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Access to Algebra I, Gateway to Success: The Impact of Eighth-Grade Algebra I.

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Access to Algebra I, Gateway to Success:

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by

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ABSTRACT

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An understanding of Algebra I and the role that this foundational course plays as an entry to the college preparatory pathway in secondary education and its influence on mathematical achievement is an integral component for the education of American youth in the global world of science and technology. Achievements in high school curricula are cumulative; each course completed determines which paths will be open to the student and which postsecondary education options will be available. In today's world, these options are necessary for the competitive world market. Algebra I is the prerequisite course for subsequent high school math pathways. Students exposed to higher level math and science pathways in high school score higher on college entrance exams such as the American College Test (ACT), and they are more likely to be successful in college due to greater competence in math (Conley, 2006).

This research examined the effect of early Algebra I exposure in the 8^{th} grade on students in 2 city school systems in Northeast Tennessee. More specifically, this study explored the correlation between Algebra I completion in the 8^{th} grade and subsequent student achievement. The number of math classes attempted by high school seniors and ACT achievement scores,

suggested that early exposure to algebra yields more math class participation and higher levels of mathematic achievement.

This study found that students who successfully completed Algebra I in the 8th grade were able to earn more higher level high school math course credits than students who did not successfully complete Algebra I in grade 8. Successful completion of Algebra I in middle school allowed students to enroll in more varied and higher level math courses throughout their high school career.

DEDICATION

This study is dedicated:

To my husband Joe who has been the best husband a wife could ever ask for, and he has always exhibited patience and freely offered words of encouragement.

To my parents Gene and Lynda Skelton who have encouraged me through this entire process.

To my friend, Karen, for her constant companionship. I have been very fortunate to have a wonderful friend who was able to accompany me on this journey.

CONTENTS

CHAPTER 1

INTRODUCTION

High school graduates must be prepared to compete in a modern global economy that relies heavily on the development and application of science and technology. Algebra, a mathematical system referred to as the language of the information age, is considered a gateway course that if completed early positions students on a path of accelerated mathematical learning at the secondary level (Steen, 1999) and helps prepare them to meet the challenges of a rigorous academic curriculum. Traditionally, school systems have introduced Algebra I in grade nine. However, in recent years many school systems have offered early enrollment in grades seven and eight. According to Smith (1992) and Steen (1999), an early introduction to algebra benefits students by increasing the amount of accumulated math credits that students can earn and by improving their performance on standardized tests. Therefore, it can be argued that the earlier students take algebra, the better prepared they are to succeed in a highly competitive world.

The mathematics curriculum in the United States is organized sequentially so that students can gain mastery in one course before progressing to a higher level course. Typically, high schools offer math courses in the following order: Algebra I, Geometry, and Algebra II, followed by a fourth-year mathematics course such as Pre-Calculus, Calculus, Advanced Placement Calculus, or Probability and Statistics. Due to the sequential nature of math courses, decisions pertaining to the courses selected and the semester in which they are completed can impact and potentially limit students' academic choices and pathways within the standard 4-year high school program and beyond.

In order to determine mathematical readiness for entrance to the postsecondary level, most colleges and universities look for the successful completion of higher level math courses. Algebra I is a prerequisite for the college preparatory pathway in the state of Tennessee (Tennessee Department of Education, 2006). However, it is the individual school administrations that decide whether to adopt traditional or early enrollment algebra pathways.

Students who must use the traditional pathway that entails waiting until grade nine to complete Algebra I are limited in their opportunities to enroll in higher level math and science courses that are needed for postsecondary preparation. However, students who follow the early enrollment pathway by completing Algebra I in middle school are offered more academic choices in their high school curriculum. According to Smith (1992), this early advantage does not end with high school graduation but continues to benefit students planning on college enrollment.

Statement of the Problem

According to Smith (1992), at least 80% of American eighth graders are intellectually capable of learning algebraic content. She further suggested that if students would benefit in any way from taking Algebra In grade eight, then it should be offered to all students regardless of individual differences. The purpose of this study is to examine the relationship between eighth-grade completion of Algebra I and ninth-grade-or-later completion of Algebra I for students in two Northeast Tennessee high schools. This study examines the role of Algebra I in both the traditional (grade nine) and early enrollment (grade seven and eight) pathways by comparing accumulated math credits and the standardized test scores of high school seniors.

Research Questions

In order to determine if early enrollment in Algebra I supports greater academic success in high school, the following research questions are posed:

1. Is there a relationship between the grade in which Algebra I is completed and American College Test (ACT) composite scores?
2. Is there a relationship between the grade in which Algebra I is completed and ACT math scores?
3. Is there a relationship between the number of higher level math courses completed in high school and ACT composite scores?
4. Is there a relationship between the number of high level math courses completed in high school and ACT math scores?

Significance of the Study

Literature supports the advantages of offering early enrollment algebra because it allows more time for students to take additional higher level math classes during high school, which results in higher standardized test scores (National Commission on Excellence in Education [NCES], 1983; Smith, 1992). However, the literature does not address the comparison between the grade level at which Algebra I was completed and the number of subsequent math courses taken and ACT achievement. If individual school administrations can determine at which grade(s) Algebra I should be taught, they should do so with the purpose of providing all students with equal opportunity to study mathematics.

Definition of Terms

1. Advanced Placement Classes – college level courses offered at high schools across the United States and Canada. Achievement exams are given to students at the end of the course. This exam allows the student to attain college credit for this work provided that the student scores high enough on the exam.
2. Core Curriculum Units - the course selections required for high school graduation.
3. Delayed Enrollment Pathway – introduction of Algebra I in grades 10 or later, followed by Geometry, and Algebra II.
4. Early Enrollment Pathway – introduction of Algebra I in grade seven or eight, followed by Geometry, Algebra II, and one or more higher level mathematics course(s) in the sophomore, junior, or senior years. This pathway allows more academic choices and accumulation of a greater quantity of higher level math credits during the course of high school education.
5. Electives – optional courses that may be completed in addition to required courses.
6. Gateway Courses - prerequisite academic courses that must be taken and successfully completed before a student can take subsequent courses (Mathematics Equals Opportunity, 1997). For example, a student must successfully complete Algebra I before higher level courses such as Geometry, Algebra II, Pre-Calculus, and Advanced Placement Calculus can be taken.
7. High School Credit – high school classes completed with a "D" letter grade or better. High school students in Tennessee must accrue 20 credits to graduate. These credits must include core curriculum units (three math credits, three science credits, four English credits, three social studies credits, one wellness credit) and six elective credits

(Tennessee Department of Education, 2006). However, students beginning high school in Fall 2009 must accrue 22 credits to graduate. These credits include core curriculum units (four math credits, three science credits, four English credits, three social studies credits, one and one half physical education and wellness credits, one half personal finance credit, two credits in foreign language, and one credit in fine arts) and three elective credits (Tennessee Department of Education, 2009).

8. Prerequisite - a course that must be successfully completed prior to enrollment in a more advanced course.
9. Specific Pathway (university or technical) Units - the amount and type of units of coursework needed for college/university acceptance (university pathway) or job force or technical college acceptance (technical pathway) following high school graduation.
10. Student Success - students who complete Algebra I and enroll in Geometry or another higher level math class.
11. Traditional Pathway – introduction of Algebra I in grade nine, followed by Geometry, Algebra II, and a higher level mathematics course such as Pre-Calculus, Calculus, Advanced Placement Calculus, or Probability and Statistics taken during the senior year.

Delimitations and Limitations

A major limitation of this study is a small data set (N=571). Although the entire population of the 2007-2008 senior class of the two sample schools was included in this study, a data set of this size cannot necessarily be generalized to a larger population.

Another limitation of this study is that students who were eligible to take Algebra I in seventh or eighth grade and consequently took the class may have been the type of student who would have taken more math courses and scored higher on tests whether they took Algebra I early or not. This study uses data from two school systems that offer early Algebra I in their middle schools.

Summary

As students prepare for today’s highly competitive global market, they require maximum opportunities for education (Darling, 2006). The purpose of the study is to examine whether offering early enrollment algebra to students in grade eight significantly impacts students’ academic achievement and better prepares them to succeed in college or the workplace.

CHAPTER 2

REVIEW OF LITERATURE

This chapter explores the practices, beliefs, and assumptions related to math instruction in the past and present. It addresses policy implications related to the grade in which Algebra I is offered to students. It also addresses how the grade in which Algebra I is offered impacts students, parents, teachers, and administrators; how this relates to state and national assessments; how this relates to high school graduation requirements; and how this relates to meeting the needs of the workplace.

Historical Background

Historically math has been largely neglected as a primary field of study because the primary focus of academics has been the humanities. One of the few early examples of mathematics education was found in ancient Greece. Arithmetic instruction was offered to the middle and artesian classes, and geometry instruction was offered exclusively to a few upper classes. Later during the Grecian period, Plato wrote that everything in the world and universe could be mathematically expressed, and math became a discipline that served as a jumping-off point for philosophical thought (O'Conner & Robertson, 2000). This belief was termed "the science of numbers" and resulted in a progressive course of mathematics instruction that took place during the first 10 years of a student's education (O'Conner & Robertson, 2000). The middle 400s to 1000s was termed the Dark Ages because the Church attempted to control all learning in order to ensure that it was in line with its teachings. During this time there was no research in mathematics except for the research done in the abbeys of the Roman Catholic Church. Gerbert, a French scholar who became Pope Sylvester, is known to have advocated in Europe the use of Indian-Arabic numerals, which lacked the concept or representation of zero, and he also created an abacus, designed a terrestrial and celestial globe, and established the first European school, which he located in France (Schrader, 1967). Medieval European interest in mathematics was driven by the belief that mathematics provided the key to understanding the created order of nature (Schrader, 1967). Mathematics in Europe started to progress during the end of the Middle Ages and the early part of the Renaissance (1100s-1400s). Mathematics knowledge at that time was based not on a Greek but on an Islamic framework. During the 1100s through the 1400s there was a rebirth in mathematics, and European scholars traveled to Spain and Sicily seeking scientific Arabic texts that sparked an increased interest in mathematics (Abraham, 2006).

Historically mathematics education has at times been a largely neglected field of study, and at other times it has been the focus of great debate. As a consequence waves of educational reform have reshaped and redefined mathematical literacy.

During the 16th century European mathematical developments arose rapidly, contributing to and benefiting from modern advances in the physical sciences. Through the 17th century an unprecedented explosion of mathematical and scientific ideas across Europe erupted (Bloch, 1992). Scientists such as Galileo observed the moon of Jupiter with a telescope, Tycho Brahe gathered and used his mathematical findings to describe the position of the plants in the sky, and Johannes Kepler formulated mathematical laws of planetary motion.

After 1700 a movement to found learned societies spread throughout the American colonies and Europe (Mathematics, 2009). The period from 1700 to 1800 became known as the century of analysis where the consolidation of calculus and its application to mechanics was developed. The close relationship between mathematics and mechanics in the 18th century had roots extending deep into Enlightenment thought where secular views were based on reason or human understanding only (Mathematics, 2009). The modern division between physics and mathematics and the association of the latter with logic had not yet developed (Mathematics, 2009).

