers, and 2536 fourth-grade students—revealed that fourth-grade students have greater achievement in reading and mathematics when they attend schools that have higher levels of teacher collaboration. Cooper et. al (2005) conducted interviews, reviewed documents, and made site visits to 11 diverse North Carolina high schools that historically demonstrated high performance on state assessments in an attempt to identify common themes contributing to their success. His analysis revealed that each of the schools exhibited similarities. First, students and teachers worked well together in a non-threatening school climate. Second, "safety nets" were created to allow students to catch up when they fell behind. Third, teachers worked collaboratively using data to plan for instruction. Fourth, department chairpersons exhibited strong leadership to ensure that all students mastered subject matter. Finally, collaborative leadership propelled lesson planning, instructional strategies, and assessment.

Hall (2007) presented a descriptive case study which explored professional development models in two successful Southern California K-8 school districts. Data derived from teachers and administrators in semi-structured interviews produced similar results. Both districts focused teacher collaboration activities on student achievement by reviewing student work, analyzing test data, and sharing instructional methods that had been tried and proven to be effective in classroom settings. A comprehensive study which surveyed 262 Title I elementary (K-5) schools found that extensive analysis of student data and structured opportunities for teachers to focus on the data provided a predictive measure to identify a school as being either a low-performing or high-performing organization (Lorey, 2005).

Many other studies, however, reported little or no significant relationship between the presence of teacher collaboration and student achievement. Naughton (2006) examined the relationship between mathematics teachers' involvement in structured collaboration programs and middle school students' mathematics achievement. The participants—353 middle-school mathematics teachers from Washington State—completed a survey designed to quantify their level of participation in teacher collaboration activities. Then, achievement scores of students in schools where teachers were collaborative were compared with the achievement scores of students in schools where teachers were isolated or moderately isolated. Finally, the relative importance of a school's level of teacher collaboration was compared with socioeconomic status (SES) as a predictor of student mathematical achievement. Naughton revealed that the degree of mathematics collaboration level was not a significant ($p <. 05$) factor in student achievement. He also showed that while SES was a significant predictor of student achievement, teacher collaboration was not (Naughton, 2006).

In summary, three studies outlined in this section maintained that there was no significant relationship between the level of teacher collaboration and student achievement. Naughton employed a descriptive survey to determine the level of teachers' perception of their level of collaboration and he used Washington state standardized test data to measure middle school student's mathematical achievement. He concluded that socioeconomic factors (SES) had greater impact than teacher collaboration in influencing student achievement. Grom (2005), in her investigation of grade-levels teams at three middle schools, also found no link between the amount of teacher collaboration and student achievement. Curry's study involving six Critical Friend Groups (2008) also found little correlation between the increased collegiality among its members and increased student outcomes.

However, the majority of research studies reviewed suggested that teacher collaboration might be a possible factor in increasing student learning and achievement scores. Each of these studies featured a backwards design element. The presence of increased student achievement results over a period of time with the presence of moderate or high degrees of teacher collaboration prompted various researchers to conclude that teacher collaboration and student achievement may be related. Each author surveyed, however, insisted that there was no evidence to support the hypothesis that increased teacher collaboration produced increases in student achievement scores.

Both Barrett and Flores chose schools for their studies that were either high-performing or that had exhibited a pattern of improvement over a period of time. Barrett chose seven high-performing schools and two average-performing schools as control groups. It is this author's opinion that the study would be improved by increasing the sample size of the control groups. Goddard et al. (2007) used a large sample size—47 elementary schools, 452 teachers, and 2,536 students—and paired comparisons of their student's state test scores provided the strongest evidence of a possible connection between teacher perceptions of their level of collaboration and subsequent student outcomes.

I found significant evidence to suggest a possible correlation between the level of teacher collaboration and student achievement. Research also suggested that one of the primary benefits of collaboration was in providing teachers with opportunities to work with colleagues on curriculum and professional development. Perhaps the most significant products of teacher collaboration are that teachers may increase their subject knowledge and learn how to improve their instructional strategies and delivery methods. On the other hand, no research studies indicated the presence of a cause-effect relationship between teacher collaboration and student achievement. While teachers' involvement in collaborative activities may enhance their teaching skills, motivate them to take risks in the classroom, and possible with a better attitude, the conclusion that student achievement increased solely as a result of higher levels of teacher collaboration was not substantiated in the literature.

Conclusion

This exhaustive review of scholarly literature focused on the practices that were adopted and used in each summer intervention program from 2003 through Summer 2007. They were (a) extended learning time, (b) mastery learning, (c) direct instruction, (d) single-sex grouping, and (e) teacher collaboration. Strong evidence from the review suggested that providing additional time either after school or during the summer positively could increase student achievement or help struggling students to meet course standards and "catch up" with their classmates. In addition, after-school and summer programs can positively affect student self-efficacy, even when academic achievement is not the primary focus of the program.

Evidence also existed in the literature that mastery learning, with its emphasis on monitoring and correction of errors, was helpful in identifying specific student academic weaknesses and addressing them in a timely manner. Two critical elements cited by many authors was the need to break the curriculum into smaller units so that correction can be made more quickly and the need to place students in very small or individualized instructional settings.

Mastery learning and direct instruction appear to be highly correlated methods of instruction. A survey of the literature revealed an overwhelming advocacy of the use to direct instruction to meet the needs of at-risk and special education students. Conversely, other authors maintained that students taught with direct instruction strategies performed at significantly lower levels than students taught with cooperative learning strategies.

Although the surveyed literature did not provide conclusive findings to suggest that higher degrees of teacher collaboration caused increased student achievement, there were several studies that indicated that their collaboration caused them to focus better on the standards they were teaching and the instructional strategies that would enable their students to better understand the standards.

Section 3: The Methodology

In this section, I present the methods used in the study. This section is divided into five parts. In the first part, I outline the research design of the study and give a rationale for its selection. In the second part, I describe and justify the population, sampling method used, sample size, eligibility criteria for inclusion in the sample, and detailed sample attributes. In the third part, I identify and describe the instrumentation used in the study. This section contains detailed information about the type of instrument, how the instrument measured concepts, calculation of scores and their meaning, procedures to assess the reliability and validity of the instrument, and an explanation of data used to measure the variables of the study. In the fourth part, I describe the data collection process, the type of scale used for each variable, a listing of hypotheses based on relevant research questions, and a detailed analysis of data using descriptive and inferential statistics. In the final part, I describe procedures that were followed to protect confidentiality, informed consent, and protection from harm for the participants in the study.

Research Design

This quantitative study used a quasi experimental, pre-post comparison group design. The students who participated in the summer intervention program served as the treatment group. The students who did not participate in the summer program but who took both Algebra 1 and the GATEWAY EXAM the following year served as the comparison group.

Setting and Sample

Many students who were identified by their teachers as having good mathematical skills took algebra in middle school before they entered high school. In spite of this early instruction, some middle school students did not pass the GATEWAY exam at the end of their algebra class. These students were invited to participate in the summer program and were included in the population and thus were considered as possibilities for inclusion in the study sample. This study focused on the summer intervention programs that took place from 2003 to 2007. The first two summer programs (2001 and 2002) were not included in the study because the program was only two to five days in length during early implementation and students were not yet divided into single-sex classes.

Approximately 250 students attended and completed the summer program from 2003 to 2007. To meet eligibility criteria for the study, students must have taken the GATEWAY mathematics test two or more times at the local high school. Additionally, they had to attend the local school during the regular school year both before and after the summer program in which they participated. Students who met these criteria were considered for the study sample.

Instrumentation and Materials

Characteristics of the Tennessee GATEWAY Mathematics Exam

The GATEWAY mathematics exam is one of three end-of-course assessments that students must pass in order to earn a Tennessee high school diploma. The test measures students' mathematical competency in five areas: (a) numbers and operations, (b) algebra, (c) geometry, (d) measurement, and (e) data analysis and probability. Each domain contains several standards and corresponding performance indicators that form the foundation of the Algebra I curriculum. A complete listing of the 56 performance indicators which are assessed by the GATEWAY mathematics exam is presented in Table 1 (Tennessee Department of Education, 2009). The GATEWAY exam, in multiple-choice format, contains about 60-65 items. Some of these items are used for "field-testing" and are not included to compute students' raw score (number of questions answered correctly). State officials establish "cut" scores for each test administration to correlate student raw scores to three achievement levels: "not proficient", "proficient" and "advanced". Since the inception of GATEWAY testing in Spring 2001, raw scores required to demonstrate a "proficient" level have ranged from 30 to 32 correctly answered questions whereas the raw scores required to demonstrate an "advanced" level have ranged from 41-42 correctly answered questions. After grading, test results are returned to the local schools along with a conversion table that allows teachers to record student grades on a percentage basis.

Reliability and Validity

All Tennessee GATEWAY exams—biology, English, and mathematics—are evaluated on an ongoing basis to support their validity in areas of design, content specifications, item development, and psychometric characteristics (Tennessee Department of Education, 2008). *Content-related validity*, the relationship between instructional standards and test content, was analyzed as test developers met with educational experts to measure correlation of knowledge and skills established in curricula and assessed by test items.

Confirmatory factor analysis (CFA) was performed on test data for the 2004-2005 and 2005-2006 academic years to ensure *construct validity*, the ability of GATEWAY exams to contain items that represent instructional objectives previously identified as those expected of high school graduates. As part of the CFA, several statistical tests were used to compare test items with a hypothesized model of the standard each test item should contain to determine the degree of acceptable fit. Notable among these are the Comparative Fit Index (CFI) and the Root Mean Square Error of Approximation (RMSEA). CFI values range from zero to 1.0, with values larger than 0.90 indicating acceptable data fit (North Carolina State University, 2009). RMSEA values which are less than 0.05 indicate good fit while values as high as 0.08 demonstrate mediocre fit (Texas Tech University, 2008). All GATEWAY exams revealed goodness of fit indices with CFI ≥ 0.97 and RMSEA ≤ 0.032 among all tests and all forms.

GATEWAY exams were also checked for construct-irrelevance, error variance caused by factors unrelated to test constructs, and for construct underrepresentation which exists when the full range of content is not addressed with test contents (Tennessee Department of Education, 2008, p. 21). This ongoing process allows test developers and educators to make changes in poor test questions and make changes that will more clearly reflect what the test items are meant to assess.

The KR-20 statistic (Crocker & Algina, 1986) was used to measure test reliability (internal consistency) across each test form. All GATEWAY tests performed well with reliability estimates ≥ 0.90 for all forms (Tennessee Department of Education, 2008, p. 30).

Test Administration Procedures

Those scheduled to take the GATEWAY mathematics exam were assigned to classrooms, each containing approximately 20-30 students. Each student with special needs was tested in small-group or individual settings according to modifications and accommodations required by their Individualized Education Programs (IEPs). Students were permitted to use graphing calculators on the exam. After completing one side of the answer sheet containing demographic information, the teacher administering the exam read scripted instructions from a state manual that prompted students to do two practice examples before beginning the actual exam. The teacher then read the correct responses to the practice examples from the instruction manual, started the test, and monitored student work by walking around to check progress and ensure test security. For the summer program that was the focus of this study, students were allowed to turn in their test and leave when they finished.

The GATEWAY mathematics test usually contains 63-65 multiple-choice items. Although the exam is untimed and most students finished within 75 minutes, students were allowed to take as long as needed to complete the test. After the final test was submitted, each teacher returned student test booklets and answer sheets to the program director. When all GATEWAY tests were completed in all subject areas, the director took the answer sheets and booklets to the district office for scoring. Results were usually returned to the school within 10 days.

Data Collection

The data collection process involved three phases: (a) identifying the population, (b) selecting the sample, and (c) coding and transferring data. A detailed description of each phase is presented below.

Identifying the Population

After receipt of approval from IRB and after receiving the superintendent's permission to access and use TN DOE student data files, I transferred records of all students who took GATEWAY mathematics exams both during the regular school year and during the summer intervention program at the local high school from 2003 to 2007. Students who failed the exam on their first attempt but chose to retake the course during the regular school term rather than participate in the summer intervention program were classified as part of the comparison group. Students who failed the exam on their first attempt but chose to participate in the summer intervention program were classified as part of the treatment group. Two groups of students were removed from consideration for the sample. The first group contained students who were allowed to take the GATEWAY exam at the local high school because it was not offered at their home school. Because TN DOE student records that I requested by were limited to the local school in the study, comparison of test results and other indicators for students from other schools was not possible. Also, since this study compared differences in student achievement between the first time and second time students took the GATEWAY exam, the records of students who were taking the exam for the first time during the summer were removed from consideration in the sample.

Students who had completed all graduation requirements in an earlier school year except for passing required GATEWAY exams were encouraged to come during the summer so that could earn a high school diploma. Because these students did not return the following year, follow-up data needed to address five of the six goals (and hypotheses) of the summer intervention program were not available. For that reason, those students were not included in this study.

Selecting the Sample

After finding the total number of students whose data indicated that they had taken the GATEWAY exam at least two times, an online calculator was used to calculate an appropriate sample size for both the comparison and treatment groups. Then, the name and de-identified number of all students in the population was entered into two columns of an EXCEL spreadsheet. The random number feature of the TI-84 Plus calculator was used to generate random numbers according to the earlier calculated sample size. I used the spreadsheet's highlighting feature to match each record with the corresponding row on the EXCEL worksheet. All records that were not highlighted after all random numbers are matched were deleted from the spreadsheet. The remaining rows will compose made up the student data used for the study.

