MATH LITERACY: THE RELATIONSHIP OF ALGEBRA, GENDER, ETHNICITY, SOCIOECONOMIC STATUS, AND AVID ENROLLMENT WITH HIGH SCHOOL MATH COURSE COMPLETION AND COLLEGE READINESS

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The questions guiding this research seek to discover the factors that affect high school math course completion and college readiness in a Texas suburban public school district. The first research question examines the relationship between 8th grade completion of Algebra I and high school mathematics course taking patterns and college readiness. The second question evaluates the relationship between race, gender, socioeconomic status and enrollment in the Advancement Via Individual Determination (AVID) program to college math readiness and high school mathematics course completion. Participants included 841 high school graduates of the class of 2006; 76% of the graduates were White, 15% Hispanic and 7% African American. Twenty-three percent of students were economically disadvantaged and 46% of students completed Algebra I in 8th grade. Chi-square, Cramer’s V, and multiple regression were conducted to evaluate possible relationships between variables. The chi-square and Cramer’s V showed statistically significant ($p<.05$) relationships between 8th grade algebra completion and both college readiness and high school math course completion. A significant statistical relationship was also found between college readiness and each of the independent variables, ethnicity, economic status, completion of 8th grade algebra and enrollment in AVID. The number of math courses completed in high school was statistically related to ethnicity and economic status. The findings of this study indicate that early access to Algebra I can positively affect the number of high school math courses a student completes and the likelihood that the student will be college ready after high school graduation.
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CHAPTER 1
INTRODUCTION

Despite the mandated educational reform of the past 20 years, American children and adolescents continue to score below the international average in mathematics aptitude (Geary & Hamson, 2006). The federal government, state legislatures, school districts, and individual school campuses place high importance on implementing the laws, policies, and programs aimed at improving math education for students in kindergarten through 12th grade. Although 8th grade math scores in the United States ranked above the international level according to the Third International Mathematics and Science Study (TIMSS), 2003 math scores at the upper secondary level ranked below the international average (National Center for Education Statistics, Trends in International Mathematics and Science Study 2003(a), n.d.). Across the country college entrance exam scores on the math sections of the Scholastic Aptitude Test (SAT) and ACT (formerly known as the American College Testing program) have declined (College Board, 2006). The United States’ business sector spends as much on remedial mathematics education for its employees as is spent on school, college, and university mathematics programs combined (Battista, 1999). Sixty percent of students who graduate from high school are not prepared to take college level math at graduation and must first enroll in a remedial college mathematics course. In Texas alone $53 million a year is spent on remedial math education; nationally, remedial math education costs $17 billion (Achieve, 2006).

Statement of the Problem

Even though theories related to mathematics education and the demands of technology and the economy have changed, the mathematics taught in schools have not prepared young
people for industry or the university (Bell & Bell, 2007). Twenty-three percent of Texas high school students do not pass the math exit level state assessment, 50% of high school graduates must take a remedial course before enrolling in college credit courses, ACT and SAT math scores are decreasing, and U.S. students continue to score below the international level (National Center for Education Statistics (b), n.d., Achieve, 2006, Rooney, Hussar, Planty, Choy, Hampden-Thompson, Provasnik & Fox, 2006, Dougherty, Mellor & Smith, 2006). While there are many factors affecting mathematics education, no definitive practice or program has resulted in improved mathematics literacy.

Purpose of the Study

The purposes of this study is to examine the math course patterns of a particular group of students who completed either Algebra I or a general math course in 8th grade and to fill some of the important gaps in the present literature. This study examines whether or not the cohort of students completing Algebra I in 8th grade took more advanced math in high school, were better prepared for college, and earned higher scores on the standardized testing required of all students in Texas. The research questions are designed to address not whether there is value in completion of Algebra I at the eighth grade level, but rather how the completion of the course results in success in mathematics courses throughout high school, on ACT and SAT tests, as well as success in college mathematics.