For much of the 20th century the American education establishment was transitioning to a progressivist education agenda (Klein, 2003). In an analysis of elementary school (kindergarten through grade six) math books from early in the century, it was found that exercises focused on rote memorization of tables and simple calculations. By the late 1900s, some progressivist math programs promoted the absence of student textbooks altogether due to the perception that these types of instruction materials might interfere with student discovery (Klein, 2003).

In the early 20th century William Hearth Kilpatrick, one of the nation's most influential educational leaders, proposed that the study of algebra and geometry in high school should be discontinued and only taught as "an intellectual luxury" (Klein, 2003). Other math education experts supported Kilpatrick's view. David Snedden, founder of educational sociology, stated that "Algebra I is a nonfunctional and nearly valueless subject for 90% of all boys and 99% of all girls and no changes in method or content will change that" (Klein, 2003, p. 179). In direct opposition to these statements, the *1923 Report*, an extensive survey of secondary school curricula, underscored the importance of algebra for an educated person. It was perhaps the most comprehensive document ever written on the topic of mathematics (Klein, 2003).

By 1920 most city high schools offered four tracks: college preparatory, commercial (which prepared students for office work), vocational (which prepared students for industrial arts and home economics), and general. Most high school students followed a college preparatory course of study, but few went on to college, and less than 17% of 14- to 17-year-olds graduated from high school (Mirel, 2006). High school curricula at that time generally included courses in Algebra I, Geometry, and Advanced Math; Biology, Chemistry, and Physics; History and Social Studies; and 4 years of English.

In the 1930s education journals, textbooks, and courses for administrators and teachers advocated the major themes of progressivism (Klein, 2003). These major themes were reorganization of secondary school programs, promotion of intercultural education, wiser use of human and physical resources, and clarification and advancement of educational freedom on a wide front (Lowe, 2000). At this time, the collapse of the national economy during the Great Depression, and particularly the collapse of the youth labor market, forced a huge number of young people back to school (Mirel, 2006). Educational leaders believed a rigorous regimen of courses would force many of the new students to drop out, which was a dreadful prospect during this period of desperate economic pressure. A solution for the work-starved economy was to keep children in schools and out of the labor market. For this reason large numbers of students were placed into undemanding, nonacademic courses, and, consequently, lower academic standards were required for graduation. This shifted the nature and functions of high schools and significantly decreased the rigor of the math curriculum, all of which lowered expectations for student performance (Mirel, 2006)

The proportion of students attending school in the United States continued to increase from the 1930s and into the 1940s. At this time, colleges and universities were concerned about the low level of mathematics knowledge communicated by the K-12 education system (Woodward, 2004). However, textbooks were still based on the 1920s and 1930s curriculum. The development of atomic weapons in the 1940s and the Soviet launch of Sputnik in 1957 sparked an intense interest in the training of math and science teachers (Mirel, 2006). The political response to these era-shaping forces was the allocation of federal funding intended to increase the number of mathematics-trained teachers in order to help the United States compete internationally.

The new math curriculum of the 1950s and 1960s was characterized by an emphasis on instruction in abstract mathematical concepts at the elementary level. The National Defense Education Act (NDEA), which was passed in 1958, was designed to stimulate interest in math, science, and foreign languages and to contribute to school construction (Klein, 2003; Mirel, 2006). Additionally, during the same year the American Mathematical Society set up the School Mathematics Study Group (SMSG) headed by Edward Begle. Begle created a new curriculum for high schools (Klein, 2003). The introduction of calculus courses at the high school level was one of the contributions of this new curriculum. However, the percentage of students taking math courses actually fell slightly between 1961 and 1973 (Mirel, 2006). By the 1970s the new math was dead and the National Science Foundation (NSF) discontinued funding programs of this type (Klein, 2003). At this time a "back to basics" movement in mathematics began. During the mid-1970s, a majority of states created minimum-competency tests in basic skills, and almost half of them required students to pass those tests as a condition for graduation from high school (Klein, 2003).

Two important national reports that investigated K-12 education in the 1980s were *An Agenda for Action* and *A Nation at Risk* (Klein, 2003). The *Agenda for Action* recommended that problem-solving should be the focus of school mathematics along with new ways of teaching (Klein, 2003). For example, calculators would be accessible to students in elementary and secondary school classrooms to allow technology to replace paper-pencil computation (Klein, 2003).

A Nation at Risk called attention the need to increase teacher quality, teacher training programs, and teacher shortages, especially in math and science (Klein, 2003). The commission recommended that high school coursework include (a) four years of English; (b) three years of mathematics; (c) three years of science; (d) three years of social studies; and (e) one half year of computer science (National Commission on Excellence in Education, 1983).

By the end of the 20th century United States public schools mathematics education policies were in a state of flux (Klein, 2003). In the late 1980s the National Science Foundation (NSF) was instrumental in implementing the National Council of Teachers of Mathematics (NCTM) standards across the nation. However, the standards overemphasized statistics and data analysis and de-emphasized arithmetic and algebra (Klein, 2003).

Math Curriculum: Beliefs, Assumptions, and Organization

Algebra I is helpful in daily life. Its uses range from applying formulas for calculating miles per gallon of gasoline to functions that determine the profitability of business endeavors (Ketterlin-Geller, Junjohann, Chard, & Baker, 2007). For many students, mathematics seems useless because the only people they see using it are mathematics teachers (Ketterlin-Geller et al., 2007). Steen (2007) argued that teachers in all subjects – both academic and vocational – must demonstrate the use of mathematics regularly and significantly in the instruction of their courses in order for students to treat math as a useful tool rather than as just another course that must be completed. In order to make mathematics valuable to students, schools must make mathematics pervasive, much in the same way that writing has been in the past and still is in the present (Steen, 2007).

Algebraic reasoning builds on the understanding of numbers and mathematical relationships (Ketterlin-Geller et al., 2007). Areas of arithmetic concepts that provide the foundations for Algebra Include numbers and numerical relationships, operations, and number properties (Ketterlin-Geller et al., 2007). In order to develop algebraic reasoning, the student must understand the following key components: variables and constants, algebraically formulating word problems, symbol manipulation, and functions (Milgram, 2005).

Ketterlin-Geller et al. (2007) proposed that teaching mathematics in the elementary grades in a manner that enables students to transfer arithmetic concepts to algebraic concepts by middle school may promote success for all students engaged in mathematical reasoning.

California school districts are revamping their approach to math. The second largest school district in the nation, the Los Angeles Unified School District (LAUSD), was the first school district to opt for a single research-based math curriculum for the city’s elementary students that introduces algebra concepts in kindergarten and carries them on through every grade (eSchool News, 2008). The visual, innovative, research-based approach called *enVisionMATH* has become the most widely adopted curriculum throughout the United States (eSchool News, 2008). The program exposes young students to algebraic concepts as early as kindergarten in order to build a solid foundation for higher level math courses in middle and high school (eSchool News, 2008). *EnVisionMATH* author Dr. Randall Charles, Professor Emeritus, Department of Mathematics at San Jose State University, stated that many students had found algebra challenging because of a poor background in fractions. He said that if the introductions of algebraic concepts were presented at an early age, algebra would not be difficult to teach or learn (eSchool News, 2008).

The mathematics curriculum in the United States is organized in a common sequential fashion based on the assumption that students must gain mastery in one course before progressing to a higher level course. During the elementary years the mathematical pathway progresses from addition and subtraction to the more complex ideas of multiplying and dividing. By middle school, students should have a solid understanding of these mathematical concepts in preparation for Algebra I, which is a prerequisite for all higher level math courses such as Geometry, Algebra II, Trigonometry, and Calculus (Tennessee Department of Education, 2006).

If schools are a sorting mechanism, then taking one math class instead of another may function as a critical gateway in that sorting process. In other words, the pathway to that gate may be very different depending on which class a student takes (Smith, 1992). A college tracked high school program usually requires 5 years of math coursework: Algebra I, Geometry, Algebra II, some form of Trigonometry or Statistics, and Calculus. Carei (2006) has found that block scheduling where students have 8 semesters in which to take the five mathematics courses is a solution that provides a distinct scheduling advantage. Block scheduling restructures the school day into class blocks longer than the traditional 50 to 55-minute period. In this way, students have four longer class periods each day instead of six or seven short periods, and a high school course that normally covers the entire school year can be compressed into an intense half-year course. Block scheduling can be advantageous because students are able to take four courses per semester for a total of eight courses per year instead of six, and this allows them to earn more credits toward graduation. Additionally, they have twice as many opportunities to complete the required courses if they fail a subject, and they have a decreased number of class changes, which decreases the likelihood of disruption and disorderly conduct in the halls. Furthermore, because their study load has dropped from seven or six to four classes daily, students may have fewer tests, quizzes, and homework assignments (North Carolina Public Schools, 2006). Block scheduling also allows more time for the development of meaningful rapport between students and teachers (North Carolina Public Schools, 2006). However, the disadvantages of block scheduling include: more extensive daily homework in each discipline even though the number of homework assignments may be reduced, increased difficulty making up absences, and more difficulty keeping up with the faster pace that is inherent in block scheduling (North Carolina Public Schools, 2006).

Most Tennessee high schools are on 4x4 block scheduling. Schools B, G, and I in Table 5 in Appendix D offer some type of advanced or honors pre-Algebra I course that enables a student to cover the basic introduction of Algebra I in 8th grade. During the fall semester of their freshman year in high school, they review for a very short time and push onward to cover the standards in much greater depth and earn an Algebra I credit by the end of their first high school semester. Those schools that do not offer block scheduling do not issue a full credit by the end of the first semester due to year-long classes. The block scheduling provides an advantage in terms of hastening access to higher level math courses past Algebra I. Some of the schools surveyed in the block scheduling push their students (honors and regular) to take up to seven to eight math credits while in high school (significantly more than the mandatory four required by the state). However, those schools that offer year-long courses can only accommodate four classes unless the student takes two math courses simultaneously during one year.

Schools that do not presently offer Algebra I credit in high school but do offer some type of advanced or honors pre-Algebra I courses would have to bump the entire math curriculum down one grade level for every grade level to accommodate these students. These schools claim that they do not have the finances or the workforce necessary for such a transition.

In any subject, access to advanced courses is dependent on a student's access to a prerequisite course. Because middle and high school mathematics courses are structured sequentially, access to higher level math courses is shaped by prior mathematics success, and this acts as a gateway for continuing the sequence (Smith, 1992). In this case, Algebra I is the first major gateway in secondary mathematics. Students must take it before 10th grade in order to take advanced placement (AP) classes such as AP Calculus and AP Statistics by their senior year. Algebra I is also the gateway for science classes such as Chemistry and Physics.