Coding and Transferring Data

After the sample was chosen, additional data fields were transferred to each student record in the EXCEL spreadsheet. These data fields included the following:

- Unique student record number
- Student school grade (9-12)
- Year of participation in the summer program
- 1st time GATEWAY raw score
- 2nd time GATEWAY raw score
- Student raw score in each domain (numbers/operations, algebra, geometry, measurement, and data analysis/probability) of the GATEWAY mathematics test

- Student grades in mathematics courses for the years before participation in the program
- Student grades in mathematics courses for the years after participation in the program
- GPA in classes taken before summer program
- GPA in classes taken after summer program
- Number of classes failed during school year before summer program
- Number of classes failed during school year after summer program
- Number of days absent from school during school year before summer program
- Number of days absent from school during school year after summer program

Only TN DOE records were used to provide data that were entered manually into EXCEL. Since all data records were de-identified before the researcher received them, concerns about confidentiality, the risk associated with confidentiality and protection from harm were minimal.

Data Analysis

Research Questions and Hypotheses

The following research questions and hypotheses directed this study:

RQ1: What is the relationship between academic intervention (i.e., summer intervention involvement versus Algebra 1 course completion) and student achievement, as measured by GATEWAY math scores?

H_O1: There is no significant difference in student achievement, as measured by GATEWAY mathematics scores, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

H_A1: There is a significant difference in student achievement, as measured by GATEWAY mathematics scores, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

RQ2: What is the relationship between academic intervention (i.e., summer intervention involvement versus Algebra 1 course completion) and student academic performance, as measured by the number of absences for the next regular school semester?

H_O2: There is no significant difference in student academic performance, as measured by the number of absences for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

H_A2: There is a significant difference in student academic performance, as measured by the number of absences for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

RQ3: What is the relationship between academic intervention (i.e., summer intervention involvement versus Algebra 1 course completion) and student academic performance, as measured by the number of absences for the next regular school semester?

H$_O$3: There is no significant difference in student academic performance, as measured by the final mathematics grade earned for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

H$_A$3: There is a significant difference in student academic performance, as measured by the final mathematics grade earned for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

RQ4: What is the relationship between academic intervention (i.e., summer intervention involvement versus Algebra 1 course completion) and student academic performance, as measured by the number of courses passed for the next regular school semester?

H$_O$4: There is no significant difference in student academic performance, as measured by the number of courses passed for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

H$_A$4: There is a significant difference in student academic performance, as measured by the number of course passed for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

RQ5: What is the relationship between academic intervention (i.e., summer intervention involvement versus Algebra 1 course completion) and student academic performance, as measured by GPAs for the next regular school semester?

H_O5: There is no significant difference in student academic performance, as measured by GPAs for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

H_A5: There is a significant difference in student academic performance, as measured by GPAs for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

Independent and Dependent Variables, Statistical Tests

An interval scale was used to measure each of the dependent variables in the five null hypotheses. These dependent variables were (a) the difference in individual student scores on the GATEWAY mathematics exam on the first attempt before the summer program and the scores on the exam on their second attempt, after participation in the program; (b) the number of days missed during the regular school year preceding the summer program and the number of days missed during the regular school year following the program; (c) students' final grade in their mathematics class during the year before attending the summer program and students' final grade in their mathematics class during the year following the program; (d) the number of course failures for the school year before the summer program and the number of course failures for the school year after the program; and (e) student grade point average for the school year before attending the summer program and grade point average for the school year after attending the program. Pre- and post-data for these variables were collected for students who participated in the summer program (the treatment group) before taking the GATEWAY exam for the second time and for students that took a semester-long Algebra 1 class (the control group) before taking the GATEWAY exam for the second time.

A multivariate analysis of covariance (MANCOVA) was used to test the overall null hypothesis that there was no significant difference on student academic indicator variables (the dependent variables) between those who participated in the summer program and those that did not. The independent variable was the summer intervention program and the five correlated dependent variables were those listed above. The covariates in this case were the prescores that corresponded to the post dependent variables. MANCOVA was used to determine the overall effect the summer program had on the dependent variables (J. P. Stevens, 2009). It was appropriate for this study to determine whether the summer intervention program (independent variable) affected student test scores, grade point averages, attendance and success in subsequent mathematics courses (dependent variables) more than the regular semester classes. If the null hypothesis is rejected, subsequent univariate analysis will test each of the five separate hypotheses described above in order to determine which of the dependent variables contributed to the overall effect. Each analysis compared the post dependent variables between the comparison and treatment groups. I entered data into the Statistical Package for Social Sciences (SPSS) Version 16.0 for Windows for analysis and a MANCOVA was run, which included pre-test for multi-variate normality on the dependent variables as well as homogeneity of variance of the dependent variables. The overall hypothesis was tested at a .05 *alpha* level using a non-directional two-tailed test to determine whether a significant mean difference existed.

Measures Taken to Protect the Rights of Participants

I acquired from de-identified records from the Tennessee Department of Education. After receiving permission from IRB to begin data collection and after receiving permission from appropriate district personnel, I extracted data from these sources to an EXCEL file and assigned a unique identification number. I did not include dentifying participant data, assuring anonymity of all students. I was the only person to see the raw data. Computer files that were used as “working” files to analyze data (EXCEL and SPSS) were password-protected and stored only on my home computer. Because this study used only archived data, involved no additional student participation, and contained only de-identified data, the risk associated with confidentiality and protection from harm was minimal.

Section 4: Presentation And Analysis of Data

The purpose of this study was to determine the effectiveness of a three-week summer intervention program in improving student achievement on the second attempt to pass the GATEWAY mathematics exam and to determine the effectiveness of the program in improving achievement in subsequent mathematics courses, overall achievement (measured by GPA and number of math classes failed after the intervention), and attendance patterns. Hence there are five dependent variables and one independent factor/group: the treatment and control group. Rather than run five separate univariate tests of statistical inference using *t* tests or ANCOVAS, a Multiple Analysis of Covariance (MANCOVA) was chosen as the most appropriate test. A multivariate analysis of covariance (MANCOVA) is an extension of the ANCOVA model, in which it is possible to test the effects of one or more independent variables on multiple dependent variables. The calculation involved in computing the multivariate F statistic in this case is a complex mathematical procedure that uses matrix algebra. A significant MANCOVA result tells the researcher that there exists a linear combination of the dependent variables that is separating the two groups, whereas subsequent univariate F tests allow the researcher to examine which of the dependent variables are contributing to this difference. The alpha level is kept constant. Therefore, using MANCOVA reduces the chance of a Type I error that could occur when multiple *t* tests or ANOVAS are used instead (Gravetter & Wallnau, 2005; Lix & Keselman, 1998; Wilcox, 2001). MANCOVA is considered a better choice than using multiple *t* tests because it measures interactions among the dependent variables with their covariates, thus allowing for the control of pregroup differences. Before using MANCOVA, it is standard procedure to conduct pretests on data to ensure that two basic assumptions—normality of dependent variables and homogeneity of variances—were not violated. The following sections detail the pretests that were conducted to address each of these assumptions.

Testing MANCOVA Assumptions

Normal Distribution

MANCOVA requires that all dependent variables as well as their corresponding covariates be normally distributed within each group. Data for normal distributions, when displayed in line plots or histograms, exhibit a uni-modal, symmetrical bell-shaped curve. Normal distributions contain data that cluster near the mean and contain relatively few examples at one extreme or another. Data sets that are not normally distributed will show evidence of *skewness* or *kurtosis*. Skewness, which can be measured in positive or negative values, refers to the asymmetry of the probability distribution of data. A negative skew indicates that the tail on the left side of a probability distribution is more extended than the right side and that more data members (including the median) lie to the right of the mean. A positive skew indicates that the tail on the right side is more extended than the left side and more values lie to the left of the mean. Kurtosis measures whether data are peaked or flat relative to a normal distribution. Data sets containing high kurtosis display one or more distinct peaks near the mean, decline rapidly, and have heavy tails. Data sets containing low kurtosis are flatter near the mean.

To check for significant skewness or kurtosis, descriptive statistics were conducted using SPSS for both the summer intervention group (shown in Table 1) and the comparison group (shown in Table 2).

Table 1

Descriptive Statistics for Summer Group

						Skewness		Kurtosis	
Dependent Variable	N	Min	Max	Mean	Std Dev	Statistic	Std Err	Statistic	Std Err
Student's 1st Gateway Score	118	1	30	25.68	4.232	-2.591	.223	9.913	.442
Student's 2nd Gateway Score	118	18	47	35.56	5.142	-0.341	.223	0.502	.442
Math Grade Before Intervention	118	42	97	75.90	8.151	-0.744	.223	2.438	.442
Math Grade After Intervention	118	10	95	72.85	12.025	-1.321	.223	2.819	.442
GPA Before Intervention	118	0.222	3.556	1.80	0.620	0.044	.223	0.377	.442
GPA After Intervention	118	0.000	3.250	1.90	0.760	-0.468	.223	-0.136	.442
Failed Before Intervention	118	0	4	0.32	.750	2.734	.223	7.774	.442
Failed After Intervention	118	0	4	0.61	1.030	1.705	.223	2.106	.442
Absences Before Intervention	118	0	49	6.33	6.729	3.157	.223	14.854	.442
Absences After Intervention	118	1	35	5.68	5.726	2.273	.223	6.624	.442

Table 2

Descriptive Statistics for Regular School Year Group

						Skewness		Kurtosis	
	N	Min	Max	Mean	Std Dev	Statistic	Std Err	Statistic	Std Err
Student's 1st Gateway Score	98	0	29	22.87	4.714	-1.322	.244	4.361	.483
Student's 2nd Gateway Score	98	16	46	31.14	6.166	-0.116	.244	0.452	.483
Math Grade Before Intervention	98	24	94	73.70	12.751	-1.482	.244	3.440	.483
Math Grade After Intervention	98	16	95	69.15	15.205	-1.222	.244	2.331	.483
GPA Before Intervention	98	0.000	3.250	1.65	0.758	-0.216	.244	-0.769	.483
GPA After Intervention	98	0.000	3.750	1.80	0.870	-0.275	.244	-0.560	.483
Failed Before Intervention	98	0	4	0.80	1.093	1.239	.244	0.502	.483
Failed After Intervention	98	0	4	0.79	1.178	1.395	.244	0.802	.483
Absences Before Intervention	98	1	48	8.31	8.388	2.483	.244	7.727	.483
Absences After Intervention	98	1	50	8.32	8.966	2.510	.244	7.384	.483

Many statisticians maintain that skewness and kurtosis become significant when data values are found to be more than approximately two standard errors either side of zero. As Tables 1 and 2 show, seven of the ten dependent variables and covariates exhibited significant degrees of either skewness or kurtosis or both. Only pretest-GPA averages and total-GPA averages fell within acceptable values for both indicators. Figure 1 and Figure 2 are histograms that graphically depict skewness and kurtosis for 2 of the 15 variables (final grades in mathematics classes and absences).

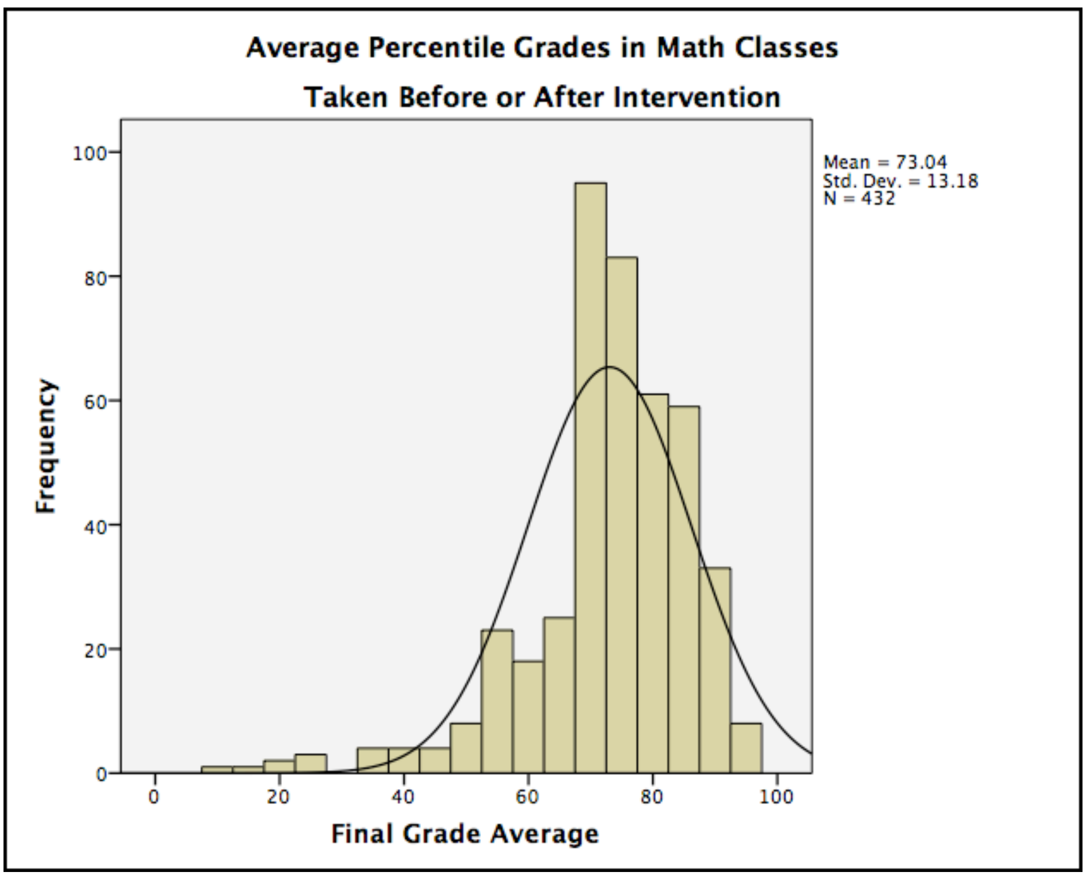


Figure 1. Histogram showing the final grade average in math classes taken before and after intervention. Note significant skewness, kurtosis, and several outliers that fall more than three standard deviations below the mean.