Research Questions

The research questions for this study include:

1. If a student takes Algebra I in 8th grade, is the student more likely to complete four
years of high school math courses and also be ready to take a college level mathematics course after high school graduation?

2. What is the relationship between race, gender, socioeconomic status, and enrollment in the Advancement Via Individual Determination (AVID) program have on college math readiness as measured by college and university standards and high school mathematics course completion?

It is hypothesized that there is no relationship between 8th grade Algebra I and high school math course completion and college readiness. Because most current research shows that the gender gap in math access and achievement has narrowed, it is hypothesized that there will be no relationship between gender and high school mathematics course completion and college readiness. The hypotheses relating socioeconomic status and ethnicity to college readiness and high school math course taking patterns predicts that there will be a statistically significant relationship. AVID reports that 74% of students served through the program are accepted to a four year university but it is hypothesized that there will not be a significant relationship among AVID enrollment, college readiness, and high school math course completion.

Overall, the questions guiding this research sought to discover how the completion of 8th grade Algebra I, gender, ethnicity, socioeconomic status, and enrollment in the Advancement via Individual Determination (AVID) program relate to high school math course completion, college readiness, and state assessment scores in a Texas suburban public school district.

Rationale

As schools seek a solution to improved mathematics achievement, they must consider the sequence and acceleration of math education. One important course in this sequence, Algebra I, has been identified as the portal through which students must travel to access knowledge and a
full range of academic and economic opportunities that would not otherwise be available to them (Gamoran & Hannigan, 2000). Many districts encourage students to complete Algebra I in 8th grade while some districts strictly limit the number of students who have access to high school mathematics in 8th grade. Research indicates that 8th grade completion of Algebra I directly influences the math literacy and mathematical ability of students (Ma, 2000, Gamoran & Hannigan, 2000, Useem, 1992). However, the relationship between 8th grade algebra and college readiness, standardized testing, and high school course taking patterns is unclear. An important consideration is whether students who complete Algebra I in 8th grade are more or less likely to complete four years of mathematics in high school. Since many high school graduates are not able to meet the standard required to begin college level math and English, the effect of finishing 8th grade Algebra I on college readiness must be evaluated. Also, in the age of accountability, it is important to examine the impact completing Algebra I in 8th grade has on the state mandated, standardized exam.

Most states’ high school graduation criteria require students to complete fewer than four years of math in high school. However, research by Adelman (1999) found that 83% of high school graduates who completed calculus in high school went on to earn a college degree. Only by completing Algebra I in 8th grade is a student prepared for and able to take calculus in high school. This pipeline to higher mathematics and increased opportunity runs directly through the Algebra I course. Seventy-four percent of students who complete precalculus and 39% of students who complete Algebra II earn college degrees. Yet, only one-half of the states in the United States require Algebra II for high school graduation (Zinth, 2006). Caranevale and Desrochers (2003) found that five of six young people in the top quarter of the income distribution completed Algebra II in high school. These findings indicate that high school
According to Larson (2007) current course taking policies are responsible for widening the achievement gap between white, not economically disadvantaged students and black, Hispanic, or economically disadvantaged students. A student who is provided the opportunity to learn Algebra I in 8th grade enhances his or her future course taking choices and resultant effect on college degree completion. Moses, Cobb and Cobb (2002) believe that the absence of math literacy limits the economic access of poor people and people of color.