Algebra in Relation to Current Federal Education Policy

The No Child Left Behind (NCLB) Act of 2001 used scientifically based research to guide instructional practices in classrooms throughout the country. That act served as a culmination of more than 4 decades of federal public education expansion that began with the Elementary and Secondary Education Act (ESEA) of 1965 (National Conference of State Legislatures [NCSL], 2006). President Lyndon B. Johnson's "War on Poverty" included the ESEA and appropriated approximately $2 billion in the 1st year for the purpose of helping states improve educational opportunities for the underclass. NCLB is based on the idea of stronger accountability for school outcomes and more choices for parents in educational methods such as charter schools (Education Government, 2006). The act provided an unparalleled increase in federal resources to states to improve low-performing schools. In order to meet the requirements of the NCLB act, states are required to increase student testing, collect and disseminate subgroup results, place a highly qualified teacher in every classroom, and guarantee that all students regardless of socioeconomic factors achieve a “proficient” level of education by the 2014-2015 school year (NCSL, 2006). According to this act, students must take state-developed tests (called state assessments) every year in grades three through eight and at least once in high school. The states use these tests to compare schools and determine if they meet state reading and math goals through adequate yearly progress (AYP). NCLB mandates that students be tested in high school but does not require these tests to be used as a graduation requirement.

Policy Implications: Early Delivery of Algebra I for High School Students

According to a survey by the National Action Council for Minorities in Engineering (NACME), 86% of students said they would like to attend college after graduation (United States Department of Education, 1997). Nearly two thirds said they were interested in taking Advanced Placement courses, but less than half of the 9th through 11th grade students surveyed stated they planned to take Trigonometry or Algebra II in high school. This suggests a gap between the interests of many high school students and the reality of preparing for college. It could be that those students were not aware of the math requirements for admittance into their preferred college. A student with Calculus on a high school transcript is likely to have more options in college and program selection than a student who has not successfully completed advanced mathematics courses.

Both algebra and geometry courses have been recommended for all high school students regardless of whether they enter college or the workplace following high school (Sweeney, 1984). According to *Mathematics Equals Opportunity*, studies have indicated that students who take more demanding math courses show higher gains in mathematics achievement than students who take less challenging courses (Starr, 2003). The Department of Education (1997) reported that students who do not take Algebra I early in their educational careers risk closing the door on many important opportunities.

Early mathematics achievement in high school has been identified as the single strongest predictor of whether or not a student will continue to take advanced courses (Smith, 1996). Students who do not perform well in mathematics by 10th grade admit to feeling discouraged from continuing in higher level mathematics. Consequently, the amount and type of high school mathematics courses taken is largely determined by the high school curriculum. Smith (1996) suggested that this early achievement could be considered an important contributing factor to mathematics accomplishment by the end of high school. Courses beyond Algebra II have been found to have a positive effect on student performance and college readiness (ACT Inc., 2004).

According to Castro, “Mathematics is the language of science, and Algebra I is the minimum vocabulary that scientists of every discipline use to describe their work,” (United States Department of Education, 1997, p.16). Fratt (2006) commented that Algebra connected elementary to high school math and opens the door to higher level math. The Action Agenda for Improving America’s High Schools concluded that in order to reinstate value to the high school diploma, a minimum requirement in the math curriculum needed to include Algebra I, Geometry, Algebra II, and data analysis and statistics within the high school coursework (Achieve Inc., 2005).

Math skills that are needed as a prerequisite to learning Algebra I include: exponent laws, polynomials, like terms, distributive law, common factoring, solving simple equations, solving equations with variables on both sides and brackets, solving equations with fractions, determining the equation of a line given point and Y-intercept, determining the equation of a line given two points, graphing equations using a table of values, graphing equations using slope and Y-intercept, and graphing equations using the X and Y intercepts.

Is Algebra I an Appropriate Math Course in Grades Seven or Eight?

Today many schools feature an early enrollment pathway by offering Algebra I in seventh and eighth-grade, but debate continues. Many parents and students have asked, "Is algebra an appropriate course to offer in middle school?" Many researchers and educators would answer "Yes". Smith (1992) said that at least 80% of American eighth-graders were intellectually capable of learning algebraic content. That suggests that students who take Algebra I in grade seven or eight could capitalize on the learning experience because they are able to access more academic choices during the course of their high school education. However, middle school students who are only offered a pre-Algebra course are more limited in both time and opportunity to access higher level math courses in high school, thereby placing them at a disadvantage in terms of equivalency in mathematics achievement.

Algebra I in eighth-grade was once reserved for mathematically gifted students. In 1990, only one in six eighth-graders was enrolled in an algebra course (Loveless, 2008). President Clinton brought early mathematic achievement to public attention when he commented that around the world middle school aged students were learning Algebra I and Geometry, while in the United States just a quarter of all students took Algebra I before high school. During the 1990s, Clinton and other prominent leaders began urging schools to increase middle school enrollment in Algebra I and Geometry classes (Loveless, 2008). United States Secretary of Education Richard Riley urged students to "take Algebra beginning in the eighth-grade and build from there" (Loveless, 2008, p. 2). Moses labeled algebra "The New Civil Right" (Loveless, 2008, p.2).

The push for universal eighth-grade Algebra Is based on an argument for equity not on empirical evidence (Loveless, 2008). By 2007, eighth-grade enrollment in algebra reached 31% nationally, nearly doubling the 1990 proportion (Loveless, 2008). Transcript studies indicated that 83% of students who completed Algebra I in eighth-grade took Geometry in ninth grade and completed Calculus or another advanced math course during high school (Loveless, 2008).

Loveless (2008) argued that general math or remedial math courses tended to be curricular dead ends, leading to more courses with the same title and little or no progression in mathematical content. Students can complete Algebra I in eighth grade and then complete a sequence of Geometry as a freshman, Algebra II as a sophomore, and Pre-Calculus as a junior. Calculus could be taken in the senior year of high school (Loveless, 2008).

Taking secondary math courses is a means to an end not an end in itself. Students take math courses in order to learn mathematics (Loveless, 2008). However, policies mandating Algebra I classes for all eighth-graders will not necessarily improve mathematics competency (Loveless, 2008). Massachusetts had the highest state score (298) on the 2007 National Assessment of Education Progress (NAEP). Forty-five percent of Massachusetts eighth-graders were enrolled in advanced math (Loveless, 2008). Conversely, North Dakota and Vermont were ranked third and fourth in math achievement but enrolled a relatively low percentage of eighth graders in advanced math: 21% and 26% respectively (Loveless, 2008). A Pearson correlation coefficient for NAEP score and advanced math enrollment is -0.09 (Loveless, 2008). The national average NAEP math score in eighth-grade math has been rising steadily. It increased by 8 points from 2000 to 2007, from 273 to 281 (Loveless, 2008). Studies have shown that about 1 out of every 13 eighth-graders in an advanced math class knows very little mathematics (Loveless, 2008). This means that on average 2 students in a class of 26 students are several years below grade level (Loveless, 2008). In the 2007 NAEP study, the teachers of the students who were several years below grade level were more likely to have taught for less than 5 years (30.3 % versus 22.5 %), less likely to hold a regular or advanced teaching certificate (74.7 % versus 82.5 %), and less likely to have majored in mathematics as an undergraduate (20.1 % versus 26.2 %) (Loveless, 2008). Unprepared students arrive in algebra classes that are staffed by underprepared teachers, and, thus, no social benefit is produced (Loveless, 2008).

Whereas advocates for placement of low performing eighth-graders in algebra classes argue that a more rigorous course is always preferable to a less rigorous one, the burden is left for the teacher to make up students' skill deficiencies (Loveless, 2008). When an unprepared eighth-grade student is placed in an Algebra I class, the teacher is expected to teach in 1 year all of the material that has not been learned in the previous several years in addition to the algebra content (Loveless, 2008). This affects the unprepared eighth-grader who will waste a year lost in a curriculum that the student is not ready to handle. Additionally, this affects the eighth-grader who is prepared for Algebra I because the teacher will have less time available to devote to the students who are performing well (Loveless, 2008). Teachers have reported that classes of students with widely diverse mathematics preparation impede effective teaching (Loveless, 2008).

Policies regarding whether or not to allow high school credit to be awarded prior to high school enrollment vary from school to school. Some school policies state that any eighth-grade student who receives a grade lower than a B minus in Algebra I on the yearly report card must retake Algebra I in the ninth-grade. Other schools do not allow any credit prior to high school because work accomplished in middle school would affect the student's high school grade point average (GPA), and salutatorian or valedictorian honors are traditionally awarded based solely on high school performance.

The question of whether early enrollment in Algebra I in eighth-grade increases math literacy or math phobia is another debate. Some fear that pushing algebra too early will instill a fear of math in students who are not ready and affect their desire to learn math in later years (Starr, 2003). Supporters of eighth-grade algebra including educators, politicians, and parents have reported that introducing algebraic concepts in elementary school and offering Algebra I in middle school: 1) alleviates the fear of algebra, 2) allows students to enroll in more demanding math and science courses upon reaching high school, and 3) provides an opportunity to enroll in a wider variety of higher level courses in high school (Starr, 2003). This view supports the notion that early experiences with algebra will increase learner confidence and create successful opportunities for upper level high school courses.

Opponents of eighth-grade algebra classes have cited three potential disadvantages. First, allowing students to enroll early in Algebra I means middle school teachers have one less year to provide students with the building blocks of higher level math, and, therefore, students would miss instruction in necessary math skills and concepts. Second, a student who experiences early frustration or failure may not be inclined to follow academic paths that require higher level math skills, or the student may become discouraged with the algebra pathway in general. Because mathematics learning builds heavily on prior knowledge, difficulty in mathematics in the first part of high school or earlier severely limits the likelihood of continued learning (Smith, 1992). Finally, middle school students may not be developmentally ready for the abstract thinking that algebra requires (Starr, 2003). For example, a student may be able to solve number equations, but prior to the development of abstract thought capabilities, variable substitutions could create an insurmountable source of confusion. Also, high school math teachers worry about the quality of Algebra I instruction given by middle school teachers who lack a sufficient background (Starr, 2003). Steen (1999) argued that in order for Algebra I to benefit eighth-grade students, middle school classes need to be taught by well-prepared teachers who are able to counteract the negative aspects of early algebra exposure.

Early enrollment in algebra could also lead to making Calculus a required course in the senior year of high school. Could all students successfully complete a Calculus course? Achievement of this ideal would require that the middle and elementary school math curriculum include early preparation. Additionally, if no accommodations were made available, the rigor of Calculus courses may cause an increase in dropout rates.

Is Algebra Important for Parents, Teachers, and School Administrators?

Advice from teachers and parents regarding student course choices are important in high school. According to a survey by the National Action Council for Minorities in Engineering (NACME), 91% of parents want their children to continue their education beyond high school (Mathematics Equal Opportunity, 1997). However, the Department of Education (1997) found that in most schools parent involvement decreases as students progress in grade level. Students whose parents remain positively involved are more likely to take advanced mathematics courses.

Smith (1992) found that the parents' role in selecting their child's courses affects which students takes Algebra I in the eighth-grade. However, in a study by the United States Department of Education (1997) students were asked who decided the mathematics courses they took and 79% indicated they had made the decision by themselves. This suggests that while parents may influence some students, the students themselves make many decisions in secondary school.