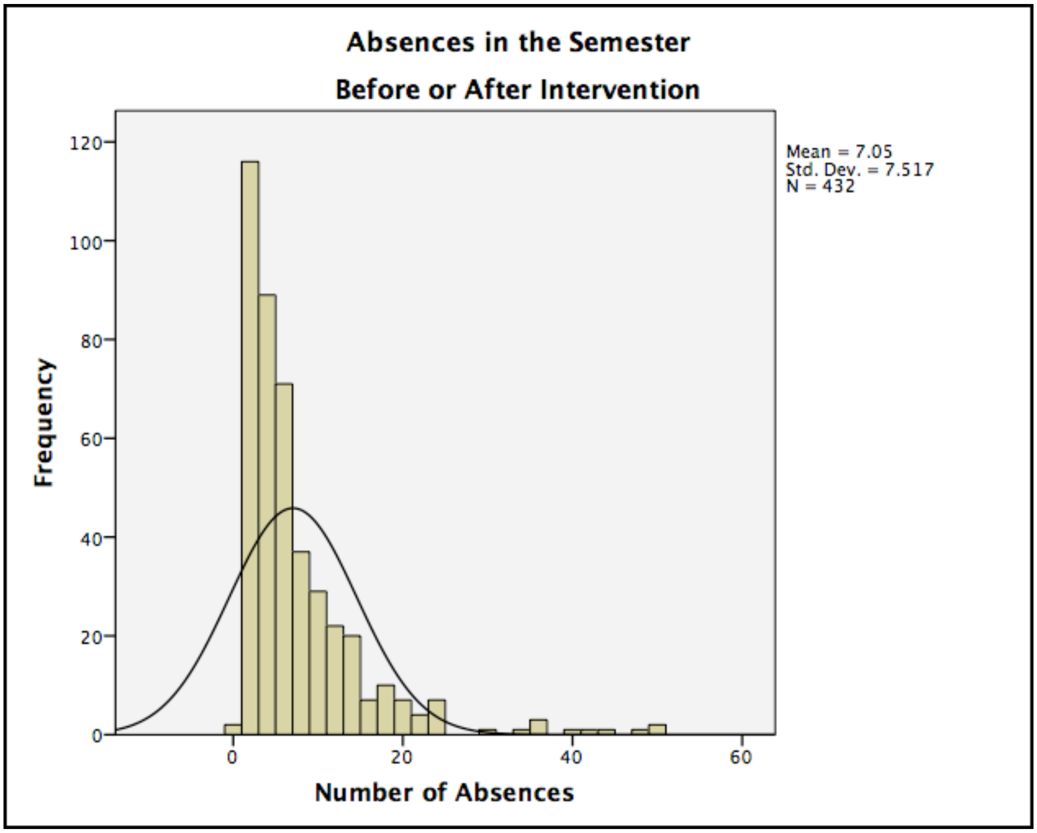


Figure 2. Histogram showing the number of semester absences before and after intervention. Note significant skewness, kurtosis, and several outliers that fall more than three standard deviations above the mean.

Homogeneity of Variances and Equality of Covariance

An Analysis of Covariance (ANCOVA) requires that the variances of the dependent variables between groups be non-significantly different. Because of the interplay among the dependent variables, a MANCOVA is more stringent and also requires that the covariance matrices be non-significantly different between groups. Levene's Test of Equality of Error Variances was used to test the null hypothesis that the error variance of the dependent variables was equal across groups. Results from the test (shown in Table 3) indicated that one of the variables, absences after intervention, failed to have equal error variances between the intervention and comparison groups.

Table 3

Levene's Test of Equality of Error Variances

Dependent Variable	F	df1	df2	Significance
Student 2nd GATEWAY score	.548	1	214	.460
Math Final Average After Intervention	.151	1	214	.698
GPA After Intervention	4.265	1	214	.040
Classes Failed After Intervention	1.114	1	214	.292
Absences After Intervention	14.665	1	214	.000

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
Design: Intercept + GWTest1 + PreMath + PreGPA + PreFail + PreAbsence + SumORReg

An immediate cause for concern was that there was a significant difference in error variances across the grade point average (F=4.265, p = 0.040) and absences (F=14.665, p <0.001) groups.

Box's M statistic (shown in Table 4), which is used to test for homogeneity of covariance matrices (George & Mallery, 2005), produces an F approximation used to compute its significance. Results from the Box's M statistic, which tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups, revealed that p < 0.000. This indicated that there were significant differences between the covariances of the dependent and covariate matrices.

Table 4

Box's M Test of Equality of Covariance Matrices

Box's M	F	df1	df2	Significance
53.204	3.457	15	171384.398	.000

Note. Box's M Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.
Design: Intercept + GWTest1 + PreMath + PreGPA + PreFail + PreAbsence + SumORReg

Violations of MANCOVA Assumptions

Many authors insist that researchers should seek other alternatives to using MANCOVA when basis assumptions are violated. Gravetter and Wallnau (2005) maintained that the assumption of a normal distribution generally is less a cause for concern than the failure of data to contain homogeneity of variances among populations. Some authors suggest that, in order for MANCOVA to be appropriate, a significant relationship between dependent variables with their covariates and homogeneity of variances between groups must be satisfied (J. P. Stevens, 2009). Conversely, others maintain that violations to normality are not terribly serious in ANCOVA and MANCOVA (Glass, Peckham, & Sanders, 1972).

Most, if not all, of the violations of MANCOVA assumptions in this study seem to be attributed to some degree by the presence of *outlier*s. An outlier is a data value that lies outside the overall pattern of a distribution (Moore & McCabe, 1999). Outliers often play a significant effect in influencing the mean and standard deviation values of a data set and also contribute to whether data sets have normal or abnormal distributions.

Outliers also directly influence the skewness and kurtosis of data distributions.

Although no standard definition exists for an outlier, some authors consider a data value to be an outlier if its corresponding *z*-score lies outside three standard deviations (Sincich, 1986) or four standard deviations on either side of the mean (M. S. Younger, 1979). According to the Empirical Rule, 99.7% of all data in a normal distribution lies within three standard deviation of the mean. Table 5 illustrates the number of outliers that should be expected in a normal distribution within three standard deviations of the mean for each dependent variable and its covariate as well as the number of outliers that were actually present within the data.

Normalizing the Data

Researchers recommend many remedies to address circumstances when data does not form a normal distribution, when variances are unequal, and when multivariate normality is not present. These include classical methods such as (a) using software programs to generate Monte Carlo simulations (research with dummy data) (Thompson, Green, Stockford, Yu, & Lo, 2002); (b) use of non-parametric test such as the Whitney-Mann-Wilcoxon test (Gibbons, 1993; Keselman & Zumbo, 1997); (c) “robust” procedures such as trimmed means (where outliers in both tails are omitted) and Winsorized variances to deal with the problem of multiple violations (Yuen, 1974); and (d) data transformation designed to change an abnormal data set into one with a normal distribution (Behrens, 1997; Ferketich & Verran, 1994; Rasmussen & Dunlap, 1991).

Table 5

Number of Expected Outliers in Dependent and Covariate Data Groups

Data Group	N	Expected Outliers	Actual Outliers	Ratio of Actual Outliers to Expected Outliers
GATEWAY scores 1^{st} attempt	216	0.648	2	3.09
GATEWAY scores 2^{nd} attempt	216	0.648	0	0.00
Average in Previous Mathematics Class	216	0.648	6	9.26
Average in Subsequent Mathematics Class	216	0.648	6	9.26
Previous GPA	216	0.648	0	0.00
Subsequent GPA	216	0.648	0	0.00
Classes Failed Before Intervention	216	0.648	3	4.63
Classes Failed After Intervention	216	0.648	6	9.26
Absences Before Intervention	216	0.648	5	7.72
Absences After Intervention	216	0.648	5	7.72

I chose data transformation to address observed violations of MANCOVA assumptions. This was accomplished using the five-step process shown below:

- Each dependent and covariate data value (e.g., 1^{st} GATEWAY score and 2^{nd} GATEWAY score was pasted into a new column in an EXCEL worksheet and then sorted from “high” to “low” order.
- The RANK(x) command was used to assign a rank to each data value.
- The ranks were adjusted to reflect “ties” when data values were equal. For example, if two values ranked 12, they were changed to 12.5, since one of them

would be 12 and the other would be 13. If there were five 12's, they were changed to 14, which is the average of 12, 13, 14, 15, and 16.

- Using given functions, a normal order statistic median (NOSM) value was calculated for each data value based on its rank.
- Finally, the NORMSINV function was used to convert the NOSM values into normalized z-scores for the data.

The purposes of normalizing the data were to (a) eliminate or significantly reduce skewness and kurtosis associated with the raw data; (b) create homogeneity of variances across the two populations (experimental and control groups), and (c) create multivariate normality across each dependent variable and its covariate group. As shown in Table 6 and Table 7, the degree of skewness and kurtosis was decreased substantially by the data transformation.

Results from the Box's M statistic using the normalized data (shown in Table 8) revealed that $p < 0.000$. Although significant differences still exist between the covariances of the dependent and covariate matrices at an alpha level of .05, it is clear that normalizing data reduced those differences substantially.

Table 6

Descriptive Statistics for Summer Group Using Normalized Data

Dependent or Covariate Variable	N	Min	Max	Mean	Std Dev	Skewness Statistic	Skewness Std Err	Kurtosis Statistic	Kurtosis Std Err
Student’s 1st Gateway Score	118	-2.66	.32	-.46	.56	-1.426	.223	2.199	.442
Student’s 2nd Gateway Score	118	-1.61	2.95	.92	.69	-.311	.223	1.529	.442
Math Avg Before Intervention	118	-1.83	2.95	.14	.76	.295	.223	.675	.442
Math Avg After Intervention	118	-3.05	2.57	.03	1.14	-.057	.223	-.464	.442
GPA Before Intervention	118	-2.34	2.66	.02	.80	.403	.223	1.281	.442
GPA After Intervention	118	.1.83	2.66	.27	1.00	.199	.223	-.313	.442
Failed Before Intervention	118	-.43	2.26	-.15	.59	1.984	.223	3.071	.442
Failed After Intervention	118	-.43	2.26	.07	.77	1.205	.223	.215	.442
Absences Before Intervention	118	-2.78	2.66	-.09	.97	-.033	.223	.180	.442
Absences After Intervention	118	-1.51	2.08	-.18	.92	.293	.223	-.590	.442

Table 7

Descriptive Statistics for Regular School Year Group Using Normalized Data

Dependent or Covariate Variable	N	Min	Max	Mean	Std Dev	Skewness Statistic	Skewness Std Err	Kurtosis Statistic	Kurtosis Std Err
Student’s 1st Gateway Score	98	-3.05	0.13	-0.88	0.65	-.477	.244	.309	.483
Student’s 2nd Gateway Score	98	-1.91	2.50	0.33	0.87	-.331	.244	.666	.483
Math Avg Before Intervention	98	-2.22	2.30	0.03	0.98	.035	.244	-.187	.483
Math Avg After Intervention	98	-2.66	2.57	-0.27	1.05	.222	.244	-.178	.483
GPA Before Intervention	98	-1.82	2.08	-0.10	.90	-.016	.244	-.555	.483
GPA After Intervention	98	-2.01	2.66	0.25	1.14	.218	.244	-.497	.483
Failed Before Intervention	98	-0.43	2.26	0.22	0.80	.725	.244	-.821	.483
Failed After Intervention	98	-0.43	2.26	0.19	0.84	.949	.244	-.418	.483
Absences Before Intervention	98	-1.51	2.50	0.20	0.98	-.020	.244	-.404	.483
Absences After Intervention	98	-1.51	2.66	0.18	0.96	.252	.244	-.332	.483

Table 8

Box's M Test of Equality of Covariance Matrices Using Normalized Data

Box's M	F	df1	df2	Significance
26.091	1.695	15	165428.709	.045

Note: Box's M Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.
Design: Intercept + GW1Transf + PreMathTf + PreGPATf + PreFailTf + PreAbsenceTf + SumORReg

Figure 3 and Figure 4 (shown below) provide a side-by-side comparison of how normalized data values reduced the number of outliers and provided a more normal distribution suitable for MANCOVA tests.