In 2006, the Education Trust and Thomas B. Fordham Foundation launched the American Diploma Project to identify knowledge and skills students need in English and math to be college ready. Results of the project showed that 60% of high school graduates must complete a not-for-credit developmental, or remedial, course in either English or math in order to meet the criteria to enroll in a credit earning college level math or English course (Achieve, 2006). In Texas 44% of high school graduates must take a developmental math course in college (Texas State Higher Education Coordinating Board, 2002). Many of the students who take remedial classes fail to earn a college degree. Sixty-three percent of students who take remedial math and 76% of students who take remedial reading do not complete a college degree. The effect of remedial courses is far-reaching. Forty percent of all high school graduates enroll in community college; many of these students must complete developmental courses before enrolling in college level math or English. Only 20% of community college students will go on to earn a college degree (Doyle, 2006). In contrast, 58% of students who enroll in a four year university complete a bachelor’s degree. Not only can taking remedial courses decrease the likelihood of earning a bachelor’s degree, the cost of taking these not for credit classes uses valuable funds allocated for
degree attainment. With the cost of postsecondary education increasing at a rate of 10 to 24% across the country, paying for remedial courses becomes a financial hardship impacting college degree attainment.

One of the purposes of math education and math literacy must be to prepare students for postsecondary education. How well secondary math education prepares students for college and careers has economic, college completion, and standard of living implications. Schoenfeld (2002) identifies the lack of math competence and ability as a barrier to full participation in the economic mainstream. The fastest growing sectors of the economy require students to have education beyond high school. Educational level is positively correlated with increased income levels, decreased unemployment rates, and improved quality of life (Berry, 2003). College graduates, as compared to their counterparts who do not complete college, more than double their earnings over a lifetime (Porter, 2002). They also are more likely to enjoy increased levels of saving, increased personal and professional mobility, improved quality of life for their offspring, better consumer decision making, and more hobbies and leisure activities. Porter’s research (2002) found a positive correlation between completion of higher education and good health for college graduates and their children. Students inadequately prepared in mathematics limit their college major and career choices. In fact, according to Useem (1992) the math and science programs at the university level are dependent on international students and would be in disarray if reliant on U.S. students only.

According to data gathered through Achieve (2006), some postsecondary education is required for 67% of all new jobs in the United States. However, the reality is few students are well prepared for college mathematics courses after high school graduation. Achieve found that of every 100 high school freshmen who enter high school in Texas, 64 complete high school in
four years, 35 enter college immediately, 22 are still enrolled at their sophomore year, and 13 graduate from college within four years. Nationally 68 of every 100 students graduate from high school, 40 enter college immediately, 27 enroll for their sophomore year, and 18 graduate on time. This gap requires further study.

**Historical Context and Theoretical Basis**

To illustrate the dismal state of math skill and understanding consider the following example from an international mathematics test: “What is the approximate value of 19/20 + 23/25?” Given the choices of 1, 2, 42, and 45, 50% of United States 8th graders chose 42 or 45 (Steen, 2007). These 8th graders could not recognize that 19/20 and 23/25 are both fractions approximately equal to one. When students have difficulty solving a simple arithmetic problem it is unlikely that they will be able to complete the higher level, analytical problem solving required in Algebra I and subsequent higher level mathematics courses. This poses a problem that has not been adequately addressed through public education, theory, or research.

The importance of mathematics and quantitative literacy in the lives of ordinary people emerged slowly. In colonial America, leaders such as Benjamin Franklin and Thomas Jefferson promoted numeracy as a way to empirically evaluate the new democracy. Over time quantitative methods became a dominant form of acceptable evidence (Steen, 2001). In the early 19th century there was increased focus on quantitative description and numerical reasoning as a result of the vast transformation of the economy (Cohen, 2001). When the economy moved from an emphasis on farming to commercialization and industrialization the level of mathematics literacy required of workers and citizens increased as the level of education provided by the state increased (Ellis,
As a result of increased public access to education, Americans became a more math literate population at the end of the twentieth century.

Access to public education profoundly changed the mathematics literacy standard in America. Initially grammar schools taught arithmetic, and colleges taught mathematics. As secondary schools became conventional, teaching mathematics like algebra, geometry and calculus moved to the secondary level (Steen, 2001). However, teaching and learning how to think and reason mathematically, not simply applying mathematical algorithms, is still noticeably absent from the traditional secondary school curriculum. According to Hagues-Hallett (2001), mathematics education has focused solely on learning mathematics principles without a focus on identifying and analyzing mathematics in context. Teaching mathematics in context affects math literacy by using insight involving reflection, judgment, and experience.