Smith stated that the bond between teachers and students also plays an important role in encouraging learning and increasing student motivation. Students were more likely to attempt challenging coursework regardless of their individual background characteristics in schools that fostered a bond between students and teacher. Schools often push students to take more than the mandatory courses required by the state. If students are to compete in a global economy, math, science, and technology courses must become a priority for all schools and all students. However, students in high school do not always have the foresight to make such decisions and have to be pushed in order to see the value of these subjects.

Schools also play an important role in determining which courses students take especially with regards to mathematics courses (Smith, 1992). School systems that offered Algebra I in eighth-grade correlated positively with those schools that provided Calculus in high school. However, some schools that offered Algebra I in eighth grade did not allow open enrollment; instead, they limited access to specific students. These differences were linked to school structure, student body demographics, and the learning environment adopted by the school (Smith, 1992).

There are multiple ways in which Algebra I is offered (Table 5 in Appendix D). Although most districts offered some type of Algebra I in at least one of their middle schools, some offered Algebra I credit for high school, others offered a math elective credit and required students to retake Algebra I in ninth grade, and still others did not offer any credit and required the student to retake Algebra I in ninth-grade but sometimes offered an abbreviated process. The requirements needed to enroll in Algebra I in middle school varied in detail, but they generally required teacher recommendation, elevated past standardized scores, and good marks in prior math courses. Only 1 of the 11 schools surveyed offered Algebra I in seventh grade.

Among the stand-alone middle schools (sixth through eighth-grade) across the United States, 87% offered Algebra I or some type of Algebra I instruction such as pre-Algebra (Smith, 1992). In schools with other combinations of grades served (Kindergarten through 12^{th}-grade and 8^{th} through 12^{th}-grade schools) over half of the schools made Algebra I an option available to all eighth-grade students. These differences suggest that the grades served in a building are a factor in determining how the district assigns advanced courses (Smith, 1992).

Smith (1992) found that demographic differences had also contributed to whether or not Algebra I was provided as part of the eighth-grade mathematics curriculum. Middle schools that offered Algebra I were found to be different from those that did not. They were more likely to be a public middle school and a stand alone middle school and have a large student roster. Smith also suggested that enrollment size of the school may influence the amount of flexibility students have in taking different mathematics courses, but it may also increase the availability of nonchallenging academic options (Smith, 1992). Districts offering Algebra I in eighth grade and subsequently Calculus in high school have tended to be more common in areas that serve high numbers of college bound students (Smith, 1992). In the 38 surrounding schools analyzed, one in two Kindergarten through 12^{th}-grade schools, zero in 16 Kindergarten through eighth-grade schools, and 13 in 20 sixth through eighth-grade schools (included one eighth through ninth-grade school) offered seventh or eighth grade Algebra I, as noted in Table 6 in Appendix E.

Algebra has increasingly become the focus of mathematics discussions in schools and districts across the United States, and policymakers have emphasized the importance of developing algebraic reasoning at increasingly earlier ages (Ketterlin-Geller et al., 2007). Wu

(1999) reported that mathematicians and mathematics educators have been speaking up about the need to increase teachers' awareness and abilities for teaching algebra across all grades. The National Council of Teachers of Mathematics has attempted to create standards to bridge the gap between elementary arithmetic and middle school arithmetic by embedding algebraic reasoning standards in elementary school mathematics (Ketterlin-Geller et al., 2007). Now in grades three to five, Algebra Is embedded with number operations as one of the three main focal points and beginning in grade six, Algebra I is the predominant topic nationwide (Ketterlin-Geller et al., 2007).

Is Algebra Important for State and National Evaluators?

On August 26, 1981, Secretary of Education, T.H. Bell formed the National Commission on Excellence in Education in order to examine the quality of education in the United States. The Commission's charter consisted of several tasks that assessed the quality of teaching and learning in the United States' public and private schools, colleges, and universities by comparing American schools and colleges with those of other advanced nations, studying the relationship between student achievement in high school and college admissions requirements, and defining problems to be overcome (Education Government, 2006). The Commission also examined patterns of courses that high school students took from 1964 to 1969 and compared them with course patterns from 1976 to 1981 (Education Government, 2006). The report of this examination, *A Nation at Risk* (National Commission on Excellence in Education, 1983) contained recommendations for educational improvement.

A Nation at Risk (National Commission on Excellence in Education, 1983*)* is one of the most important documents in the United States from the last quarter of the 20th century for math and science educators. Additionally, other policy statements for mathematics education surfaced during the 1980s. These included *An Agenda for Action* (Hill, 1980), *Curriculum and Evaluation Standards* (Crosswhite, 1989), and *Everybody Counts* (National Research Council, 1989). All of these statements stressed the need for improving math and science instruction.

As a result of the publication of *A Nation at Risk* (National Commission on Excellence in Education, 1983) and other important policy statements and changes in federal and state regulations, a heavy dependence on standardized tests has been developed. Presently, almost half of all states require high school students to pass an exit exam to graduate (Phillips, 2008). Bob Schaeffer of the National Center for Fair and Open Tests stated that exit exams gained popularity in the early 1990s, but several states have been reconsidering their use (Phillips, 2008). Today both math and science testing is implemented at the state level with curriculum standards and End-of-Course (EOC) testing.

The Tennessee State Department of Education assesses students' overall understanding and comprehension of each math and science course completed during their high school careers by using both EOC and Gateway testing. Tennessee instituted Gateway testing in 1992 and these replaced the Competency Assessments as diploma requirements in 2001 (Phillips, 2008; Taylor, 2008). These examinations were intended to raise the academic bar for all high school students and increase teacher accountability for students' academic performance. The EOC and Gateway results must count for no less than 15% of the student's grade in the semester in which the test was administered (Tennessee Department of Education, 2006). Tennessee requires students to take four EOC exams: Math Foundations II, English I, US History, and Physical Science. There are also Gateway exams for Algebra I, English II, and Biology I. Tennessee's Gateway test scores have three categories: "Below Proficient," "Proficient," and "Advanced" (Tennessee

Department of Education, 2006). Seventy-six percent of first-time test takers passed the Gateway EOC Algebra I test in 2005 (Achieve Inc., 2006) with an Algebra I passing “proficiency” score of 30. This passing score has remained the same since the beginning of the Gateway testing program; however, the “advanced” score decreased from 42 to 41 in 2006 (Tennessee Department of Education, 2006). Summer 2008 was the last time that the Math Foundations II and Physical Science End-of-Course test was administered.

As of the 2009-2010 school year, the Gateway tests will be eliminated and End-of-Course examinations will be given in English I, English II, English III, Algebra I, Geometry, Algebra II, US History, Biology I, Chemistry, and Physics. Gateway requirements for diplomas will be removed for the entering high school freshman class of 2009-2010 (Taylor, 2008). Tennessee will no longer be requiring a competency exam in order to graduate. The results of these examinations will be factored into the student’s grade at a percentage determined by the State Board of Education (Tennessee State Board of Education, 2007). Upon full implementation, 75% of the student’s yearly grade will be based on the teacher assigned grades for the course and the remaining 25% will come from the End-of-Course test grade (Tennessee State Board of Education, 2009). The weight of the End-of-Course examination on the student’s course average is as follows for entering ninth-graders: fall of 2009 is 20%, and fall of 2011 and thereafter will be 25% (Tennessee State Board of Education, 2009). Unlike the previous Gateway tests that required passing all three tests for graduation, students under the new plan will not be required to pass any one examination. Instead, students must achieve a passing score for the yearly grade in the class in accordance with the State Board of Education’s uniform grading policy (Tennessee State Board of Education, 2007). David Sevier, a research associate for the Tennessee Board of Education, stated that “we realized that a low-level test that measures minimum competency, like the Gateway exam, was probably not sufficient" (as cited in Phillips, 2008, p. 1). According to Becky Ashe, Science Supervisor and Interim Director of Curriculum in the Knox County School systems, when measured against the rest of the country, Tennessee's teaching and testing does not cover the subject in enough detail (Knox County Schools, 2009). The 10 new subject tests will be more challenging than the Gateway. Jeff Warren, a Memphis City School board member, says that the new more challenging final exams will allow Tennessee schools to compare achievement on a national level (as cited in Phillips, 2008, p. 1). However, some detractors of the current proposal, such as Dr. Jim McIntyre, superintendent of Knox County Schools, stated that the lack of a requirement for students to pass any EOC in order to graduate under the current state proposal is a shortcoming. McIntyre has asked state officials to consider requiring a passing grade on the EOC as a condition for graduation (Knox County Schools, 2009). McIntyre stated that requiring a passing grade on the EOC will give the proper emphasis and importance to the standards and content (Knox County Schools, 2009).

The National Assessment of Educational Progress (NAEP), also called "The Nation's Report Card," is the only continuing national assessment of America's students. Students from public and private schools are selected and tested in subject areas with different groups, and the subjects are assessed on alternate years (National Education Association, 2006). Math is tested on a cycle with reading every 2 years in grades four and eight across the nation. The reading and math test is comprised of approximately 30-60 questions in order to ensure accuracy and correct for variability in all school districts. The questions are spiraled so that no student takes a complete test or the same set of items (National Education Association, 2006).

Tennessee NAEP mathematics scores have increased from 1992 to 2005, but they have remained slightly lower than the national average (NCES, 2006). Scaled score results range from

0 to 500. Although the national average scores have remained higher than Tennessee's scores, the margin of difference has narrowed between 1992, when Tennessee eighth-graders scored 259 compared to a national average of 267, and 2005, when the eighth-grade mathematics state average was 271, compared to a national average of 278 (NCES, 2006). The achievement level is also given for each test and year in which the test was given. The test results are divided into three sections: basic, proficient, and advanced. Tennessee eighth-graders scoring at or above proficient in the NAEP math from 1992 to 2005 have increased from 12% to 21%, an increase of 9% (NCES, 2006). The nation has also increased in eighth-grade math from 20% to 28%, an increase of 8% (NCES, 2006).

The "Nation's Report Card" stated that in 2005, 29% of Tennessee eighth-graders were taking at least one of the following math courses: Algebra I, Algebra II, or Geometry. This percentage is much lower than the national average of 41% of eighth-grade students, and the median percentage of 56% in the top five states (NCES, 2006).

The Carl D. Perkins Career and Technical Education Act of 2006, Perkins IV, is a federal law, P.L. 109-270. The purpose of this act was to develop the academic career and technical skills of secondary and postsecondary students enrolled in career and technical education programs (Tennessee State Board of Education, 2009). To comply with the law, the Career and Technical Education Division of the Department of Education will administer End-of-Course tests in designated courses such as Algebra I (Tennessee State Board of Education, 2009).

How is Algebra Related to State Graduation Credit Requirements?

Successful completion of Algebra I is one of the first math requirements that must be met to comply with graduation standards set by the state. One in three students who enter ninth-grade fails to graduate with his or her class (Barton, 2005). Although mathematics is not solely to blame, it is the academic subject that students have failed most often (Steen, 2007). How do Tennessee graduation rates compare to the other 49 states? In 2002, Tennessee ranked third lowest in the nation with a 57% graduation rate (Greene & Winters, 2005). In 2003, 60% of Tennessee high school freshman graduated on time with a regular diploma (NCES, 2006). This percentage is much lower than the 2003 national average of 70% and the 85% that was the median senior graduation percentage of the top five states (NCES, 2006). Currently, 13 states require students to take Algebra II in order to graduate from high school, up from just two states in 2005 (Achieve, 2007).