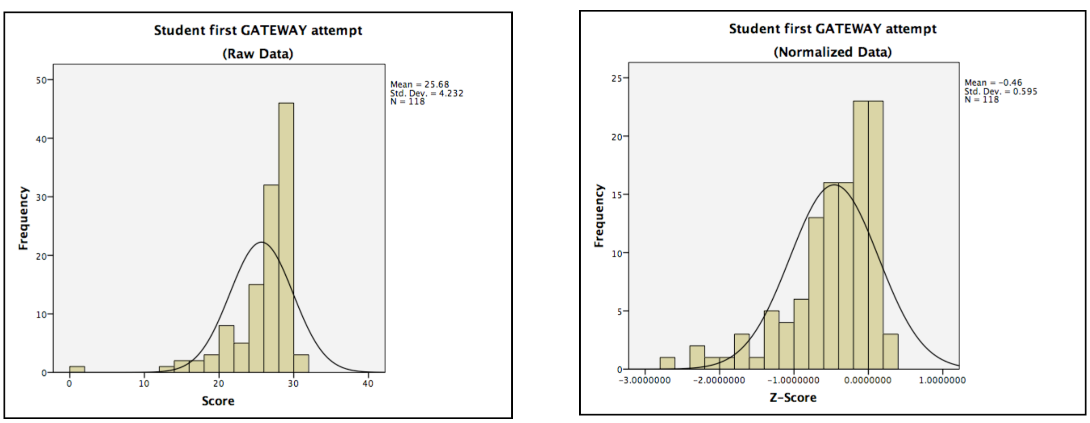
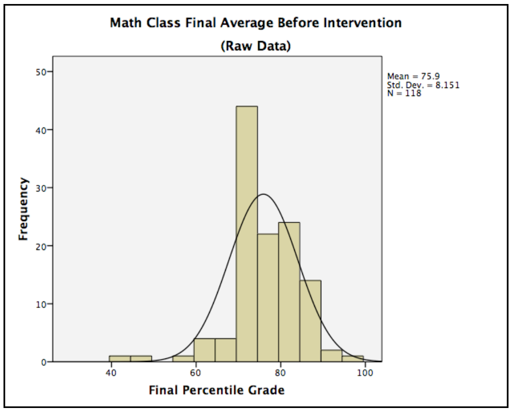


Figure 3. Side-by-side histograms showing the effect of data normalization on student gateway scores (1st attempt)



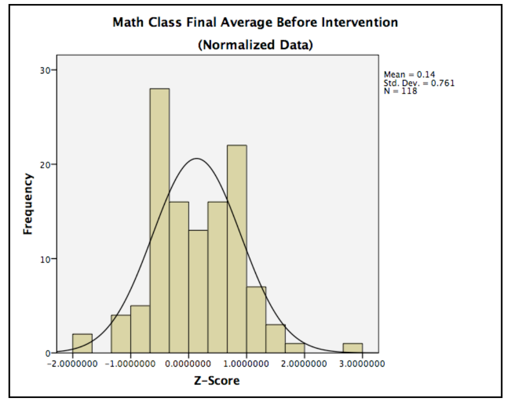


Figure 4. Side-by-side histograms showing the effect of data normalization on student final math classes averages before intervention

For completeness, the MANCOVA was run on both the raw and the transformed data sets. The next two sections report the results of data analysis using raw data and transformed data.

Results of Analysis of Raw Data

A multivariate analysis was conducted on five student academic performance indicators (GATEWAY scores, final mathematics class averages, grade point averages, number of failed courses, and number of absences) to determine the effects of the intervention program in which they participated (3-week summer program or regular semester course). Initial GATEWAY scores and the other four students' performance indicators before their intervention program were used as covariates. The assumption of variance-covariance homogeneity was not satisfied, but Brown (1996) indicated that violations of that assumption present a problem only if the data values are norm-referenced and are being used for norm-referencing. He further maintained that skewed distribution might be desirable for criterion-referenced indicators. For example, students who show improvement on an achievement test (positively skewed distribution) after a course of study may be demonstrating that teaching and learning did indeed take place. This is especially true if scores were very low (negatively skewed distribution) at the beginning of the course.

The MANCOVA test showed an overall significant effect of the 3-week summer intervention program on GATEWAY test scores, mathematics class averages, grade point averages, number of course passed, and attendance ($F = 5.024$, $p < 0.001$). Descriptive statistics of regular school term group versus summer program group on pre- and post-student achievement performance indicators are shown in Table 9 and multivariate results are given in Table 10. Univariate F tests, shown in Table 11, were then generated to determine which indicators contributed to the overall significance of the findings. In the following section, I report the results of the univariate F tests using raw data for each research question and corresponding hypotheses.

RQ1: What is the relationship between academic intervention (i.e., summer intervention involvement versus Algebra 1 course completion) and student achievement, as measured by GATEWAY math scores?

H_O1: There is no significant difference in student achievement, as measured by GATEWAY mathematics scores, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

H_A1: There is a significant difference in student achievement, as measured by GATEWAY mathematics scores, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

This null hypothesis was rejected because the univariate *F* test indicated a significant difference on the scores earned between the intervention and comparison groups from students' second attempt on the GATEWAY exam ($F = 18.583$, $p < 0.001$).

RQ2: What is the relationship between academic intervention (i.e., summer intervention involvement versus Algebra 1 course completion) and student academic performance, as measured by the number of absences for the next regular school semester?

H_O2: There is no significant difference in student academic performance, as measured by the number of absences for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

H_A2: There is a significant difference in student academic performance, as measured by the number of absences for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

This null hypothesis was not rejected. A univariate test indicated no significant difference between the intervention and comparison groups on attendance ($F = 2.800$, $p = 0.096$).

RQ3: What is the relationship between academic intervention (i.e., summer intervention involvement versus Algebra 1 course completion) and student academic performance, as measured by the number of absences for the next regular school semester?

H_O3: There is no significant difference in student academic performance, as measured by the final mathematics grade earned for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

H_A3: There is a significant difference in student academic performance, as measured by the final mathematics grade earned for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

This null hypothesis was not rejected since a univariate test indicated no significant difference between the intervention and comparison groups in final percentage grades earned in subsequent mathematics classes for the semester following their second attempt on the GATEWAY exam ($F = 1.849$, $p = 0.175$).

RQ4: What is the relationship between academic intervention (i.e., summer intervention involvement versus Algebra 1 course completion) and student academic performance, as measured by the number of courses passed for the next regular school semester?

H_O4: There is no significant difference in student academic performance, as measured by the number of courses passed for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

H_A4: There is a significant difference in student academic performance, as measured by the number of course passed for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

This null hypothesis was supported. A univariate test indicated no significant difference between the intervention and comparison groups in the number of classes that students passed for the semester following the summer program ($F = 0.005$, $p = 0.925$).

RQ5: What is the relationship between academic intervention (i.e., summer intervention involvement versus Algebra 1 course completion) and student academic performance, as measured by GPAs for the next regular school semester?

H_O5: There is no significant difference in student academic performance, as measured by GPAs for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

H_A5: There is a significant difference in student academic performance, as measured by GPAs for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

This null hypothesis was supported. A univariate test indicated no significant difference between the intervention and comparison groups in student grade point averages for the semester following the summer program ($F = 0.097$, $p = 0.762$).

Table 9. *Descriptive Statistics of Regular School Term Group Versus Summer Program Group on Pre- And Post- Student Achievement Performance Indicators (Raw Data).*

	Pre-data			Post-data		
	n	Mean	SD	*n*	Mean	SD
GATEWAY exam scores						
Summer program group	118	25.68	4.232	118	35.56	5.142
Regular school group	98	22.87	4.714	118	31.14	6.166
Math course final average						
Summer program group	118	75.90	8.151	118	72.85	12.025
Regular school group	98	73.70	12.751	98	69.15	15.205
Grade point average						
Summer program group	118	1.80	0.620	118	1.90	0.760
Regular school group	98	1.65	0.758	98	1.80	0.870
Number of failed classes						
Summer program group	118	0.32	0.750	118	0.61	1.030
Regular school group	98	0.80	1.093	98	0.79	1.178
Number of absences						
Summer program group	118	6.33	6.729	118	5.68	5.726
Regular school group	98	8.31	8.388	98	8.32	8.966

Table 10.

Effects of the Summer Program on Student Academic Performance Indicators Using Raw Data.

Source of Variance	Hotelling's Trace	df	Multivariate F***
Summer Program	.123	5	5.024

*** $p < 0.001$

Table 11

Univariate Test Results Using Raw Data

Dependent Variable	F	df	Significance
GATEWAY 2nd attempt	18.383	1	$p < .001$
Post- Math Class Average	1.849	1	.175
Post- GPA	.097	1	.756
Post- Number of Failed Classes	.005	1	.946
Post- Number of Absences	2.801	1	.094

Results of Analysis of Transformed Data

A multivariate analysis was also conducted on transformed data (z-scores) for the five student performance indicators to determine the relative effects of the intervention program in which they participated (3-week summer program or regular semester course). The MANCOVA test showed an overall significant effect of the 3-week summer intervention program on GATEWAY test scores, mathematics class averages, grade point averages, number of courses passed, and attendance ($F = 5.028$, $p < 0.001$). Descriptive statistics are reported in Table 12 and multivariate test results are given in Table 13. After multivariate significance was found, univariate *F* tests (Table 14) using normalized data were then run to determine which indicators contributed to the overall significance of the findings. In the following paragraphs, I report the results of the univariate *F* tests using normalized data for each research question and corresponding hypotheses

RQ1: What is the relationship between academic intervention (i.e., summer intervention involvement versus Algebra 1 course completion) and student achievement, as measured by GATEWAY math scores?

H_O1: There is no significant difference in student achievement, as measured by GATEWAY mathematics scores, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

H_A1: There is a significant difference in student achievement, as measured by GATEWAY mathematics scores, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

This null hypothesis was rejected since the univariate *F* test indicated a significant difference on the scores earned between the intervention and comparison groups from students' second attempt on the GATEWAY exam ($F = 18.383$, $p < 0.001$).

RQ2: What is the relationship between academic intervention (i.e., summer intervention involvement versus Algebra 1 course completion) and student academic performance, as measured by the number of absences for the next regular school semester?

*H_O*2: There is no significant difference in student academic performance, as measured by the number of absences for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

*H_A*2: There is a significant difference in student academic performance, as measured by the number of absences for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

This null hypothesis was not rejected. A univariate test indicated no significant difference between the intervention and comparison groups on attendance ($F = 1.547$, $p = 0.215$).

RQ3: What is the relationship between academic intervention (i.e., summer intervention involvement versus Algebra 1 course completion) and student academic performance, as measured by the number of absences for the next regular school semester?

*H_O*3: There is no significant difference in student academic performance, as measured by the final mathematics grade earned for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

*H_A*3: There is a significant difference in student academic performance, as

measured by the final mathematics grade earned for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

This null hypothesis was not rejected since a univariate test indicated no significant difference between the intervention and comparison groups in final percentage grades earned in subsequent mathematics classes for the semester following their second attempt on the GATEWAY exam ($F = 2.535$, $p = 0.113$).

RQ4: What is the relationship between academic intervention (i.e., summer intervention involvement versus Algebra 1 course completion) and student academic performance, as measured by the number of courses passed for the next regular school semester?

$H_O 4$: There is no significant difference in student academic performance, as measured by the number of courses passed for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

$H_A 4$: There is a significant difference in student academic performance, as measured by the number of course passed for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

This null hypothesis was supported. A univariate test indicated no significant difference between the intervention and comparison groups in the number of classes that students passed for the semester following the summer program ($F = 0.009$, $p = 0.925$).

RQ5: What is the relationship between academic intervention (i.e., summer intervention involvement versus Algebra 1 course completion) and student academic performance, as measured by GPAs for the next regular school semester?

H_O5: There is no significant difference in student academic performance, as measured by GPAs for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

H_A5: There is a significant difference in student academic performance, as measured by GPAs for the next regular school semester, between students who participated in a summer intervention program and students who did not participate in the program but who completed an Algebra 1 course during the following regular school year.

This null hypothesis was supported. A univariate test indicated no significant difference between the intervention and comparison groups in student grade point averages for the semester following the summer program ($F = 0.092$, $p = 0.726$)

Table 12

Descriptive Statistics of Regular School Term Group Versus Summer Program Group on Pre- And Post- Student Achievement Performance Indicators (Normalized Data)

Performance Indicator	Pre-data *n*	Pre-data Mean	Pre-data SD	Post-data *n*	Post-data Mean	Post-data SD
GATEWAY exam scores						
Summer program group	118	-.46	.56	118	.92	.69
Regular school group	98	-0.88	0.65	98	0.33	0.87
Math course final average						
Summer program group	118	.14	.76	118	.03	1.14
Regular school group	98	0.03	0.98	98	-0.27	1.05
Grade point average						
Summer program group	118	.02	.80	118	.27	1.00
Regular school group	98	-0.10	.90	98	0.25	1.14
Number of failed classes						
Summer program group	118	-.15	.59	118	.07	.77
Regular school group	98	0.22	0.80	98	0.19	0.84
Number of absences						
Summer program group	118	-.09	.97	118	-.18	.92
Regular school group	98	0.20	0.98	98	0.18	0.96

Table 13.