In the past, theories related to learning mathematics have focused mainly on cognitive research where the student’s understanding of mathematical concepts and ways of learning were studied (Even & Schwarz, 2003). Mathematics education research in the 1990s began taking sociocultural aspects of learning into account and became the foundation of research related to practice. The sociocultural approach highlights student and teacher participation in learning and teaching activities and the interaction between teaching and learning and between knowledge and practice. Wilson and Peterson (2006) identify three contemporary ideas about learning. First, learning is a process of the student’s active engagement. No longer are students expected to complacently sit and receive information. Students learn best when they are actively involved, constructing their own learning. Secondly, learning is individual and social. Students know and understand by doing and working with others. Finally, current theories of learning (Even & Schwarz, 2003, Steen, 2001) argue that learner differences can be used as resources, not
obstacles. These differences include variations of intelligence and diversity in ethnicity, culture and interest. Research in mathematics education commonly aligns with these three ideas by emphasizing inquiry, discourse, community, and a social construction of knowledge (Wilson & Peterson, 2006).

**Definition of Terms**

**ACT** - Formerly known as the American College Testing program, ACT is a curriculum based national college admission and placement examination. Questions on the ACT are directly related to what students have learned in high school English, math and science courses (ACT, 2008).

**Algebra I** – Algebra is a branch of mathematics that uses mathematical statements to describe relationships between things that vary over time (Texas Education Agency, 2008). Topics in Algebra I include understanding patterns, relations and functions, representing and analyzing mathematical situations, and structures using algebraic symbols, using mathematical models to represent and understand quantitative relationships, and analyzing change in various contexts (National Council of Teachers of Mathematics, 2008). Symbolic reasoning, function concepts, and relationships between equations and functions are also important concepts studied in an Algebra course.

**Advancement via Individual Determination (AVID)** – A college preparatory program for students in the academic middle and those who have been typically underserved in advanced academics. AVID students are provided the support to success in a rigorous academic curriculum that prepares them for enrollment in a four-year college or university.
CAHSEE - The California High School Exit Examination, CAHSEE, has two parts: English-language arts (ELA) and mathematics and is a diploma requirement for students graduating in 2006 and thereafter. In addition to the use of the CAHSEE as a graduation requirement, the spring CAHSEE administration is used to calculate the academic performance index for state accountability purposes and adequate yearly progress to meet federal No Child Left Behind requirements (California Department of Education, 2006).

College readiness – College readiness defines what students should know and be able to do to succeed in an entry-level college course. It is the ability to perform at a level in a college course that is sufficient to progress to another course in the subject or to transfer knowledge learned to a course in another subject area (Texas Higher Education Coordinating Board, 2007). According to the College Board (College Board, 2007), students are college ready when they have the knowledge, skills, and behaviors to complete a college course of study successfully, without remediation.

Graduation requirements - In order for high school students to receive a transcript and diploma they must meet state mandated requirements. Usually each state will require that a student earn a specific number of credits in English, math, science, social studies, and additional courses. In addition, most states require students to pass a standardized exam in order to meet graduation requirements.

Longitudinal Study of American Youth (LSAY) – The LSAY is a six year panel focusing on mathematics and science education. Data were collected from students, parents, teachers, and principals in 52 middle and high schools in the United States. This longitudinal study effectively compiled data related to students’ achievement, attitudes, and family background (Ma & Williams, 1999).
Math literacy – Also referred to as quantitative literacy, math literacy refers to mathematical content knowledge, mathematical reasoning, understanding of the social impact and utility of mathematics, understanding the nature and historical development of mathematics, and mathematical disposition (Wilkins, 2000). Math literacy is also the ability to compute and solve problems at levels of proficiency necessary to function on the job and in society to achieve one’s goals and to develop one’s knowledge and potential (Northwest Regional Educational Laboratory, n.d.),


National Assessment of Educational Progress (NAEP) – The National Assessment of Educational Progress, a nationally representative assessment of mathematics, science, writing, reading, the arts, civics, the economy, United States history, and geography assesses abilities of students in Grades 4, 8, and 12 in public and private schools. Data are collected by aggregating samples from each state and allows comparison of the performance of students in one state with the performance of students across the nation or in other states. NAEP, sponsored by the U.S. Department of Education, has been conducted for over 30 years (Rooney et al, 2006).