In 2006, the state of Tennessee required that all students complete at least one of the following in order to graduate: Algebra I, Integrated Math I, or Technical Algebra (Tennessee Department of Education, 2006). Tennessee freshmen entering high school in 2005-2006 and later must also complete one of the following: Algebra II, Geometry, Integrated Math II, or Technical Geometry. In 2001, Tennessee high school students had to pass three Gateway tests to graduate with a regular diploma. In 2005, 76% of Tennessee students taking the Gateway EOC test for the first time passed with a score of "proficient" or higher (NCES, 2006). High school requirements are again changing to reflect the new standards. As of the 2009-2010 school year, the Gateway tests will be eliminated and EOCs will be used as a percentage of the term grade. Gateway requirements for diplomas will be removed for the entering high school freshman class of 2009-2010. Other changes to begin with the graduating class for 2013 include increasing the credit requirements to 22, aligning the curriculum with Achieve's standards, developing new standards, and developing one diploma for all students (Tennessee Diploma Project, 2008). Achieve is an independent, bipartisan, nonprofit education reform organization created in 1996 by the nation's governors and corporate leaders to help states raise academic standards and graduation requirements, improve assessments, and strengthen accountability. The high school math requirements consist of one math class each year, and these would include Algebra I, Geometry, Algebra II, and one of the following upper-level options: Bridge Math, a course designed for students who have not earned a 19 on the mathematics component of the ACT by the beginning of the senior year; Finite Math, a course designed for students who are not quite ready to move to a higher math; Advanced Algebra and Trigonometry; STEM Math; Pre-Calculus; Calculus; or Statistics (Tennessee Diploma Project, 2008). The exception to these requirements is for students with an Individualized Education Program, IEP, with a math disability. These identified students will take Algebra I twice and Geometry twice. The Tennessee Department of Education passed the new graduation standards on January 25, 2008, and they will become active for the 2009-2010 school year (Tennessee Diploma Project, 2008).

The High Schools That Work (HSTW) recommended curriculum proposes that all students complete four courses in mathematics including Algebra I, Geometry, Algebra II, and either a higher level mathematics course or a specially developed mathematics course such as a senior year catch-up course (Making Middle Grades Work, 2005). Those students who complete Algebra I in eighth-grade would still be required to take four additional years of mathematics, including a mandatory senior year mathematics course (Making Middle Grades Work, 2005). Project Algebra, a comprehensive Pre-Kindergarten through 12th-grade mathematics reform effort, listed several components for increasing success in mathematics achievement: Algebra I for all eighth-graders, an algebra-rich curriculum for all grade levels, consistent pacing throughout all grades and subject areas, instruction beyond the textbook in all mathematics courses across the curriculum, and a formal pre-Algebra I in the seventh-grade (Making Middle Grade Work, 2005)

Current Trends in Mathematic Instruction in Tennessee

In early 2007 Tennessee joined the American Diploma Project Network (ADP) and Achieve initiative that had been created to ensure that all students graduate from high school prepared to face the challenges of work and college (Tennessee State Board of Education, 2008). Tennessee was the most recent Southeast state to join the network (Tennessee Diploma Project, 2008). This network consists of 30 states that are committed to restoring value to the high school diploma by increasing the rigor of high school academic standards and aligning those standards with workforce and postsecondary demands (Tennessee State Board of Education, 2008). The ADP has four specific goals: align standards and assessments, require all high school students to take challenging courses to prepare them for life after high school, build college and work-ready measures, and hold high schools and postsecondary schools accountable for student performance (American Diploma Project, 2008). The ADP network gives Tennessee a blueprint for making their standards more rigorous and aligning graduation requirements with the demands of college and employment (Tennessee Diploma Project, 2008). Due to the ADP suggestions, the standard curriculum has shifted in focus from theory and abstract concepts to strategies for application and relation (Knox County Schools, 2009). The ADP project is led by the Tennessee Alignment Committee, a panel of state and local government officials, businesses, and postsecondary and K-12 leaders from across the state (Tennessee Diploma Project, 2008). Upon becoming an ADP state, Tennessee began the work of revising core content standards in the areas of Algebra I, Algebra II, and Geometry (Tennessee State Board of Education, 2008). Feedback on proposed changes was solicited from employers and educators across the state during the past year and standards were revised by writing teams comprised of grade 9-12 educators and college professors.

In June 2007 the standards were modified to ensure alignment with ADP benchmarks, ACT benchmarks, NAEP standards, and NCTM standards (Tennessee State Board of Education, 2008). Additionally, revisions of Algebra I, Algebra II, and Geometry standards were submitted in November 2007. Simultaneously, Kindergarten through eight mathematics standards were revised to support the increased expectations of the high school courses. In January 2008, Tennessee's State Board of Education approved the proposed changes, and those changes will take effect for the high school class of 2013 (Tennessee Department of Education, 2008). The new curriculum will introduce algebraic concepts in sixth grade in order to prepare students for eighth- and ninth-grade algebra classes, and these classes will then be expanded on in a variety of upper level math classes in the high school curriculum (Knox County Schools, 2009). These new Algebra I standards have added 29 new principles to the 2009-2010 End-Of-Course required standards, an equivalent of one semester in high school.

The Value of Algebra for Students Entering Colleges and Universities

In 2008, Tennessee was highlighted in Achieve, Inc's annual report. This *Closing the Expectations Gap* report assessed states in five areas. The report advises that states 1) align high school standards with the expectations of college and the workplace; 2) align high school graduation requirements with college and career-ready expectations; 3) develop college and career-ready assessment systems; 4) develop longitudinal data systems, which is a chronological study that attempts to establish a relationship between cause and effect; and 5) develop accountability and reporting systems that promote college and career readiness (Achieve, Inc, 2008). Tennessee fulfilled three of the five quality benchmarks and is in the process of meeting the remaining two standards: developing longitudinal data systems and developing accountability and reporting systems that promote college and career readiness (Tennessee Department of Education, 2008).

The American College Testing System administers a national aptitude test called the ACT that is used for college admittance criteria throughout the postsecondary system in the United States. The ACT is a universal evaluation used to assess the student potential of individuals from varying educational backgrounds. More than 1.2 million high school graduates took the exam in 2006. This type of measurement corrects for variation in grade point averages due to rigor and curriculum differences in schools, systems, and states for thousands of students. The ACT News Release (2001) suggested that students who take more math courses are better prepared for college than students who do not.

The math portion of the ACT involves 60 math questions: 24 pre-algebra, 18 intermediate algebra and coordinate geometry, and 18 plane geometry and trigonometry (ACT, 2006). Students with four or more math courses scored higher on the exam than those who had completed three or fewer courses (ACT, 2006). Two factors reflecting higher ACT achievement were rigorous coursework preparation and high grades. These results were independent of family background characteristics, students' attitudes about school, and teacher, counselor, or parent supervision.

Course pathways seem to be the primary indicator of increased mathematical rigor and subsequent ACT achievement as evidenced by the fact that students who had no algebra or only

Algebra I by the 10th grade achieved significantly lower scores. These results were based on groups with the same level of math proficiency in the eighth-grade year, the first recognized year of high school pathway assessment (United States Department of Education, 1997). There is little doubt that early algebra exposure and more advanced math coursework is a powerful indicator of subsequent mathematics achievement (NCES, 1996).

There is very strong support for increased math instruction at the secondary level. A National Educational Longitudinal Study (NELS) conducted by the Department of Education in 1997 found 83% of students who took Algebra I and Geometry enrolled in college within 2 years of their scheduled high school graduation, and of the students who did not take Algebra I and Geometry only 32% went to college. Similar statistics are reflected in *Mathematics Equals Opportunity* (Starr, 2003). One in three students who enter college must remediate major parts of high school mathematics as a prerequisite for college math courses such as College Algebra or Elementary Statistics (Greene & Winters, 2005). Research indicates that students who pass Algebra II in high school are 4.15 times more likely to graduate from college than students who did not (Adelman, 1999). Algebra II is a prerequisite for College Algebra, the mathematics course most commonly required for postsecondary degrees (Steen, 2007). Most college students who have not completed Algebra II at the secondary level will need to take remedial mathematics (Steen, 2007). In 2004, the National Science Foundation stated that finishing a course beyond Algebra II in high school more than doubled the odds that a student who entered postsecondary education would complete a bachelor's degree (Campbell, Branting, & Carson, 2005).

Many science educators debate the effect of the order in which students take science courses that consequently affects the order in which math courses are taken. Since the 1890s, biology has tended to start the sequence, followed by chemistry, and then physics (Washington Times, 2007). However, a study by Sadler and Tai surveyed 8,474 students taking introductory science courses at 63 United States colleges and universities found that based on a scale of 1 to 100 every year of high school math a student took added 1.86 points to his or her grade in college chemistry, and taking chemistry in high school added 1.72 points to the college grade, but taking biology or physics in high school had no significant impact on the college chemistry grade (Washington Times, 2007). Likewise, students taking college biology and physics had similar results (Washington Times, 2007). As a result of the study, Sadler concluded that the "most important thing for high school science teachers is to make sure there is lots of math in whatever science course they teach" and that "math is so important in college science" (Washington Times, 2007, p. 1). Additionally, Sadler noted that "for each additional year of mathematics, there's a benefit" (Washington Times, 2007, p.1).

Furthermore, studies by the Department of Education (1997) show that students who take rigorous math and science courses are more likely to go to college than those who do not. Therefore, college admission officers throughout the country consider the student's high school course schedule to be the blueprint of the high school career, with additional math courses adding strength to that record. The math track that allows for the completion of the highest level course in high school gives the student the widest range of future options, even if the student is not sure of his or her career plans (ACT, 2006).

Most 2-year colleges require degree-seeking students to take a mathematics placement exam. High test scores exempt students from taking remedial math courses (Northeast State Community College, 2007). Students find that many of the most popular majors offered at 2-year colleges require rigorous math courses. For example, the nursing major at Northeast State Community College requires a statistics course (Northeast State Community College, 2007).

Four-year colleges and universities require at least 3 and sometimes 4 years of mathematics in high school, although placement exams or ACT scores may be used to exempt students (United States Department of Education, 1997). According to the College Board in 1997, 68% of incoming freshmen at 4-year colleges and universities had completed 4 years of mathematics in high school (United States Department of Education, 1997).

Does Algebra Have Value in the Workplace?

Algebra is not only important for students wishing to continue their education, but it is also important in the workplace. Seventeen years ago Smith (1992) found that unskilled young adults were increasingly unable to obtain factory work and that the new technology-based jobs needed specifically skilled workers with a background in math. Unfortunately, this problem continues to grow. More recent workforce projections suggest a growing shortage of United States citizens with the kinds of technical skills that build on courses such as Algebra II (Committee on Science, Engineering, and Public Policy, 2007). As shown by employment and education data, Algebra II is a "threshold course" for high paying jobs, and five in six young people in the top quarter of the income distribution have completed Algebra II (Carnevale & Desrochers, 2003).