Effects of the Summer Program on Student Academic Performance Indicators Using Normalized Data

Source of Variance	Hotelling's Trace	df	Multivariate F***
Summer Program	.124	5	5.028

*** $p < 0.001$

Table 14

Univariate Test Results Using Normalized Data

Dependent Variable	F	df	Significance
GATEWAY 2nd attempt	18.383	1	$p < .001$
Post- Math Class Average	2.535	1	.113
Post- GPA	.092	1	.762
Post- Number of Failed Classes	.009	1	.935
Post- Number of Absences	1.547	1	.215

Summary of Findings

A multivariate analysis of covariance (MANCOVA) was chosen to measure and determine whether five academic indicators of students who participated in a three weeks summer intervention program were significantly different than students who later participated in an 18-week regular school mathematics class. Pre-tests revealed possible violations of MANCOVA assumptions (absence of normal distributions, lack of homogeneity of variances, and unequal covariances). A decision was made to use transformation techniques on the raw data to produce a more normal distribution. Then two separate MANCOVA analyses were conducted, one on the raw data and one on the transformed data. Results from the analyses revealed statistically similar results: Students who participated in the summer intervention program scored significantly higher on their second attempt on the GATEWAY exam than students who did not participate in the program. But there was no statistical difference between the summer group (treatment) and the regular school group (control) on later grade point averages, success in subsequent mathematics classes, number of failed classes, and attendance.

Section 5: Summary, Conclusions, Recommendations, And Commentary

The purpose of this study was to determine whether a 3-week summer program was effective in preparing students to pass a high-stakes test they previously failed. Results found that the summer program provided the learning experiences and practice that allowed the participants to make significantly higher scores on their second attempt than those who retook an algebra class and their second GATEWAY exam during an 18-week semester. Another result found that the summer program did not significantly affect future student attendance or academic performance during the semester immediately following the summer program.

Interpretation of Findings

The purpose of this study was to determine the effectiveness of a 3-week summer intervention program in improving student achievement on the second attempt to pass the GATEWAY mathematics exam and to determine the effectiveness of the program in improving achievement in subsequent mathematics courses, overall achievement (measured by GPA and number of math classes failed after the intervention), and attendance patterns. For this study, statistical tests were conducted to determine if participation in the summer intervention program caused students to meet academic indicators at a significantly higher level than students who did not participate in the program. Overall, students who participated in the summer program performed at a significantly higher level than students who repeated an algebra I class during the regular school year.

Research Question 1

The first research question assessed the statistical difference in students' second GATEWAY exam scores between students in the treatment group and students in the comparison group. Students who participated in the summer intervention program made significantly higher scores when they took the GATEWAY exam on their second attempt than the comparison group. Perhaps students in the summer program became more motivated to achieve because they knew that they would be able to get their test scores back more quickly. Students may have also been able to focus more on mathematics during the summer since it was the only class in which they were involved. Significant differences on test scores could also be attributed to the selective process in which students were chosen for the program. Students who made a raw score of 25 or greater on their first GATEWAY exam were invited to attend the summer program. Students who made a raw score less than 25 were allowed to attend, but they were not formally invited (parents were not contacted) or asked individually to participate. As a result of this selective process, first GATEWAY test scores from students in the summer group were higher and contained less variability than those in the comparison group. This helps to explain the presence of skewness and kurtosis as well as the lack of normality within the comparison group data set.

Research Question 2

The second research question assessed the statistical difference in final averages in subsequent mathematics courses in the following semester between students in the summer program and students in the comparison group? No statistical difference was found between the two groups. Over 90% of the students took geometry after completing

Algebra I. While transferring the individual student averages to an EXCEL spreadsheet, I observed that, in both the summer and comparison groups, there were a large percentage of students who struggled to do well in their geometry class. Although algebra skills are prerequisite and vital to geometry, students may have experienced difficulty with the visualization required to understand spatial relationships.

Research Question 3

The third research question assessed the statistical difference in student grade point averages in the following semester between students in the summer program and students in the comparison group? No significant difference was found between the two groups.

Research Question 4

The fourth research question assessed the statistical difference in the number of course failed in the following semester between students in the summer program and students in the comparison group? No significant difference was found between the two groups.

Research Question 5

The fifth research question assessed the statistical difference in the number of absences in the following semester between students in the summer program and students in the comparison group? Again, no significant difference was found between the two groups. Although it did not reach statistical significance, the mean and standard deviation on this variable were very different between the treatment group $(\mu = 5.68,\ \sigma = 5.726)$ and the comparison group $(\mu = 8.32,\ \sigma = 8.966)$.

In summary, the summer intervention program was effective in preparing students to pass their GATEWAY exam on their second attempt. On the other hand, the program did not significantly produce desired outcomes in performance during the regular school year in attendance and academic achievement.

Limitations of Research Findings

A MANCOVA was chosen as the statistical procedure to use for data analysis based on the multiple and related dependent variables to be tested and the probability of differences existing in the pre-dependent variables between groups. MANCOVA works well when there is one or more independent variable (such as in this case, the program type) and there are multiple dependent variables (test score, grade point averages number of failed classes, average in subsequent math class, and number of absences). As indicated earlier, utilization of multiple *t* tests greatly increases the likelihood of a Type I error and hence was not seriously considered as the best statistical procedure for this study.

MANCOVA has certain assumptions about the data to be analyzed that must be considered before using it for data analysis. Although there were concerns about skewness and kurtosis, MANCOVA provided the best statistical tests to determine the efficacy of the summer program. MANCOVA is beneficial because it can control the five dependent variables—test scores, GPAs, math grades in subsequent mathematics courses, number of failed courses, and number of absences—that are in theory related to each other, as evidenced by their corresponding correlation coefficients (0.143-0.794).

There were two concerns that influence the findings. First, confidence in results where MANCOVA assumptions are violated is somewhat weakened since statisticians are not in agreement about how those violations affect results. Smaller sample sizes (when $N < 250$) frequently produce abnormal data distributions that display significant levels of skewness and kurtosis (Wheeler, 1995). Monte-Carlo studies (studies which use "dummy data" which is often computer-generated) show that, randomly-generated samples of different sizes from a data set reveal that, as sample size is increased, data become more normally distributed while skewness and kurtosis decrease (McNeese, 2010).

Second, the research study examined test scores and performance indicators for students who were re-taking their GATEWAY exam for the second time. However, many students who participated in the summer program were attempting to pass the test for the third, fourth, or fifth time. As a result, a substantial number of students who passed the exam after the second attempt are not represented in this study.

Implications of the Study

As long as students fail high-stakes exams, there will be a need for remediation. The traditional method of providing this remediation required students to repeat the course during a regular school term or during an extended summer school class. This study suggests that students demonstrated greater academic performance, as shown by their scores from the second GATEWAY attempt, after participation in an intense three-week summer program compared with repeating the course during a regular school term or during an extended summer program. This study also found that success students experienced during the summer program failed to contribute significantly to their success in future mathematics classes or success in other subjects as evidenced by improved grade point averages. Findings also suggested that success during the summer program did little to motivate students to improve attendance during the subsequent regular school term.

The summer program was successful in helping participants pass their GATEWAY mathematics exams and therefore could be viewed as a positive force for social change, yet it was quite limited in its ability to address previous student weaknesses or gaps in mathematical understanding. The achievement gaps evidenced by poor student difficulty in doing well on standardized tests within this study are consistent with performance by students on a national level. Although student achievement scores have risen significantly across almost all measured demographic areas, there are still areas of major concern. According to the most recent findings from government agencies that monitor educational progress, the achievement gap between black and white students that became the catalyst for the reform efforts of the last two decades has not changed significantly (National Center for Educational Statistics, 2010a, 2010b, 2010c; Statistics, 2010). Similarly, there has been no significant reduction in the achievement gap between students who are economically disadvantaged and those who are not.

Failure to significantly lower these achievement gaps despite massive reform efforts provides strong motivation for future researchers to identify and isolate factors that could assist in empowering more students to achieve higher learning levels. The following section contains recommendations for future research based on findings from this study and from personal observations of educational trends and reform efforts during the last decade.

Implications for Social Change

NCLB (2002) was designed to ensure that all students, regardless of race or class or socioeconomic background, have equal opportunity to learn at higher levels at their fullest potential, yet many students struggle to pass high-stakes assessments that only require minimal proficiency. As a result, teachers and administrators in public school settings must initiate learning opportunities to enable students to “catch up” with grade-level expectations. The summer intervention program in this study was designed to promote higher performance among low-performing students and enable them to have a positive learning experience following disappointing results on their mathematics exam during the preceding regular school year. This study will provide empirical evidence to stakeholders about the promise of summer programs to increase student academic achievement as demonstrated by higher GATEWAY test scores, success in future mathematics courses, and grade point average. The study also measured changes in student performance by comparing school attendance before and after the summer program. A secondary goal was that participation in the summer program would positively influence future educational pursuits and inspire hope among a group of students who would otherwise perpetuate the generational cycle of poverty.

This summer program endeavored to find solutions to help struggling learners who often have deficient skills. As a result, its efficacy is important to all stakeholders: students, parents, education, and policy makers. Students who continue to be unsuccessful in school often choose to exert minimal effort or eventually drop out. It is important that stakeholders research and find strategies that work to encourage them to pursue their education. This study adds to the body of research that is dedicated to that pursuit.

Recommendations for Future Research

Before offering recommendations for future research studies, I wish to provide a framework for those recommendations by putting the historical context what “the future” means in terms of the myriad of reforms efforts that now take place in the public schools and in particular, what is taking place in the State of Tennessee.

The zeitgeist changed radically in the 1990s as published reports revealed weaknesses in United States educational achievement when compared to other industrialized nations. Reform efforts designed to increase student performance and pressure to meet accountability quotas imposed by No Child Left Behind resulted in an exponential number of experimental programs that departed from traditional and familiar patterns. One of the more recent reforms that will likely exert major influence on United States educational direction is the adoption of a national curriculum. As of this writing, 35 of the 50 state school boards have adopted the *Common Core State Standards* (CCSS), a document that outlines what students should learn at each grade level and that requires increased rigor to achieve those common standards (Common Core: State Standards Initiative, 2010).

Although the Tennessee Department of Education was one of the first state agencies to adopt the CCSS, efforts were already underway to increase the level of rigor in the GATEWAY mathematics exam. This became necessary due to substantial differences in student performance on American College Testing (ACT) exams, which most Tennessee students take as an entrance exam for college and their GATEWAY exams required for a high school diploma. Although the State of Tennessee students had consistently ranked in the top 10% of all states nationally making AYP in mathematics, students scores on ACT exams placed them in the bottom 20% of all states nationally. Other factors, such as higher rates of participation on ACT exams, contributed to the differences. But the extremity of the difference between student scores on the two exams led to a complete overhaul of curriculum frameworks. Beginning in 2010, high school GATEWAY exams will be replaced by two end-of-course exams that are geared to more effectively assess the mastery of standards considered prerequisite to college- and work-readiness. The *Explore* test will be given to eighth grade students and the *PLAN College and Readiness Test* will be given to students in the tenth grade (Tennessee High School Graduation Requirements, 2010). Because the GATEWAY test will be replaced, my recommendations for future research focuses on studies involving short-term intervention programs that focus on test remediation and recommendations for studies that address student achievement gaps in mathematics.

Future studies that use a mixed methods approach are needed to gather student and teacher input about the efficacy of summer intervention programs. Mixed methods approaches are used to “combine quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study” (R. B. Johnson & Onwuegbuzie, 2004). This study, by design, used quantitative data analysis to determine whether or not a summer intervention program produced significant differences in student academic performance indicators compared to students that did not participate. The study would have been enhanced by the additional of qualitative data, such as follow-up interviews with students and teachers, to explore their perceptions about the strengths and weaknesses of the program as well as their suggestions for improvement in future programs.

Second, future studies are needed to explore the question of whether summer intervention programs are more effective for girls than boys when classes are divided by gender. The number of single-sex classes in American high schools, which declined substantially beginning in 1960s, began to increase with the rewriting and passage of Title IX legislation of the federal Education Amendments in 2006 (Meyer, 2008). The new guidelines gave school districts legal grounds to allow single-sex public schools and classes for the first time in over 30 years as long as they provide a justifiable cause for the separate classes, offer a coeducational option as well, and evaluate the efficacy of the classes every two years. This legislation, combined with the accountability pressures to meet AYP benchmarks, caused district and local school leaders to experiment with separating boys and girls to determine whether or not they could focus more on learning. Increasing numbers of single-sex programs, coupled with the scarcity of current research on those programs, provide extensive opportunities for scholarly work.

Third, future studies are needed to determine whether the summer programs can be effective to help students who made lower than the “cut score” established by teachers as a condition for participation in the program. Teachers allowed students who made a score of 25 or higher to participate in the summer program, but they reasoned that students with lower scores would likely benefit more by repeating the class during the regular school year since this would provide 15 additional weeks to gain mastery of important algebra concepts. Future research studies might address whether short-term remediation programs hold the potential to help students with lower scores to make significant gains similar to those who were close to passing their high-stakes exams.

Fourth, future studies are needed to determine whether or not brief summer intervention programs can be effective by providing the time necessary for students to master standards in depth as required by the more rigorous mathematics frameworks that are being adopted currently in the United States. As every state moves towards more rigorous standards in all disciplines in all grades (K-12), questions have already arisen about whether students who fall behind will be able to catch up. One argument suggests that since some students are falling behind now when the standards are easier, then it is likely they will fall further behind when the standards become more difficult. Proponents of the more rigorous standards maintain that when students work cooperatively to complete difficult real-world application, their ability to demonstrate mastery of the concepts will improve as a result. Although the number of students who fail to meet standards may be reduced, there is a strong likelihood that students will continue to fall behind and need additional time to learn in order to remain on grade level. For that reason, future research will be needed to determine what type of summer programs show promise in supporting students who are falling behind.