National Council of Teachers of Mathematics (NCTM) – NCTM, a professional organization with 100,000 members and 250 affiliates throughout the United States and Canada, provides vision, leadership, and professional development to support teachers of mathematics (National Council of Teachers of Mathematics, n.d.).
National Education Summit on High School – Sponsored by Achieve, Inc. and the National Governors Association, the National Education Summit on High School meets to address the needs of America’s educational system. Governors, policy makers, CEOs, and educators address core issues related to strengthening requirements for rigorous coursework, creating a partnership between K-12 education and colleges and universities to set common expectations, improving teacher and principal leadership, and expanding options for students to achieve high standards (Maurer, 2005).

No Child Left Behind (NCLB) Act – In 2001, the federal government under the leadership of President George W. Bush enacted the No Child Left Behind Act in an effort to increase accountability for states, school districts, and schools, provide greater choice for parents and students, and increase flexibility for states and local educational agencies in the use of Federal education dollars. The NCLB Act strengthens accountability by requiring states to implement statewide accountability systems for all public schools and students. These systems must be based on challenging standards in reading and mathematics, annual testing for all students in Grades 3-8, and statewide objectives ensuring that all groups of students reach proficiency within 12 years (U.S. Department of Education, 2008).

National Educational Longitudinal Study (NELS) – NELS provides three in-school waves of data about the experiences of students as they leave elementary school, progress through high school, and enter post-secondary institutions or the work force (National Education Longitudinal Study NELS 88, 2008). Data from NELS, collected through achievement tests in reading, social studies, mathematics, and science and through student questionnaires, have impacted policy-relevant research about educational processes and outcomes. (National Education Longitudinal Study of 1988, 2008).
Scholastic Aptitude Test (SAT) – Sponsored by the College Board, the SAT is a three hour and 45 minute test that measures critical thinking, mathematical reasoning, and writing skills of students preparing for admission to a college or university. Most United States universities and colleges require students to submit a SAT or ACT score as a requirement for college admission (College Board, 2008).

Southern Regional Education Board (SREB) – Composed of government and education leaders in 16 states, the SREB works to advance education and address key education issues related to P-20 education to help states and institutions form long-range plans and policies (Southern Regional Education Board, 2008). One of the SREB middle grades goals is to increase the percentage of 8th graders who perform at the proficient level and are ready to complete college preparatory work in high school (Cooney and Bottoms, 2003).

Texas Academic Skills Program (TASP) – Mandated by the 78th Texas legislature, TASP was designed to determine whether students possess the basic skills in reading, writing, and mathematics necessary for success in university courses. TASP requires college applicants to complete an exam measuring competency in reading, writing, and mathematics before enrolling in college level courses. Students who meet specified criteria may be eligible for an exemption from meeting the TASP requirement. The TASP program was replaced by the Texas Success Initiative through action of the 78th Texas legislature (Texas Success Initiative, n.d.).

Texas Assessment of Knowledge and Skills (TAKS) – Mandated by the 76th Texas legislature, TAKS measures the statewide curriculum in reading at Grades 3-9; in writing at Grades 4 and 7; in English Language Arts at Grades 10 and 11; in mathematics at Grades 3-11; in science at Grades 5, 10, and 11; and social studies at Grades 8, 10, and 11. High school students must pass each of the five sections of the 11th grade, Exit level, examination in order to
meet graduation requirements. The TAKS is used as a measurement of accountability required by the No Child Left Behind Act (Texas Education Agency, 2008).