Awareness of the need for mathematics education in the workforce has been around for over 20 years. In 1989 the National Council of Teachers of Mathematics (NCTM) created curriculum education standards that called for more emphasis on conceptual understanding and problem solving informed by a constructivist understanding of how children learn (Woodward, 2004). These standards recommended teaching elements of algebra as early as fifth grade and elements of calculus as early as ninth grade. The Secretary's Commission on Achieving Necessary Skills (SCANS) report captured the country's anxiety about its transformation from a postindustrial economy to an information economy (Woodward, 2004). The SCAN report listed skills that high performance schools should produce and high performance workplaces should require that consisted of five basic competences built on a three-part foundation: arithmetic and mathematics, thinking skills, and personal qualities. Additionally, *America's Choice: High Skills or Low Wages*, the report of the Commission of the American Workforce in June 1990, focused on the need for education to produce knowledgeable workers who possess high levels of mathematical literacy and are proficient in the uses of technology (Woodward, 2004).

Mathematics and science related disciplines such as engineering and architecture typically have required an education consisting of rigorous mathematics courses (United States Department of Education, 1997). High school mathematics teaches students to express relationships between different quantities by using mathematical equations. Taking higher level math courses has benefited students who continued their education in 2- or 4-year institutions and those who went into the workforce (United States Department of Education, 1997). According to a study by Achieve entitled *Raise High School Graduation Requirements* (n.d.), 84% of those who hold highly paid professional jobs took Algebra II or higher math courses in high school. The same study found that 88% of noncollege students who took Algebra II or higher math courses in high school were more likely to say they were prepared for the math they are likely to face in the workplace (Achieve, n.d.).

Ketterlin-Geller et al. stated that most employers expected their employees to translate work-related problems into general mathematical models, from operating technology-based equipment to calculating discounts for merchandise. Additionally, solving complex problems such as chemical equations involved in the study of drug interactions are demanded by many careers in the fields of science and technology (2007).

The United States Department of Education (1997) found that mathematics ability was increasingly becoming a requirement for well-paying jobs. Clearly, this trend has continued. Jobs that once required little background in mathematics now require specific skills in algebra, geometry, measurement, probability, and statistics. Archibald (2004) found that in order to enter the information technology field, an employee needs to understand binary systems and computer operations, both of which are derived from advanced math skills. Twenty years ago the National Research Council (NRC) (1989) reported that the future of mathematics education linked career opportunity directly with training in mathematics. Smith (1996) found a direct correlation between employment rate and salary earned with the level of mathematics completed.

Research Brief (2001) published by the Association for Supervision and Curriculum Development stated that students who had taken more advanced math courses in high school are more likely to pursue postsecondary education and to have higher earnings. Rose and Betts in *Math Matters: The Links Between High School Curriculum, College Graduation, and Earnings* found a strong relationship between taking advanced math courses in high school and high earnings 10 years after graduation (*Research Brief*, 2001). However, even though the level of math courses correlates with college graduation rates and earnings, correlation does not necessarily imply causation. In order to capture the true effects of curriculum, Rose and Betts took into account as many other potentially contributing factors as the data would allow: the student's demographic characteristics including ethnicity and gender; measures of student motivation and ability such as grade point average; family background including parental education and income; and characteristics of the high school including school size, teachers' education level, and the percentage of disadvantaged students at the school (*Research Brief*, 2001). They found that students who take more advanced math classes learned skills that have been applicable to certain jobs and that they may also learn logic and reasoning skills that indirectly make them more productive. Learning advanced math may produce more skills needed in employment and lead to promotion into more demanding and better paid positions (*Research Brief*, 2001).

Taking advanced math courses certainly may affect earnings in the workforce. One extra course in algebra or geometry is associated with 6.3% higher earnings after controlling for the student's demographic, family, and high school characteristics (*Research Brief*, 2001). According to *Mathematics Equals Opportunity*, workers who have a background of demanding math and science courses have been more likely to be employed and earn higher wages than students without a background even if those workers did not attend college (Starr, 2003).

Summary

Mathematics education has continued to be reshaped and redefined throughout history. As our society grows increasingly more technological and complex, the need for math literacy and mathematics education will likely continue to grow. Today math curriculums are organized sequentially with Algebra I serving as the prerequisite for all higher level math courses. Consequently, access to advanced courses is dependent on access to this prerequisite. Many school systems begin the algebra pathway in grade nine (traditional) while others offer Algebra I to students in grades seven and eight (early enrollment). Students who have the option to enroll early in algebra are able to access more academic choices later in the high school curriculum.

The literature presented in this chapter indicates that students who are exposed to algebra early and who take more demanding math courses in high school subsequently show higher gains in mathematics achievement and develop a greater capacity for logical thinking. Advanced courses have a positive effect on student performance and college readiness. Therefore, students who take Algebra I in seventh or eighth grade have a wider range of future options whether they choose to enter college or the workplace. As a result of increased dependence on computer technology, the importance of algebra has far-reaching impacts on student assessments, state graduation credit requirements, preparation for college entrance exams, acceptance into colleges and universities, and performance in the workplace.

CHAPTER 3

METHODOLOGY

Introduction

This study examined the grade level in which students completed Algebra I (traditional [grade nine] and early enrollment [grade seven or eight] pathways) by comparing high school credits earned and standardized test scores. This study used a correlation research design, examining the credits earned and tested scores of high school seniors from two high schools during the 2007-2008 school year. The results of this study can aid education officials and administrators in considering whether or not to provide Algebra I to eighth-grade students.

Research Design

This study compared assessment measures of three groups of students (those students who completed Algebra I in seventh or eighth grade, ninth grade, or later) using a correlation research design. The correlation research design allowed for the use of statistical techniques that identified a degree of association between the predictor and dependent variables (Stencel, 2005). The predictor variable was the grade in which students successfully completed Algebra I: eighth grade, ninth grade, or later. The criterion variables were number of math credits successfully completed past Algebra I, ACT composite scores, and ACT math scores. If the ACT was taken more than one time, the highest score was used.

Pearson *r* bivariate correlation test was used to analyze the data. Pearson *r* correlation tests the magnitude and direction of the association between two variables that are on an interval or ratio scale. All statistical analyses were conducted using the Statistical Program for the Social Sciences (SPSS) Windows version 11.0 with the alpha level set at 0.05.

School Community Demographics

Research data were accessed and procured from two high schools in two city school systems in Northeast Tennessee. The data were collected from the population of 2004-2005 freshmen and 2007-2008 seniors from each of the two schools. The population of the two towns where the two city school systems are located averaged 29,818 people in 2007 (City Data, 2009). The percentage of white residents within the two towns equaled 92.35%, with black residents accounting for 5.4% of the population. The percentage of high school graduates equaled 74.7%, and 24.5% of those persons went on to attain a bachelor's degree or higher. The median household income of the area was $29,786.50 (City Data, 2009). The land area within the two towns averaged 26.5 square miles (City Data, 2009).

Procedure

A permission letter was sent to the superintendents of the two city school systems. Upon receipt of the superintendent's consent, data were obtained from each school. The focus of data collection was transcript analysis of math courses completed to ascertain the grade level at which Algebra I was completed, ACT composite score, and ACT math score. The data were collected between July 2008 and December 2008. Students' names and schools' names were eliminated from the analysis to guarantee anonymity.

Research Questions

In order to determine if early enrollment pathways supported greater academic success, the following research questions were addressed:

1. Is there a relationship between the grade in which Algebra I is completed and composite ACT scores?

Ho1: Students who successfully completed Algebra I in the eighth-grade did not have significantly higher composite ACT scores than students who did not successfully complete Algebra I in grade eight.

2. Is there a relationship between the grade in which Algebra I is completed and ACT math scores?

Ho2: Students who successfully completed Algebra I in the eighth-grade did not have significantly higher ACT math scores than students who did not successfully complete Algebra I in grade eight.

3. Is there a relationship between the number of higher level math courses completed and ACT composite scores?

Ho3: Students who successfully completed higher level high school math courses did not have significantly higher composite ACT scores than students who did not complete higher level high school math courses.

4. Is there a relationship between the number of higher level math courses completed and ACT math scores?

Ho4: Students who successfully completed higher level high school math courses did not have significantly higher ACT math scores than students who did not complete higher level high school math courses.

Data Analysis

The data collected for each student consisted of archival data from the school systems that specified the quantity of math courses completed after Algebra I, ACT composite scores, and ACT math scores. The compiled data were transferred into SPSS software for analysis and a Pearson *r* bivariate correlation test was completed. Three student groupings were obtained from the data set: students who successfully completed Algebra I during their eighth-grade year; students who successfully completed Algebra I during their ninth-grade year; and students who successfully completed Algebra I during their 10^{th}, 11^{th}, or 12^{th}-grade year.

Summary

This study examined the relationship between early enrollment Algebra I and academic achievement by high school seniors during the 2007-2008 year from the high schools of two city school systems in Northeast Tennessee. Pearson *r* bivariate correlation tests used the following variables: number of math credits successfully completed past Algebra I, year of Algebra I credit attainment, ACT math scores if taken, and ACT composite scores if taken. The results of the data analyses are presented in Chapter 4.

CHAPTER 4

DATA ANALYSIS

Introduction

The research questions introduced in Chapter 1 and the associated hypotheses presented in Chapter 3 are addressed in Chapter 4. The purpose of this study was to better understand the relationship between the grade in which students enrolled in Algebra I and ACT scores and number of higher level math credits earned. This study examined the role of Algebra I in both the traditional (grade nine) and early enrollment (grades seven or eight) pathways by comparing the number of high school math credits and standardized test scores earned by seniors. The data for the study were collected from two city school systems in Northeast Tennessee, and demographic similarities and differences are presented in Table 2 in Appendix A. Table 3 in Appendix B compares the demographics of the surrounding counties and towns. Data from test scores of seniors in the class of 2007-2008 were used for the study. Out of a total of 571 students, 164 students successfully completed Algebra I in either the 7th or 8th grade, 174 students completed Algebra I in 9th grade, 180 students successfully completed Algebra I in the 10th grade, and 53 students completed Algebra I in the 11th or 12th grade (see Table 4 in Appendix C). Ten math courses were offered in the two schools studied: Math Foundations, Algebra I, Geometry, Pre-Algebra II, Algebra II, Statistics, Trigonometry, Pre-Calculus, AP Calculus, and AP Statistics. Math Foundations class is the only class lower than Algebra I. The names of some courses were not exactly the same for both districts; however, the content of the course offerings was quite similar. As seen in Table 5 in Appendix D, 11 of the 582 students in the study did not successfully complete any math course higher than Math Foundations, nor did they successfully complete Algebra I. One hundred four students completed Algebra I as their highest math course, 198 completed Algebra II as their highest math course, and 269 students completed at least one math course higher than Algebra II. The study was guided by four research questions and the corresponding null hypotheses. Table 1 shows the correlation results of research questions #1-#4.

Analysis of Research Questions

Pearson *r* bivariate correlation test was used to analyze the data. Presentation of these data follows the organizational format of Chapter 3.