Finally, future studies are needed in elementary and middle school grades to better identify learning gaps in order to provide remediation on a more immediate basis. An important finding from this study revealed that the summer program did not significantly affect student academic performance indicators on a long-term basis. This finding was not unexpected, since many students who participated in the study have demonstrated poor performance throughout their formal school experience, as evidenced by their elementary and middle school's substandard CRCT scores over several years. The massive body of research speaks in unison about how non-school factors play critical roles in helping to prepare children to enter school with the skills needed for success. My final recommendation suggests that more studies need to be conducted about achievement in the elementary and middle school grades to determine exactly where and why achievement gaps are occurring. To ameliorate student attendance and achievement in high school, educators must not only identify individual student deficiencies at an early age, but must constantly find and employ strategies, based on scholarly research, that prevent achievement gaps from taking place. To correct these differences will require a massive support system, much greater than the ones currently in place.

Closing Statement

Remediation programs have historically been scheduled during the summer months to allow students an opportunity to catch up with grade-level standards and be successful in later coursework. The recent practice of using high-stakes tests to assess whether student learning has taken place led to an increase in summer programs that focused on preparing students for these exams. Using student exam scores to classify schools as "successful" or "failing" institutions places considerable burden upon all educational leaders to plan and more importantly, evaluate their current programs to make sure they are performing well.

Results from this study provide strong statistical support to suggest that students who participated in the summer intervention program made higher scores on their second GATEWAY attempt than students who did not participate in the program. But the evidence also found that participation in the program was not a factor in causing an increase in student academic performance and student attendance during the following regular school year. This is consistent with research findings that maintain that student success in remediation programs does not guarantee success in future academic endeavors (Alexander, Entwisle, & Olson, 2007; Olson, 2001).

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Appendix A: Description of the Summer Invention Program

Administrators expressed disappointment when test results from the Spring 2001 administration of the GATEWAY mathematics exam were returned to the school. Since only 40.4% of students earned a passing score, it became apparent that demonstrating AYP was unlikely. Two teachers, in an attempt to give students an opportunity to retake the test, approached the principal to request his permission to conduct a remediation program during the summer. After receiving authorization, the teachers conducted two separate summer intervention programs. Students from Perry Middle School and Taylor High School who made a raw score of 25 or more on their GATEWAY test during the spring were invited to participate in a five-day review program for 90 minutes each day. Teachers decided that student GATEWAY scores lower than 25 represented a very weak understanding of the standards and reasoned that students would be better serves to repeat the course during the regular school year to work on their deficiencies. Students from Anderson Middle School were invited to a two-day review program the following Saturday and Monday for three hours each day. This group met at a local community center because the home school was being used for other workshops. The students who attended either review program were given the chance to retake the GATEWAY exam the following week. Only 26% of these students passed the exam on their second attempt.

During the following year fall and spring semesters, only 40.7% of Taylor High students passed their GATEWAY exams. A five-day summer program (2002) for three hours per day was carried out for students who had earned a raw score of at least 25. Again, students who attended the review program were given the opportunity to retake their test. When test scores were received, results revealed that only 35.2% of students passed the test. Although some improvement occurred in later years, many students failed to earn passing GATEWAY scores during the regular spring and fall semesters. Teachers who taught in the summer program expressed dissatisfaction with the number of students who continued to struggle to pass their high-stakes exam. Table 15 contains a year-by-year comparison of Taylor High's GATEWAY proficiency levels with overall Tennessee state proficiency levels.

Table A1

Comparison of Taylor High GATEWAY Proficiency Levels with Overall Tennessee State Proficiency Levels

	% Below Proficient		% Proficient		% Advanced	
School Year	Taylor High	State	Taylor High	State	Taylor High	State
2001-2002	62.3%	29.4%	33.0%	48.0%	4.7%	29.3%
2002-2003	66.1%	25.0%	35.0%	30.0%	4.0%	45.0%
2003-2004	48.1%	23.7%	46.0%	32.9%	5.9%	43.3%
2004-2005	41.6%	24.1%	48.3%	33.2%	10.1%	42.7%
2005-2006	32.7%	24.2%	49.8%	31.3%	17.5%	44.5%

Significant changes took place in the Summer 2003 intervention program. First, Taylor High School achieved Title I status, which produced a dramatic increase in funding for remediation. Six new positions—a director, an assistant director, three coaches, and one additional teacher—were added to the three-teacher staff from the previous summer. Second, the program was expanded to 15 student days and included two additional days for teacher planning and collaboration. Teachers were assigned total responsibility for designing the program and presenting recommendations to the program director.

During the collaboration and planning sessions, teachers discussed the type of remediation structure needed and the best instructional strategies to reach all students in the program. Teachers expressed that students who came to the summer program, as a rule, were weak in their understanding of mathematical standards, were not focused on learning at the level required to increase their understanding, and were failing to assume personal responsibility for learning. Teachers also agreed that student progress must be monitored more closely. These major concerns and subsequent discussion led to the following recommendations and procedures that were presented to and approved by the program director:

- Students were divided into three groups: girls in grades 9-12, boys in grades 9-12, and combined boys and girls who had completed eighth grade during the spring. Teachers believed that single-sex separation would permit students to focus more on mathematical standards than on each other, a trend that had been observed in previous summer programs.
- Teachers downloaded the Mathematics Item Sampler (IS) from the TN DOE web site (Tennessee Department of Education, 2007) to serve as the primary curriculum for the program. A copy of five selected pages from the Item Sampler is included in Appendix D. Teachers maintained that standards must be explained explicitly for students to be able to gain understanding. The items (N-88) from the IS were divided into eight parts. This resulted in about 10 items per day that teachers would address during Days 2-9 of the program. Teachers then took turns

selecting which objectives they would teach on each day. For example, if the standards represented by Items 1-10 from the Item Sampler were to be taught on Day 1, Teacher A would choose a number from one to ten to represent the item number representing the first objective that he would teach. Then, Teacher B would choose from among the nine items that were left. This process continued until all ten items had been selected. An example of lesson plans that were developed and submitted to the program director is found in Appendix C.

- Student groups rotated from one classroom to another, spending 35 minutes with each teacher. Teachers reviewed either two or three standards, assigned practice exercises specific to the standards, and checked student work by reviewing the assignment at the end of the class period.
- Students took a pretest on the first day of the program. The results were entered into an EXCEL spreadsheet and were used later in the program to help in measuring student progress after the first eight days of instruction.
- Students took daily quizzes that were designed to measure their understanding of the objectives. The scores were recorded in an EXCEL spreadsheet to monitor progress. Students who consistently failed to make 70% or higher on daily quizzes were assigned to a coach for one-on-one instruction.
- Teachers administered a posttest after all standards were addressed, usually on the tenth day of the program. After grading, teachers used an EXCEL spreadsheet to indicate each student's response on each posttest item. A value of "1" was entered to indicate a correct response while a value of "0" was entered to indicate an incorrect response. After all test results were entered, teachers used the data to

identify students who needed additional assistance and to spotlight standards that needed to be readdressed. Appendix F contains an example of a typical spreadsheet used to record students' mastery of standards.

- Teachers measured each student's progress in the program by analyzing daily quiz and posttest scores. Students who scored below 75% on the posttest or averaged less than 70% on daily quizzes worked with a tutor, either one-to-one or in small groups during Days 11-13 of the program. Students who scored 75% or greater on the posttest and averaged more than 70% on daily quizzes returned to the regular rotation. The four regular teachers reviewed the standards with which students were still struggling as revealed by their quiz and posttest results. Three daily practice quizzes are included in Appendix E.
- Students who demonstrated good performance on quizzes and posttests or obtained tutor permission took their GATEWAY exam on Day 14 of the program. These students were not required to attend the program on Day 15. Students who exhibited marginal or poor performance worked with a tutor or one of the four regular teachers and took their exam on Day 15.
- The director encouraged students at the beginning of the program to take individual responsibility for learning so that they would experience success when re-taking their GATEWAY exam. He assured them that the instructional staff in the summer program believed that all students would pass their exam. This "setting the tone" kept behavioral issues at a minimum and allowed teachers and students to focus on the learning process. Teachers commented that the positive

climate during the summer program often contrasted with negative behavior experienced during the regular school year.

There was a significant increase in the percentage of students who passed the exam in Summer 2003 compared with the percentage of students who passed the exam in Summer 2001 or Summer 2002. Table 16 contains the summary of student results from GATEWAY exams taken at the end of each summer intervention program from 2001-2007. It is important to note that this table contains all students who took the GATEWAY exam during its summer administration. Therefore, the table includes students who were taking the exam for the third or fourth time as well as students who took the test the test without participating in the summer program itself.

TABLE A2

Students Who Took the GATEWAY Mathematics Exam After Completing the 3-Week Summer Intervention Program (Treatment Group)

Participation Year	Number of Students			Number Passing			Percent Passing		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
2001	23	28	51	7	11	18	30.4%	39.3%	35.2%
2002	31	32	63	13	12	25	41.9%	37.5%	39.7%
2003	30	28	58	20	21	41	66.7%	75.0%	70.7%
2004	27	25	52	26	25	51	96.3%	100%	98.1%
2005	30	26	56	26	25	51	86.7%	96.2%	91.1%
2006	22	32	54	16	32	48	72.7%	100%	88.9%
2007	29	18	47	29	18	47	100%	100%	100%
TOTALS	192	189	381	137	144	281	71.4%	76.2%	73.8%

Note: 380 of the 381 summer program participants were African-American. The one exception was a single Caucasian male who participated in the Summer 2004 program.

Table 17 shows the number of student who took the GATEWAY mathematics exam (2nd or 3rd attempt) during the regular school year after completing a semester-long class. Data for 2001 are not shown because no student second attempts were done during the regular school year.

TABLE A3

Students Who Took the GATEWAY Mathematics Exam
After Retaking a Semester Long Algebra 1 Class (Comparison Group)

Participation Year	Number of Students			Number Passing			Percent Passing		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
2002	42	39	81	22	26	48	52.4%	66.7%	59.3%
2003	47	41	88	28	30	58	59.6%	73.2%	65.9%
2004	39	26	65	28	18	46	71.8%	69.2%	70.8%
2005	29	20	49	18	13	31	62.1%	65.0%	63.3%
2006	34	21	55	21	16	37	61.8%	76.2%	67.3%
2007	22	22	44	14	15	29	63.6%	68.2%	65.9%
TOTALS	213	169	382	131	118	249	61.5%	69.8%	65.2%

Appendix B: Tennesseee Gateway Mathematics Performance Indicators by Domain and Level of Difficulty

DOMAIN: Numbers and Operations

Level	Performance Indicator
1	Select the best estimate for the coordinate of a given point on a number line (only rational)
1	Identify the opposite of a rational number
1	Determine the square root of a perfect square less than 169
1	Use exponents to simplify a monomial written in expanded form without the use of parenthesis
1	Apply order of operations when computing with integers using no more than two sets of grouping symbols and exponents 1 and 2
1	Select a reasonable solution for a real-world division problem in which the remainder must be considered
2	Order a given set of rational numbers (both fraction and decimal notations)
2	Identify the reciprocal of a rational number
2	Add and subtract algebraic expressions
2	Multiply two polynomials with each factor having no more than two terms
2	Use estimation to determine a reasonable solution for a tedious arithmetic computation
2	Select ratios and proportions to represent real-world problems (e.g. Scale drawings, sampling, etc.)
3	Apply the concept of slope to represent rate of change in a real-world situation

DOMAIN: Algebra

LEVEL	PERFORMANCE INDICATOR
1	Extend a numerical pattern
1	Translate a verbal expression into an algebraic expression or vice versa
1	Evaluate a first degree algebraic expression given values for one or more variables
1	Solve one- and two-step linear equations using integers (with integral coefficients and constants)
2	Select the algebraic notation which generalizes the pattern represented by data in a given table
2	Translate a verbal sentence into an algebraic equation or vice versa
2	Select the graph that represents a given linear function expressed in slope-intercept form
2	Solve multi-step linear equations (more than two steps, variables on one side of the equation with no use of parentheses)
2	Solve multi-step linear equations (more than two steps, with variables on both sides of the equation with no use of parentheses)
2	Solve multi-step linear equations (more than two steps, with one set of parentheses on each side of the equation)
2	Select the linear graph that models the given real-world situation described in a narrative (no data set given)
2	Select the linear graph that models the given real-world situation described in a tabular set of data or vice versa
2	Evaluate an algebraic expression given values for one or more variables using grouping symbols and/or exponents less than four
2	Determine the slope from the graph of a linear equation
2	Apply the concept of rate of change to solve real-world problems
2	Select the appropriate graphical representation on the coordinate plane of a linear inequality (given in standard form or slope-intercept form)

DOMAIN: Algebra (continued)

LEVEL	PERFORMANCE INDICATOR
2	Select the non-linear graph that models the given real-world situation or vice versa
2	Identify the graphical representation of the solution to a one variable inequality on a number line
3	Solve multi-step linear inequalities in real-world situations
3	Recognize the graphical transformation that occurs when coefficients and/or constants of the corresponding linear equations are changed
3	Determine the domain and/or range of a function represented by the graph of real-world situations
3	Select the system of equations that could be used to solve a given real-world problem (Assessed beginning 2005-2006)
3	Find the solution to a quadratic equation given in standard form (integral solutions and a leading coefficient of one) (Assessed beginning 2005-2006)
3	Select the solution to a quadratic equation given solutions represented in graphical form (integral solutions and a leading coefficient of one) (Assessed beginning 2005-2006)
3	Select one of the factors (e.g., x + 3) of a quadratic equation (integral solutions and a leading coefficient of one) (assessed beginning 2005-2006)
3	Select the discriminant of a quadratic equation (integral solutions and a leading coefficient of one) (Assessed beginning 2005-2006)
3	Solve multi-step linear inequalities in real-world situations
3	Recognize the graphical transformation that occurs when coefficients and/or constants of the corresponding linear equations are changed