Texas Higher Education Coordinating Board (THECB) – Created by the Texas Legislature in 1965, the Texas Higher Education Coordinating Board develops policies and practices aimed at meeting the higher education requirements of Closing the Gaps by 2015. Colleges and universities must increase enrollment by 630,000 and support more research in the state for academic excellence (Texas Higher Education Coordinating Board, 2008).

Texas Higher Education Assessment (THEA) – The THEA test measures the reading, writing, and mathematics skills of freshmen-level college students to determine if a student can perform effectively in undergraduate certificate or degree programs in Texas public colleges and universities. THEA replaces the TASP test as an assessment instrument to evaluate incoming college students (About the THEA, 2008).

The Third International Mathematics and Science Study (TIMSS) - The Third International Mathematics and Science Study is the largest and most ambitious studies conducted by the International Association for the Evaluation of Educational Achievement (Mullis, Martin, Beaton, Gonzalez, Kelly and Smith, 1998). TIMSS consists of a mathematics and science test covering five grades. More than half a million students in more than 40 countries participated. Data collected from TIMSS has been analyzed in a many research studies related to science and math education.

Texas Success Initiative (TSI) – Mandated by the 78th Texas Legislature, the TSI is designed to measure competency in reading, writing, and mathematics in order to provide developmental studies in areas of identified deficiencies. Texas students not eligible for an exemption or waiver must take an approved placement test prior to enrolling in any Texas public
college or university. Approved placement tests include the ACT Compass, Accuplacer, Asset, and THEA exam (Texas Success Initiative, n.d.).

Limitations

The processes through which students are selected for 8th grade Algebra I are varied and non-standard, seldom relying on a measurable score or rigid criteria. Because the process through which students are chosen for 8th grade Algebra I is random, possible common characteristics, such as increased math ability, high IQ, parents educational background, are not identified. It is possible that students who complete algebra in 8th grade bring innate, superior ability in math to the table. These students might thrive in mathematics whether or not they experienced Algebra I in 8th grade. These students might have also completed more advanced mathematics in high school regardless of the mathematics course taken in 8th grade. It could be that exposure to 8th grade algebra was not the culminating factor for increased math course completion or college readiness.

There are also limits to the generalizations that can be made from the population studied in this research to the general population of students. Districts around the state and country subscribe to a wide range of entrance criteria for 8th grade algebra. In particular, students in this school district where chosen for acceleration according to policies, programs, and procedures specific to the district. This study is based solely on the unique characteristics of a particular school district in Texas.

Significance of the Problem

Because the strongest factor associated with college degree completion is the pattern of
advanced high school mathematics course attainment, studying factors associated with mathematics education has far reaching consequences. Adelman (1999) found that completing a course like precalculus in high school had more effect on college degree attainment than parents’ educational background, socio-economic status, or ethnicity. Identifying how early access to Algebra I affects high school math course completion can ultimately influence the likelihood of college degree completion.

When fewer than 30% of high school graduates who enroll in college earn a bachelor’s degree it is important to make sure that kindergarten through 12th grade education prepares students to enroll in college level courses upon high school graduation. According to data compiled by Achieve (2006) $17 billion is spent annually in the United States on remedial education. Students who are not prepared to complete college level math will be delayed in earning college credits, incur additional expense, and be less likely to earn a college degree. Educators must examine how secondary school students are prepared for college success.

Declining math scores of American children on the international and national level illustrate the need to rethink how public education is preparing students to function well in an increasingly scientifically, technologically, and mathematically based economic society. Economic opportunities are limited for those who have limited math skills. Those students who study advanced mathematics in high school have greater opportunity to compete successfully in a global economy. No Child Left Behind and the resulting accountability standards have not produced the significant improvement needed in mathematics education. Thus, examining the relationship between early access to Algebra I and mathematics literacy and proficiency adds one more piece to the puzzle of determining how secondary math education best prepares students.
While numerous studies have examined the value of Algebra I in the mathematics course taking sequence, no previous study has measured the relationship between early access to algebra and success on high school math course completion or college readiness. This study will analyze the relationship between taking 8th grade algebra and high school mathematics course taking patterns, college readiness, and mastery of the state mandated assessment.