Research Question #1

Is there a relationship between the grade (7^{th} through 12^{th} grade) in which Algebra I is completed and ACT composite scores?

Ho1 (Null Hypothesis 1): Students who successfully completed Algebra I in the eighth grade will not have significantly higher composite ACT scores than students who did not successfully complete Algebra I in grade eight.

A Pearson correlation coefficient *r* was computed to test the relationship between ACT composite scores and the grade in which Algebra I was completed. The results of the correlation analysis revealed a strong negative relationship between the grade in which Algebra I was completed (M = 9.35, SD = 1.47) and the ACT composite score (M = 22.23, SD = 4.99), and a statistically significant correlation [r (504) = -0.61, $p < .001$] was found. Using an alpha level of $p = .05$, the Ho:1 was rejected because $p < .001 (< .05)$. In general, the results suggested that students with high ACT composite scores tended to take Algebra I earlier (seventh or eighth grade).

Research Question #2

Is there a relationship between the grade in which Algebra I is completed and ACT math scores?

Ho2: Students who successfully completed Algebra I in the eighth-grade will not have significantly higher ACT math scores than students who do not successfully complete Algebra I in grade eight.

A Pearson correlation coefficient *r* was computed to test the relationship between ACT math scores and the grade in which Algebra I was completed. The results of the correlation analysis revealed a strong negative relationship between the grade in which Algebra I was completed (M = 9.35, SD = 1.47) and ACT math score (M = 22.19, SD = 5.23), and a statistically significant correlation [r (504) = -0.65, $p < .001$] was found. Using an alpha level of $p = .05$, the Ho: 2 was rejected because $p<.001 (< .05)$. In general, the results suggested that students with high ACT math scores also tended to take Algebra I earlier (seventh or eighth grade).

Research Question #3

Is there a relationship between the number of higher level math courses completed and ACT composite scores?

Ho3: Students who successfully completed one or more higher level high school math courses will not have significantly higher ACT composite scores than students who did not complete higher level high school math courses.

A Pearson correlation coefficient *r* was computed to test the relationship between ACT composite scores and the number of math credits received past Algebra I. The results of the correlation analysis revealed a strong positive relationship between ACT composite scores (M = 22.23, SD = 4.99) and the number of math credits received past Algebra I (M = 3.25, SD = 0.81), and a statistically significant correlation [r (504) = 0.65, $p < .001$] was found. Using an alpha level of $p = .05$, the Ho:3 was rejected because $p < .001$(< .05). In general, the results suggested that students with high ACT composite scores also tended to receive more math credits past Algebra I.

Research Question #4

Is there a relationship between the number of higher level math courses completed and ACT math scores?

Ho4: Students who successfully completed one or more higher level high school math courses will not have significantly higher ACT math scores than students who did not complete higher level high school math courses.

A Pearson correlation coefficient *r* was computed to test the relationship between ACT math scores and the number of math credits received past Algebra I. The results of the correlation analysis revealed a strong positive relationship between ACT math scores (M = 22.19, SD = 5.22) and the number of math credits received past Algebra I (M=3.25, SD=.81), and a statistically significant correlation [r (504) = 0.69, $p < .001$] was found. Using an alpha level of $p = .05$, the Ho:4 was rejected because $p < .001$(< .05). In general, the results suggested that students with high ACT math scores also tended to earn more math credits past Algebra I.

Two school systems, City school system A and City school system B, were analyzed and compared using transcript analysis. Additionally, 11 school systems were examined by comparing their demographics according to their 2008 Report Card and the configuration of Algebra I offerings in their middle schools. All 11 school systems were located in the Northeast section of Tennessee. Five of the 11 school systems were city school systems (School Systems A through E) and the others were county systems (School Systems F through K). Of the 11 school systems examined, 7 school systems provided either Accelerated Algebra or Algebra I in middle school. For many of the school systems, only one of the several middle schools in the system offered such an Algebra configuration. For instance, in County school system K only one of their nine middle schools offered a pre-Algebra course, and in County school system H only one of their four middle schools offered a pre-Algebra course. Only city school system A allowed for seventh-grade algebra. These data are presented in Table 6 in Appendix E.

For those school systems that offered Algebra I in middle school, some offered high school credit while others did not. City school system D required students who had successfully completed an eighth-grade Algebra I course and received a high Gateway algebra test score, to apply for high school credit for the course. City school system E was not currently giving Algebra I credit or a math elective credit, but they are looking into offering this in the future. In County school system F no Algebra I credit was given, but a math elective credit was provided for the high school transcript. County school system G was similar to County school system F in giving a math elective credit, and in addition, the student was placed in an accelerated Algebra I class in the ninth-grade. Although County school system J does not currently teach Algebra I in eighth-grade, the county is planning to implement eighth-grade algebra access in 3 years for select students.

Of the 38 schools within the 11 city and county school systems, only one of the two K-12 schools offered Algebra I in seventh or eighth grade and provided high school Algebra I credit. None of the 16 K-8 schools offered Algebra I in seventh or eighth grade. Seven of the 20 grades 6-8 middle schools (including one eighth through ninth grade school) offered Algebra I in seventh or eighth grade and provided high school Algebra I credit. These data are presented in Table 6 in Appendix E.

The scores from the Report Card 2008 of City school systems A and B were higher than most other surrounding schools in percentage of proficiency and advanced excellence in 9-12 math (Tennessee Department of Education, 2008). City school system A scored 97%, which was higher than all of the other surrounding school systems. City school system B scored 95%, the second highest score among the 10 other surrounding school districts. The summary of the Report Card 2008 is noted in Table 8 (Tennessee Department of Education, 2008).

Summary

In summary, the Pearson *r* bivariate correlation test showed a strong significant correlation between the number of math credits past Algebra I and the grade in which Algebra I was taken. Strong negative relationships were noted between the grade of Algebra I completion and ACT composite score and between grade Algebra I completion and ACT math score. Strong positive relationships were noted between the number of math credits received past Algebra I and ACT composite score and between the number of math credits received past Algebra I and ACT math score. Table 1 shows the correlation results of research questions #1-#4.

Table 1.
Correlation Results Summary of Research Questions #1-#4.

Research Question	Variable #1	Mean Variable #1	SD Variable #1	Variable #2	Mean Variable #2	SD Variable #2	Correlation Results Df	r	p
RQ#1	ACT Composite	22.23	5.0	Grade Algebra I taken	9.35	1.47	504	-0.61	<.001
RQ#2	ACT Math	22.19	5.23	Grade Algebra I taken	9.35	1.47	504	-0.65	<.001
RQ#3	ACT Composite	22.23	5.0	# of Math credits taken past Algebra I	3.25	0.81	504	0.65	<.001
RQ#4	ACT	22.19	5.23	# of Math credits taken past Algebra I	3.25	0.81	504	0.69	<.001

Note. RQ—research question; ACT—American College Testing; SD—standard deviation; Df—degrees of freedom; *r*—Pearson *r* correlation coefficient; *p*—*probability* value

The results of Chapter 4 are discussed in the summary of findings, conclusions, and recommendations in Chapter 5.

CHAPTER 5

FINDINGS, DISCUSSION, AND RECOMMENDATIONS

Introduction

Traditionally school systems introduce Algebra I in grade nine. However in recent years many schools systems have offered early enrollment in which Algebra I is offered to students in grades seven and eight. The two school systems studied provided students with an opportunity to take Algebra I in seventh or eighth grade (in Study School A) and in eighth grade (in Study School B). Both schools were city schools.

Summary of Findings

The findings in this study are similar to the conclusions presented in the literature review. *Mathematics Equals Opportunity* stated that studies have indicated that students who take more demanding math courses show higher gains in mathematics achievement than students who take less challenging courses (Starr, 2003). The analysis for research questions 3 and 4 indicate that students who complete higher level math courses tend to obtain higher ACT math and composite scores. ACT, Inc. (2004) states that courses beyond Algebra I have a positive effect on student performance and college readiness.

Of the 598 students examined in the current study, 269 successfully completed at least one math course past Algebra II, as seen in Table 5 in Appendix D. The National Center for Education Statistics (1996) stated that there is little doubt that early algebra exposure and more advanced math coursework are powerful indicators of subsequent mathematics achievement.

The data analysis for questions 1 and 2 confirms this conclusion. The results of this study confirm the conclusion drawn by the American College Testing Program (ACT, 2006), which concluded that students with four or more math courses scored higher on the exam than those who completed three courses. The data analysis for questions 3 and 4 supported this conclusion.

The two sample school districts were similar in demographic makeup to each other, as noted in Table 2 in Appendix A, and with the surrounding school systems, as noted in Table 3 in Appendix B. However, availability of Algebra I in the seventh or eighth grades was not similar when the two sample school districts were compared to the other area districts. Of the 11 city and county school systems analyzed, 10 provided seventh or eighth grade Algebra I but only 6 of the 11 offered eighth grade Algebra I to at least some of their students and provided some type of high school Algebra I credit. As noted in Table 6 in Appendix E, 7 of the 11 school systems offered Algebra I in middle school to at least some of their students.

Discussion

The results from the two districts studied showed a strong negative correlation between ACT math and composite scores and the grade in which Algebra I was taken. Additionally, the results from the study showed a strong positive correlation between ACT math and composite scores and number of math credit accrued past Algebra I.

The scores of sample School A and B were higher than most other surrounding schools in percentage of “proficient” and “advanced” students according the 2008 Report Card in 9-12 math (see Table 7 in Appendix F). School System A scored 97%, which was higher than all of the surrounding school systems. School System B scored 95%, the second highest score among the 11 examined school systems (see Table 7 in Appendix F).

There is a weakness in the study in that I was not comparing groups that I had reason to believe were initially equal. The inequality involved comparisons between the group of students who took Algebra I early and those who did not. This was a select group of students who took Algebra I early, not a group that was a reasonable sample of students. This select group was with students for whom better math achievement would be expected. To strengthen this study an additional study would need to be completed. This study would randomly assign students to groups with one group taking Algebra I in grade eight and the other taking Algebra I in grade 9. With such a study one could draw more logical conclusions

Recommendation for the Two Sampled Schools

According to Smith (1992), at least 80% of American eighth graders are intellectually capable of learning algebraic content. In my study, 164 of the 571, or 29%, of the students successfully completed Algebra I in the seventh or eighth grade. Although some states and cities have attempted to require Algebra I in middle school (Viadero, 2009), the two school districts in this study did not require Algebra I of all students. Rather, these students were selected based on the recommendations of prior teachers, past scores on standardized tests, past marks in math courses taken, and, in the case of one school, scores from the Orleans-Hanna Algebra Readiness Test (Hanna, 1998). One teacher who had previously taught at School A stated that the math teachers in that system were considering including those students who scored just below the cut-off point to still be eligible for early Algebra I. This change is due to past experiences in which students who scored high on the readiness test but not quite high enough were still able to be successful in the early Algebra I track. The recommendation for the two sampled school districts is to continue offering Algebra I in middle school.