DOMAIN: Geometry

LEVEL	PERFORMANCE INDICATOR
1	Identify ordered pairs in the coordinate plane
2	Apply the given Pythagorean Theorem to a real life problem illustrated by a diagram (no radicals in answer)
2	Apply proportion and the concepts of similar triangles to find the length of a missing side of a triangle
3	Calculate the distance between two points given the Pythagorean Theorem and the distance formula

DOMAIN: Measurement

LEVEL	PERFORMANCE INDICATOR
1	Estimate the area of irregular geometric figures on a grid
1	Calculate rates involving cost per unit to determine the best buy (no more than four samples)
1	Apply the given formula to determine the area or perimeter of a rectangle
2	Apply the given formula to find the area of a circle, the circumference of a circle, or the volume of a rectangular solid
3	Select the area representation for a given product of two one-variable binomials with positive constants and coefficients

DOMAIN: Data Analysis and Probability

LEVEL	PERFORMANCE INDICATOR
1	Determine the mean (average) of a given set of real-world data (no more than five two-digit numbers)
1	Interpret bar graphs representing real-world data
1	Interpret circle graphs (pie charts) representing real-world data
2	Choose the matching linear graph given a set of ordered pairs
2	Make a prediction from the graph of a real-world linear data set
2	Determine the median for a given set of real-world data (even number of data)
3	Compute the probability of a simple compound event (2 independent events, no more than 6 possibilities per event)

Appendix C: Lesson Plans for Gateway Summer Program

June 15-June 29, 2005

All Algebra I GATEWAY students were divided into 4 groups. Listed below are the indicators taught by date. The number preceding the indicator is the corresponding number on the state ITEM SAMPLER.

Monday, June 20, 2005

TEACHER A	TEACHER B	TEACHER C	TEACHER D
4 – identify the opposite of a rational number 7 - order a given set of rational numbers (both fraction and decimal notations) 12 - apply order of operations when computing with integers	2 – select the best estimate for the coordinate of a given point on the number line 9, 10 – select ratios and proportions to represent real-world problems	1 – select the best estimate for the coordinate of a given point on the number line 3 – identify the opposite of a rational number 6 - order a given set of rational numbers (both fraction and decimal notations)	5 – determine the square root of a perfect number less than 169 8 – identify the reciprocal of a rational number 11 – select the best estimate for the coordinate of a given point on the number line

Tuesday, June 21, 2005

TEACHER A	TEACHER B	TEACHER C	TEACHER D
16 – use exponents to simplify a monomial written in expanded form 19 – add and subtract algebraic expressions 23- extend a numerical pattern	18 – add and subtract algebraic expressions 20 – multiply two polynomials with each factor having no more than two terms 21 – select the area representation for a given product of two 0ne-variable binomials with positive constants and coefficients	13 – select a reasonable solution for a real-world problem in which the remainder must be considered 15- use estimation to determine a reasonable solution for a tedious arithmetic computation 22 – extend a numerical pattern	14- use estimation to determine a reasonable solution for a tedious arithmetic computation 17 – use exponents to simplify a monomial written in expanded form 24- translate a verbal expression into an algebraic expression

Wednesday, June 22, 2005

TEACHER A	TEACHER B	TEACHER C	TEACHER D
25 – evaluate a first degree algebraic expressing given values of one or more variables 34 – solve multi-step line equations (more than two steps, variables on both sides of the equation) 36 – select the appropriate graphical representation of a given linear inequality	29 – select the algebraic notation which generalizes the pattern represented by data in a given table 32 – translate a verbal sentence into an algebraic equation 33 – solve multi-step line equations (more than two steps, variables on both sides of the equation)	27 – evaluate an algebraic expression given values for one or more variables using grouping symbols and/or exponents less than four 28 – solve one- and two-step linear equations using integers 30 – select the algebraic notation which generalizes the pattern represented by data in a given table	26 – evaluate an algebraic expression given values for one or more variables using grouping symbols and/or exponents less than four 31 – translate a verbal sentence into an algebraic equation 35 – solve multi-step linear equations (more than two steps, with one set of parentheses on each side of the equation)

Thursday, June 23, 2005

TEACHER A	TEACHER B	TEACHER C	TEACHER D
37 – select the appropriate graphical representation of a given linear inequality 38 – identify the graphical representation of the solution to a one variable inequality on a number line	39– identify the graphical representation of the solution to a one variable inequality on a number line 44 – solve multi-step linear inequalities in real-world situations	40, 41 – apply the concept of slope to represent rate of change in a real-world situation	42 – calculate rates involving cost per unit to determine the best buy (no more than three samples) 43 – apply the concept of rate of change to solve real-world problems

Friday, June 24, 2005

TEACHER A	TEACHER B	TEACHER C	TEACHER D
46 – solve multi-step linear inequalities in real-world situations 47 – determine the mean (average) of a given set of real-world data 50 – interpret circle graphs (pie charts) representing real-world data	45 – solve multi-step linear inequalities in real-world situations 49 – interpret bar graphs representing real-world data 54 – apply counting principles of permutations or combinations in real-world situations	53, 55 – apply counting principles of permutations or combinations in real-world situations 56 – select the graph that represents a given linear function expressed in slope-intercept form	48 – interpret bar graphs representing real-world data 51 – interpret circle graphs (pie charts) representing real-world data 52- determine the median for a given set of real-world data (even number of data)

Monday, June 27, 2005

TEACHER A	TEACHER B	TEACHER C	TEACHER D
59, 60 – determine the slope from the graph of a linear equation (no labeled points) 63 – recognize the graphical transformation that occurs when coefficients and/or constants of the corresponding linear equations are changed	57 – select the graph that models the given real-world situation described in a narrative (no data points given) 62 – recognize the graphical transformation that occurs when coefficients and/or constants of the corresponding linear equations are changed 65 – determine the domain and/or range of a function represented by the graph of real-world situations	58 – select the linear graph that models the given real-world situation described in a tabular set of data 61 – select the non-linear graph that models the given real-world situation or vice versa 64 – recognize the graphical transformation that occurs when coefficients and/or constants of the corresponding linear equations are changed	66, 67 – identify ordered pairs in the coordinate plane 68 – choose the matching linear graph given a set of ordered pairs

Tuesday, June 28, 2005

TEACHER A	TEACHER B	TEACHER C	TEACHER D
69 – choose the matching linear graph given a set of ordered pairs 71 – make a prediction from the graph of a real-world linear data set	74 – extend a geometric pattern 75 – estimate the area of irregular geometric figures on a grid 78 – apply the given formula to find the area of a circle, the circumference of a circle, or the volume of a rectangular solid	72 – make a prediction from the graph of a real-world linear data set 76 – apply the given formula to determine the area or perimeter of a rectangle 80 – apply the given formula to find the area of a circle, the circumference of a circle, or the volume of a rectangular solid	70 – choose the matching graph given a set of ordered pairs 73 – extend a geometric pattern 77 – apply the given formula to determine the area or perimeter of a rectangle

Wednesday, June 29, 2005

TEACHER A	TEACHER B	TEACHER C	TEACHER D
79 – apply the given formula to find the area of a circle, the circumference of a circle, or the volume of a rectangular solid 88 – calculate the distance between two points given the Pythagorean Theorem and the distance formula	85 – apply proportion and the concepts of similar triangles to find the length of a missing side of a triangle 86 – calculate the distance between two points given the Pythagorean theorem and the distance formula	81 – apply the Pythagorean Theorem to a real life problem illustrated by a diagram (no radicals in answer) 83 – apply proportion and the concepts of similar triangles to find the length of a missing side of a triangle	82 – apply the Pythagorean Theorem to a real life problem illustrated by a diagram (no radicals in answer) 84 – apply proportion and the concepts of similar triangles to find the length of a missing side of a triangle

Appendix D: Selected Pages from Gateway Item Sampler

Reporting Category 1: **Number Sense/Theory**
Numbers 1 through 14

Performance Indicator: Select the best estimate for the coordinate of a given point on a number line (only rational).

1 Which point on the number line is closest to $-2\frac{7}{16}$?

A Point A
B Point B
C Point C
D Point D

GM010062

Performance Indicator: Identify the opposite of a rational number.

2 What is the opposite of -0.65?

F -0.56
G -0.35
H 0.13
J 0.65

GM010179

Performance Indicator: Determine the square root of a perfect square less than 169.

3 What is the square root of 100?

A 10
B 20
C 50
D 10,000

GM010379

Reporting Category 2: Algebraic Expressions

Numbers 15 through 25

Performance Indicator: Use exponents to simplify a monomial written in expanded form without the use of parentheses.

15 Simplify: $2 \bullet 2 \bullet 2 \bullet x \bullet x \bullet y \bullet y$

A $6x^2y^2$

B $8x^2y^2$

C $6 + 2x + 2y$

D $8 + 2x + 2y$

GM020007

Performance Indicator: Add and subtract algebraic expressions.

16 Which expression is equivalent to $(-2x + 5) - (-3x + 2)$?

F $x + 3$

G $x + 7$

H $-5x + 3$

J $-5x + 7$

GM020256

17 Which of the following is equivalent to $\left(-6x^4 - 9x^3 - 2x\right) + \left(-3x^3 - 2x^2 + x\right)$?

A $-6x^4 - 6x^3 + 2x^2 - 3x$

B $-6x^4 - 12x^3 - 2x^2 - x$

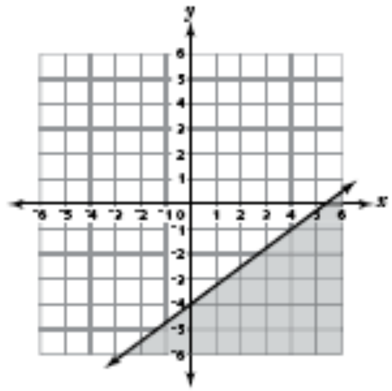
C $-6x^4 - 12x^3 + 2x^2 - 3x$

D $-9x^4 - 11x^3 - x$

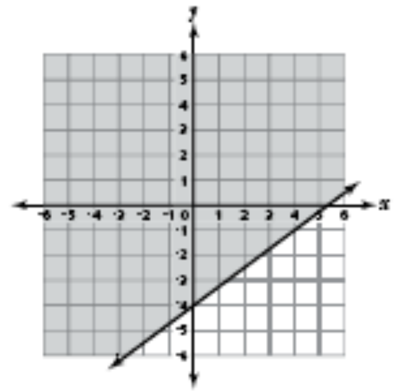
GM010271

Performance Indicator: Select the appropriate graphical representation on the coordinate plane of a given linear inequality (given in standard form or slope-intercept form).

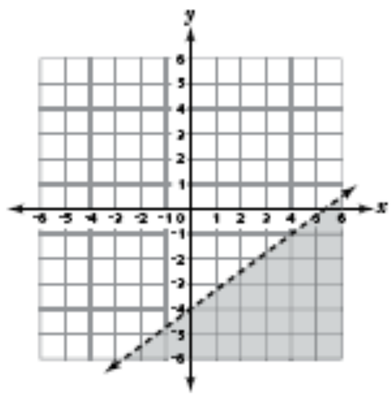
33 Which of these graphs <u>best</u> represents $y \leq \frac{3}{4}x - 4$?



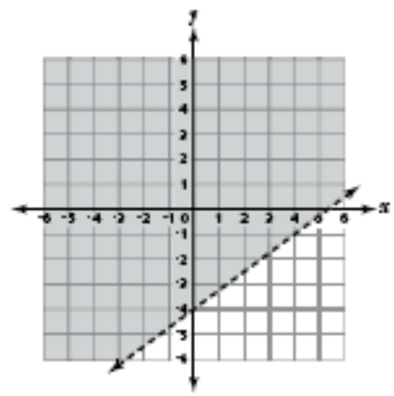
A



C



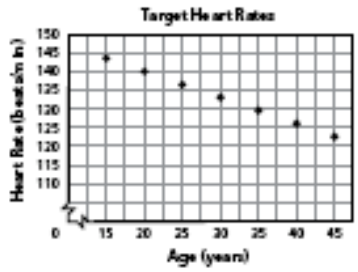
B



D

GM010261

57 The graph below shows the target heart rates during exercise for individuals based on their age.



Which table most closely matches the graph?