Organization of the Dissertation

This study is organized into five chapters. The first chapter provides an introduction to the study, statement of problem, limitations, definitions of terms, and significance. Chapter 2 reviews the literature related to the study. It explores three areas of research: mathematics education, college readiness, and high school math course taking patterns. The third chapter describes the methodology of the study, including, a description of the demographics and organizational structure of the district, data collection, and data analysis process. Chapter 4 explains the methodology used to answer the research questions and interprets the analysis of the data collection results. The fifth chapter discusses the effects of early access to Algebra I and the conclusions reached. Chapter 5 also presents implications of the study’s findings and makes recommendations for future research related to this topic.
CHAPTER 2
LITERATURE REVIEW

The Need for Math Literacy

Math literacy, the ability to compute and solve problems at levels of proficiency necessary to function on the job and in society to achieve one’s goals and to develop one’s knowledge and potential (Northwest Regional Education Laboratory, 2006), has been and is a critical issue at the district, state and national levels. The need for math literate citizens continues to grow as a result of the increased expectations of today’s quantitative world (Schoenfeld, 2002). Outstanding mathematical ability, an important societal resource, is needed to maintain leadership in today’s technological world. In order to function at the optimal level people must be math literate - able to model and understand real-world phenomena using quantitative tools, analyze and understand complex logical arguments, and use technological tools appropriately and effectively. This everyday understanding of mathematics has also been called quantitative literacy. Quantitative literacy encompasses mathematics content knowledge, math reasoning, understanding the social impact and utility of mathematics, understanding the nature and historical development of mathematics and math disposition (Wilkins, 2000). Educators, researchers, employers and professionals recognize the critical role of an everyday understanding of mathematics for well-informed and productive citizens. Numeracy, or mathematics literacy, is an understanding of math beyond the content knowledge level.

Math is a crucial indicator of future economic competitiveness because of its widespread industrial, military, and scientific application (Hall, 2001). Eighty percent of new jobs will require some postsecondary education; yet only 42% of today’s students leave high school with the skills necessary to complete college level work (Achieve, 2006). Since educating our
children to be mathematically literate is necessary for today’s quantitatively complex society, the amount of high school mathematics completed becomes a critical determinate of a student’s career and college degree options (Wilkins & Ma, 2002). Identifying the kindergarten through 12th grade curriculum that best prepares students for higher learning and competitive jobs is paramount.

A study by the National Commission on the High School Senior Year concluded high school graduates are unprepared for the literacy, computation, and problem solving demand of today’s high performance workplace (Berry, 2003). Despite the educational reform movement of the past 15 years, student achievement has not increased at the level expected (Creech, 2001). Too many students still drop out of school; too few students attend college; there has been little progress in closing the achievement gap between white and other ethnic subgroups; and too few students take a rigorous high school curriculum, especially during the last year of high school. We must provide high standards for all students, the issue of who gets what curriculum is gravely important.

Moses, Cobb and Cobb (2002) state the following:

Today . . . the most urgent social issue affecting poor people and people of color is economic access. In today’s world, economic access and full citizenship depend crucially on math and science literacy. I believe that the absence of math literacy in urban and rural communities throughout this country is an issue as urgent as the lack of Black voters in Mississippi in 1961 (p. 5).