Recommendations for Practice

To strongly support the feasibility of early access to Algebra I either for credit or as a prerequisite during the first part of the freshman year, I recommend that schools (principals and teachers) ask their districts the following questions:

1. Is there a need to assess the ability of their middle school students by using an Algebra I readiness test?
2. What would it take for a change in math delivery and teacher knowledge in kindergarten through sixth grade to better support early delivery of Algebra I?
3. Are early Algebra I students ready for a credit course?

Each one of these questions has to be considered within one's own school district. Does the school district have a recommendation system for placing a student in a pre-Algebra or Algebra I class in middle school? Some school systems allow each school to determine its own recommendation criteria; however, other school systems have a uniform policy. These recommendation systems may include prior standardized scores, prior teacher recommendations, prior work habits, and maturity level. Additionally, one sample school used the Orleans-Hanna test (Hanna, 1998) to assess Algebra I readiness. School districts may consider using such a test or creating their own math readiness test. In these cases, it is suggested that an annual review be used to determine the effectiveness of this criterion in predicting success in eighth grade Algebra.

Another action that must be undertaken by the school district is identification of the factors necessary for improving teacher knowledge and increasing the quality of math instruction delivered in grades K-6 so that students are academically ready for eighth grade Algebra I. School districts should review the programs and lessons being taught in K-sixth grade and reflect on how the curriculum and instruction can be improved through incorporation of math skills that have previously taught in higher grades. However, additional math skills cannot be successfully taught unless teacher knowledge is sufficient to support the development of student skills in these areas. Supplementary professional development must be provided to these teachers in order to enable them to correctly use and incorporate these new math skills into their present curriculum. Additionally, all grades should consider how their own math goals and standards could be taught in an interdisciplinary manner so that the students will be able to view and understand these concepts not only in the math classroom but also in the other subject classrooms.

Third, the school district must decide whether or not the Algebra I students are ready for a credit course in middle school. School districts might conclude that a pre-Algebra course in middle school would enable those students to easily master Algebra I in the first semester in high school and then be ready to take either Geometry or Algebra II during their second semester. The two sampled schools provided an example of both decisions; School A allowed students to take Algebra I in the seventh-grade, so that a small number of students were on the Unified Track determined by the Orleans Hanna Test (Hanna, 1998), or in the eighth-grade. Additionally, students who did not take Algebra I in the seventh or eighth grade could take pre-Algebra I in the eighth grade. In sample school B, students who took the Access to Algebra I in the eighth grade were able to take Algebra B during their first semester in high school, thus finishing their requirement for Algebra I. They were then able to take Access to Algebra II during their second semester in high school. Both sample schools were on block schedules that allowed them to successfully complete two math courses per year.

Fourth, the State Department of Education and the State Board of Education should consider developing incentives for school districts and providing assistance in the development of Algebra I teaching practices. This may include development of an Algebra I readiness test similar to the Orleans Hanna test (Hanna, 1998) used in School A. Additionally, these regulatory bodies could develop systems for students that need additional support to succeed in eighth grade Algebra I, create an interdisciplinary practice within the school districts, and determine criteria for assessment of Algebra I readiness that include intellectual development, work habits, and maturity.

Recommendations for Future Research

For future research, I recommend that one would investigate what impact will new and tougher standards have on student outcomes. Will the tougher standards elevate student outcomes or will student outcomes lower? Additionally, the study sample size was small and an additional larger sample study is needed to verify outcomes.

Additionally, I recommend a study that would randomly assign students to groups with one group taking Algebra I in grade eight and the other taking Algebra I in grade 9. With such a study one could draw more logical conclusions.

Summary

The purpose of this study was to assess the value of offering Algebra I earlier in a student's educational program. This study showed that quantity of math credits accrued past Algebra I and higher ACT math and composite scores positively correlated with earlier completion of Algebra I.

However, more research is needed to apply this small sample to a generalized population. Additionally, the two sample school systems had early enrollment Algebra I policies not representative of surrounding districts.

Authorities in each school system must determine its own capabilities with regard to the creation of math programs that enable students to have Algebra I access earlier rather than later. This process may involve creating an assessment for readiness, examining instructional math patterns in K-8, and teacher preparation that strengthens math knowledge in the younger grades.

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APPENDICES

APPENDIX A

Table 2.

Demographic Summary of the Cities of City School System A and City School System B.

	Northeast Tennessee City A	Northeast Tennessee City B	State of Tennessee
Population (based on 2000 census)	44,191	15,446	5,689,283
White persons	93.3%	91.4%	80.2%
Black persons	4.2%	5.7%	16.4%
High school graduates	76.5%	72.9%	75.9%
Bachelor’s degree or higher	23.6%	20.4%	19.6%
Median household income	$30,524	$29,049	$36,360
Land area (square miles)	39	14	

APPENDIX B

Table 3.
Demographic Summary of the City and County School Systems Examined.

School System	Population	White persons	Black persons	High school graduates	Bachelor's degree or higher	Median household income	Persons below poverty	Free and reduced lunches % in district
A City	44,191	93.3%	4.2%	76.5%	23.6%	$30,524	17.1%	42%
B City	14,446	91.4%	5.7%	72.9%	20.4%	$29,049	24.8%	37%
C City	59,866	90.1%	6.4%	78.8%	29.4%	$30,835	15.9%	39%
D City	25,351	95.1%	3.0%	76.1%	17.4%	$30,039	15%	43%
E City	13,925	94.7%	2.5%	68.8%	15.4%	$29,613	22.9%	41%
F County	18,107	96.1%	3.0%	58.4%	6.9%	$39,706	15%	66%
G County	59,198	96.7%	1.8%	69.1%	12.8%	$32,287	20.1%	65%
H County	116,657	93.7%	4.1%	77.2%	22.9%	$40,267	17.3%	43%
I County	153,519	96.3%	2.2%	75.8%	18.1%	$39,706	15%	40%
J County	57,054	97.2%	1.6%	70.4%	10.0%	$37,398	16.4%	57%
K County	65,971	96.5%	2.3%	69.6%	12.8%	$35,246	19.7%	55%

APPENDIX C

Table 4.
Year in School of Algebra I Successful Completion for City School System A and City School System B.

Year of successful completion of Algebra I	Number of students completing Algebra I
7th or 8th grade	164
9th grade	174
10th grade	180
11th or 12th grade	53

APPENDIX D

Table 5.
Summary of Students' Math Credits of City School System A and City School System B.

Description of highest math course completed	Number of students successfully completing math credits
1=Less than Algebra I	11
2-Algebra I	104
3=Algebra II (completed Algebra I, Geometry, and Algebra II)	198
4 = Past Algebra II (completed Algebra I, Geometry, Algebra II, and at least one higher math than Algebra II)	269

APPENDIX E

Table 6.
Summary of Algebra I Offerings Regarding Configuration of Grade Levels in the City and County School Systems Examined.

Configuration of grades levels in school	Number of schools examined	Number of schools providing Algebra I or Accelerated Algebra I in 8th grade and providing high school Algebra I credit
K-12th grade school	2	1
K-8th grade school	16	0
6th-8th grade school (includes one 8th-9th grade school)	20	7

APPENDIX F

Table 7.
Summary of the 2008 Report Card of the City and County School Systems Examined.

2008 Report Card	2007 Graduation Rate	NCLB Status	% below proficiency in 9-12 math	% proficient in 9-12 math	% advanced in 9-12 math	% proficient and advanced in 9-12 math	HS AYP summary (met AYP)
A	89.4	GS	3	36.4	60.9	97	+
B	93.7	GS	5	24.8	70.4	95	+
C	94.3	GS	5	17.9	76.6	95	+
D	85.9	GS	6	26.5	67.1	94	+
E	86.6	GS & 1 SI	6	34.8	59.2	94	+
F	87.9	GS	5	38.4	56.1	95	+
G	87.2	GS& 1 SI	16	40.8	42.8	84	+
H	80	GS& 2 T	20	37	43.2	80	+
I	81.5	GS, 1T, & 2SI	11	33.1	56	89	+
J	76.7	GS& 2SI	7	31.2	61.3	93	x
K	90.0	GS& 1T	5	32.1	62.5	95	+
State Average	90		13	36.9	49.9	87	+

GS = Good Standing
SI = School Improvement
T = Target

APPENDIX G

Letter of Permission

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Director of Schools
****
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Dear Dr. ************,

I am a doctoral student at East Tennessee State University. I am completing my dissertation through the Educational Leadership and Policy Analysis (ELPA) program at ETSU. My dissertation is entitled "Access to Algebra I: Gateway to Success. A study of the impact of the delivery of eighth-grade Algebra I in Northeast Tennessee High Schools". To be able to complete this study, permission must be granted to obtain the needed data from the central office with the archival data from 2007-2008 seniors of Dobyns Bennett High School.

During this research I am trying to determine if a relationship exists between early enrollment pathways that support greater academic success in regards to higher composite and math ACT scores and more high-level high school course credits beyond Algebra I. The timeframe of the data collection will be from July 2008 through December 2008. The IRB of ETSU has deemed the project non-research by Form 139 (see attached). After obtaining the approval of the appropriate school system officials, data will be collected from the central office and other area city central offices regarding their high schools' archival data. The needed data from the 2004-2005 freshman (2007-2008 seniors) transcripts include: transcript analysis of math courses taken and at what time (especially Algebra I) and ACT scores (both math and composite scores).

In order to ensure anonymity, the school system and the participant schools will not be referenced in the study. If you would like to preview the design of the study, a prospectus is available at your request. Please notify me of your permission for access to the 2007-2008 seniors of Dobyns Bennett High School by returning this letter with your signature.

Sincerely,

I give approval of the study being conducted in ********* High School using the data denoted above.

____________________________________ ____________________

Signature Date

VITA

EMILY JEAN SKELTON DARLING

Personal Data:	Date of Birth: June 15, 1978 Place of Birth: Kingsport, Tennessee Marital Status: Married
Education:	Public Schools: Kingsport, Tennessee East Tennessee State University, Johnson City, Tennessee: Biology, B.S. 2000 University of Tennessee at Knoxville, Knoxville, Tennessee: Secondary Education, M.A. 2003 East Tennessee State University, Johnson City, Tennessee: Educational Leadership and Policy Analysis, Ed.D., 2010
Professional Experience:	Teacher, Alcoa City Schools, Alcoa High School, July 2002-June 2003 Teacher, Washington County Schools, University School, July 2003-June 2007 Teacher, Henderson County Schools, Hendersonville High School, August 2007-June 2009 Park Ranger, National Park Service, Great Smoky Mountains National Park, June 2009-present
Additional Accomplishments:	“Drones and Worker Bees Jive in a Five Week Hive – the concept of peer mentoring/teaching” presentation at the National Association of Laboratory Schools (NALS) National Conference in Utah, Spring 2005 Science Laboratory, Renovation Project Co-leader, $110,000 grant, East Tennessee State University and University School, 2005 “Comparison of ACT Scores to Math and Science Course Sequences at University School”, *Tennessee Educational Leadership,* Fall 2006 “The Relationship Between Algebra I Classroom Grades and Algebra I Gateway Scores”, mini-grant recipient from the College of Education of East Tennessee State University, Spring 2007