Age (years)	Heart Rate (beats/min)
45	143.5
40	140
35	136.5
30	133
25	129.5
20	126
15	122.5

A

Age (years)	Heart Rate (beats/min)
15	143.5
20	140
25	136.5
30	133
35	129.5
40	126
45	122.5

B

Age (years)	Heart Rate (beats/min)
143.5	15
140	20
136.5	25
133	30
129.5	35
126	40
122.5	45

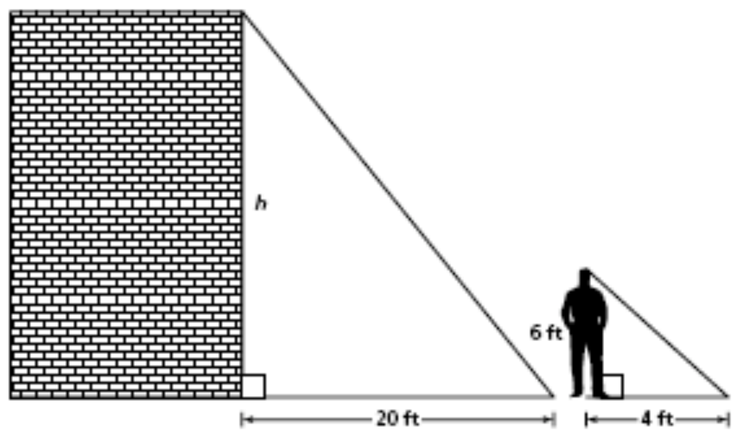
C

Age (years)	Heart Rate (beats/min)
143.5	45
140	40
136.5	35
133	30
129.5	25
126	20
122.5	15

D

GM020116

80 A man who is 6 feet tall casts a shadow that is 4 feet at the same time that a nearby building casts a shadow that is 20 feet.



<u>Note:</u> The figure is not drawn to scale.

What is *h*, the height of the building, in feet?

F 30 feet

G 26 feet

H 24 feet

J 15 feet

GM010199

Appendix E: Three Typical Daily Quizzes Given To Assess Gateway Standards

Gateway Practice Quiz 1

1 Simplify: $x \cdot y \cdot y \cdot y \cdot x \cdot x \cdot x$

A] 14xy
B] $x^4 + y^3$
C] 4x + 3y
D] x^4y^3

2 What is the next number in the sequence below?

1, 4, 8, 13, 19,

A] 24
B] 25
C] 26
D] 27

3 Which of these sets of numbers is ordered from least to greatest?

A] 9, 7.5, $^{-}2$, $^{-}4$, $^{-}4.5$
B] $^{-}4.5$, $^{-}4$, 7.5, $^{-}2$, 9
C] $^{-}2$, 7.5, $^{-}4$, $^{-}4.5$, 9
D] $^{-}4.5$, $^{-}4$, $^{-}2$, 7.5, 9

4 On a geography test, 15 students received an A and 6 students received a B. Which of these is the correct ratio of students receiving an A to students receiving a B?

A] 5 to 4
B] 5 to 2
C] 4 to 3
D] 4 to 5

5 Which of these lists the correct order of operations to simplify the expression below?

16/2 + 7(5-4)

A] divide, subtract, add, multiply
B] subtract, multiply, add, divide
C] subtract, add, multiply, divide
D] subtract, divide, multiply, add

6 How much fencing will be required to build a fence around a rectangular rabbit pen which measures 80 feet by 40 feet?

A] 120 feet
B] 200 feet
C] 240 feet
D] 3200 feet

7 Solve: 2x – 25 = 69

A] 22
B] 34
C] 38
D] 47

Gateway Practice Quiz 2

8 How many different outfits can Allen create from 5 pair of pants, 7 shirts, and 6 ties?

A] $5 + 7 + 6$
B] $5 \times 7 \times 6$
C] $(5 + 7 + 6) / 3$
D] $3(5 + 7 + 6)$

9 Solve: $5(x - 3) + 6 = 3x - 7$

A] -3
B] -1
C] 1
D] 4

10 Simplify: $\sqrt{81}$

A] $\sqrt{9}$
B] $5\sqrt{3}$
C] 7
D] 9

11 Evaluate: $x^3 - 5x^2 + 4x - 2$ given $x = -3$

A] 45
B] 21
C] -50
D] -86

12 Tameka has test scores of 97, 93, 86, 95, and 89. What is the mean of her test scores?

A] 91
B] 92
C] 93
D] 94

13 How much fencing is needed to enclose the rectangular pen below?

A] 79 feet
B] 129 feet
C] 158 feet
D] 1530 feet

14 The members of the gardening club are planting 50 bean plants. Each plant requires 3 stakes. States come in package of 20. How many packages of stakes will the club need to buy?

A] 5
B] 7
C] 8
D] 10

15 Nicholas has already saved \$47. After he receives his allowance (x), he will have \$100.00. Which of the following equations models this situation?

A] $47 - x = 100$
B] $100 + 47 = x$
C] $100 + x = 47$
D] $47 + x = 100$

16 During last week, the Atlanta Braves scored the following number of runs in the 7 games they played:

5, 6, 0, 2, 7, 4, 8

What is the median number of runs that they scored?
A] 4 B] 5 C] 6 D] 8

Gateway Practice Quiz 3

17 Marisa is buying orange juice. She has the following brands to choose from:

Brand	Size	Price
Birdseye	46 ounces	$2.56
Tropicana	50 ounces	$3.10
Minute Maid	65 ounces	$3.20

Which one of the following statements is true?

A] Birdseye is the least expensive brand per ounce.
B] Tropicana is the most expensive brand per ounce.
C] Minute Maid and Tropicana cost the same.
D] Minute Maid is the most expensive brand per ounce.

18. What are the next two numbers in the sequence below?
1, 4, 9, 16, 25, 36,

A] 46 , 46
B] 49, 58
C] 49, 64
D] 50, 76

19. At the local sandwich shop, a customer can choose between 3 kinds of bread, 4 kinds of cheese, 7 different vegetables, and 5 kinds of meat. If you can choose only 1 meat, 1 vegetable, 1 cheese, and 1 bread, then how many possible sandwiches can you make?

A] 19
B] 23
C] 420
D] 584

20. Simplify: $\sqrt{144}$

A] 144
B] 72
C] 12
D] $\sqrt{12}$

21 Which of the following is the best buy?

A] 12 pencils for $1.20
B] 20 pencils for $1.80
C] 30 pencils for $2.10
D] 50 pencils for $6.00

22 Solve: $\frac{1}{2}x - 9 = 3$

A] -6
B] 12
C] 18
D] 24

23 Sandra scored the following in the games she bowled yesterday:

130, 156, 187, 107

What was the mean score?

A] 130
B] 143
C] 145
D] 156

24 John is going to a new job where he will be earning $8 per hour. Which of the following expressions can be used to show how much he will earn for working 30 hours?

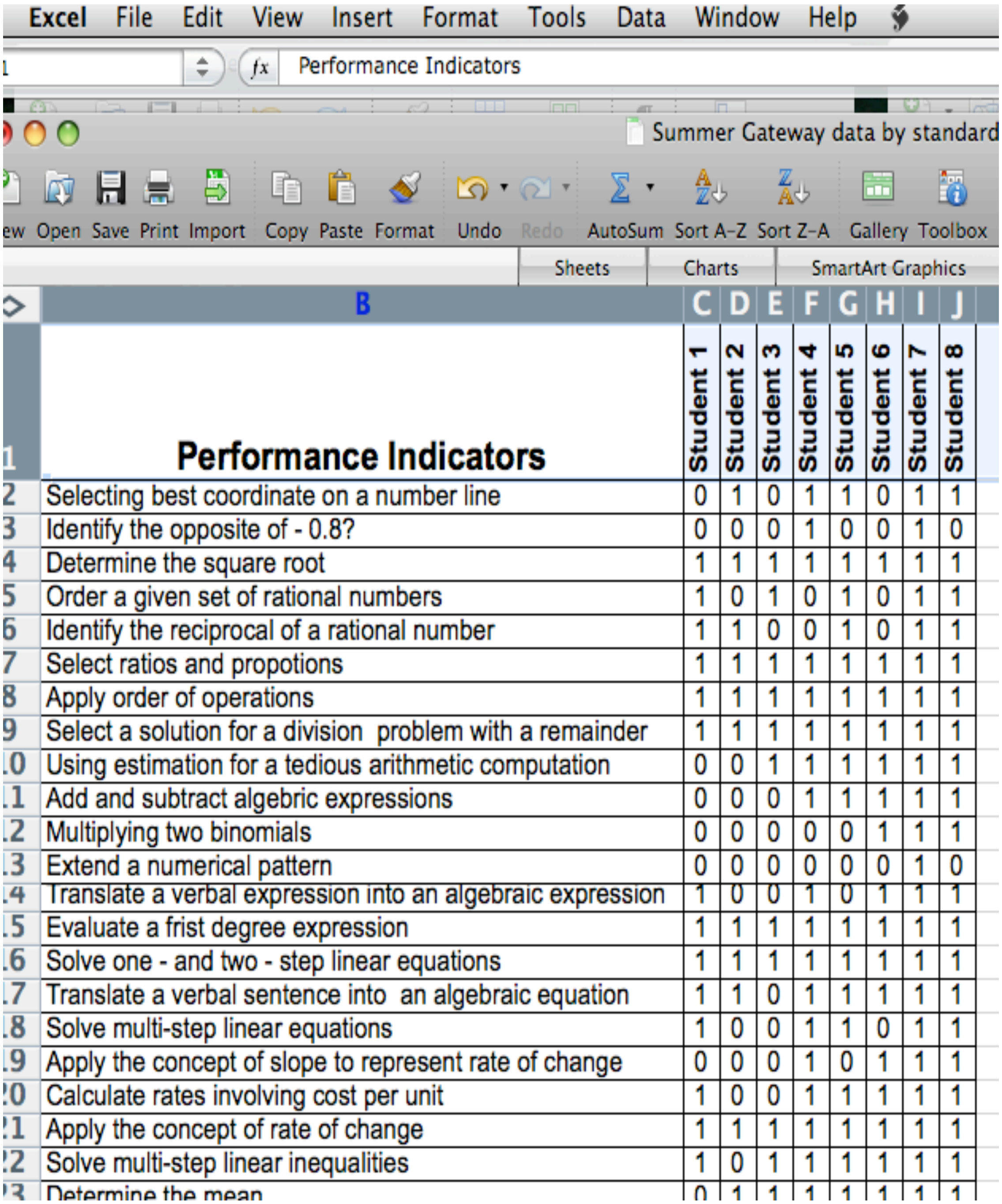
A] 8 + 30
B] 30 / 8
C] 30 x 8
D] 30 – 8

25 On six days Michael read the following numbers of pages in a book:
25, 37, 40, 12, 26, 40

What was the median number of pages he read?

A] 30
B] 143
C] 31.5
D] 180

Appendix F: Excerpt of Excel Spreadsheet Used to Measure
Student Mastery of Gateway Standards



	B	C	D	E	F	G	H	I	J
1	**Performance Indicators**	**Student 1**	**Student 2**	**Student 3**	**Student 4**	**Student 5**	**Student 6**	**Student 7**	**Student 8**
2	Selecting best coordinate on a number line	0	1	0	1	1	0	1	1
3	Identify the opposite of - 0.8?	0	0	0	1	0	0	1	0
4	Determine the square root	1	1	1	1	1	1	1	1
5	Order a given set of rational numbers	1	0	1	0	1	0	1	1
6	Identify the reciprocal of a rational number	1	1	0	0	1	0	1	1
7	Select ratios and propotions	1	1	1	1	1	1	1	1
8	Apply order of operations	1	1	1	1	1	1	1	1
9	Select a solution for a division problem with a remainder	1	1	1	1	1	1	1	1
10	Using estimation for a tedious arithmetic computation	0	0	1	1	1	1	1	1
11	Add and subtract algebric expressions	0	0	0	1	1	1	1	1
12	Multiplying two binomials	0	0	0	0	0	1	1	1
13	Extend a numerical pattern	0	0	0	0	0	0	1	0
14	Translate a verbal expression into an algebraic expression	1	0	0	1	0	1	1	1
15	Evaluate a frist degree expression	1	1	1	1	1	1	1	1
16	Solve one - and two - step linear equations	1	1	1	1	1	1	1	1
17	Translate a verbal sentence into an algebraic equation	1	1	0	1	1	1	1	1
18	Solve multi-step linear equations	1	0	0	1	1	0	1	1
19	Apply the concept of slope to represent rate of change	0	0	0	1	0	1	1	1
20	Calculate rates involving cost per unit	1	0	0	1	1	1	1	1
21	Apply the concept of rate of change	1	1	1	1	1	1	1	1
22	Solve multi-step linear inequalities	1	0	1	1	1	1	1	1
23	Determine the mean	0	1	1	1	1	1	1	1

Curriculum Vitae

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Experience

August 2006 – Present
La Fayette High School, LaFayette, GA
Mathematics Teacher

August 1985 – June 2006
Taylor High School, Chattanooga, TN
Mathematics Teacher (Served as department chair 2000-2006)

June 1998 – June 2006
University of Tennessee at Chattanooga, Chattanooga, TN
Teacher – Upward Bound program

September 1983 – June 1985
Eastside Junior High School, Chattanooga, TN
Mathematics and Vocal Music Teacher

September 1981 – June 1983
Hixson Junior High School, Chattanooga, TN
Vocal Music Teacher

January 1979 – June 1981
Brainerd Junior High School, Chattanooga, TN
Eighth Grade English and Vocal Music

Education

Walden University, Minneapolis, MN
Doctor of Education in Teacher Leadership, April 2011

Southwestern Baptist Theological Seminary, Fort Worth, TX
Master of Music, July 1976

University of Tennessee at Chattanooga, Chattanooga, TN
Bachelor of Science in Music Education, May 1973

Chattanooga State Community College, Chattanooga, TN
Extensive coursework in mathematics and computer science,
March 1983 – July 1985

Certification

Certified in Tennessee in Mathematics (9-12) and Instrumental/Vocal Music (K-12), Certified in Georgia in Mathematics (6-12)

Professional memberships

Member, National Council of Teachers of Mathematics