Moses created the Algebra Project, one of the nation’s best-recognized school reform efforts (Roach, 2004). Moses’ project focused on mathematics literacy using civil rights strategies to organize and motivate middle school students to study mathematics. Middle school students were taught to make the conceptual shift from arithmetic to algebra so that they were able to complete algebra in 8th grade and be prepared for a rigorous high school math sequence. Ninety-
two percent of students involved in the Algebra Project went on to upper-level mathematics
courses in 9th grade, twice the rate of students not in the project. Introducing Algebra to students
in 8th grade provided the gateway to mathematics literacy, the key to 21st century citizenship
(Moses et al., 2002). Studying challenging mathematics allows students to compete successfully
in the global economy.

National/International Math Studies

Results of the TIMSS, the Third International Mathematics and Science Study 2003, also
illustrate the need for improved mathematics education. Undertaken by the International
Association for the Evaluation of Educational Achievement (IEA), TIMSS was the largest, most
comprehensive, and most rigorous study of school mathematics. Five grade levels in more than
40 countries with 500,000 students participated in TIMSS. TIMSS has been used to track
changes in achievement over time and is closely linked to the curricula of participating countries
(TIMSS 2003 Results, n.d.).

One of the goals of the TIMSS was to assess the mathematics literacy, or knowledge of
math, of students in their final year of secondary school (Wilkins, 2000). The Mathematics and
Science Achievement in the Final Year of Secondary School study, a portion of the TIMSS
2003, found countries that earned high rankings in math achievement at the 8th grade level did
not always rank high in math literacy at the upper secondary level. Only five countries produced
scores above the international level at both the 8th grade and the upper secondary level. On an
international level, a link between 8th grade mathematics success and math achievement in upper
secondary school was not related. The United States ranked above the international average at
the 8th grade level and below it at the upper secondary level.
Other results of the 2003 TIMSS revealed that United States student achievement in math fell significantly in comparison to the math achievement of students in 16 other nations (National Center for Education Statistics (b), n.d.). Moreover, the TIMMS study showed that American students lose ground in math between Grades 4 and 8 and never regain it. TIMSS 2003 results concluded 8th graders improved their average mathematics performance compared to 1995 (National Center for Education Statistics (a), n.d.). Scores of United States 8th graders exceeded the international level, as well as average scores of 8th graders in 25 of the participating 44 countries.

Another study, the 2005 National Assessment of Educational Progress, NAEP (National Center for Education Statistics(b), 2006) assessed United States mathematic achievement in five content areas: number properties and operations, measurement, geometry, algebra and data analysis and probability. Participants were 152,800 8th graders from 6,500 hundred schools. Results of this study showed that mathematics achievement improved for the nation. Over the past 15 years average scores of 8th grade math students increased by 16 points on a 0 to 500 point scale. From 2003 to 2005 there was a 1-point average increase in the NAEP math assessment scores. At the 8th grade level, seven states scored higher in 2005 than in 2003. Of the 38 states participating in both the 1990 and 2005 assessment, each had a higher average score and a greater percentage of students scoring at or above the basic level in 2005 than in 1990. Texas 8th graders began scoring above the national average in 2000, gaining 1 point in 1996, 2000, and 2003. In 2005, Texas students scored, on average, 3 points higher than the national average. However, the improvement of 8th grade mathematics scores does not continue at the high school level. In 2001, 31% of high school seniors scored below the basic level in mathematics (National Center for Education Statistics (a), n.d.).
In an attempt to measure math literacy and the impact of math education, the National Center for Education Statistics (NCES) submits a report on the Condition of Education to the United States Congress (Rooney, et al., 2006). Since 1990 NCES has assessed the mathematical ability of students in Grades 4, 8 and 12 in public and private schools. One of the four assessments used to collect data for the Condition of Education report is the Program for International Student Assessment (PISA). PISA reports on the mathematics literacy and problem solving ability of students in 29 participating Organization for Economic Cooperation and Development (OECD) industrialized countries and 10 non-OECD countries. The commissioner concluded that 15-year-old students in the United States had lower average scores in mathematics literacy than students in 20 of the 28 countries participating in PISA 2003. American students scored lower in the areas of combined math literacy, specific mathematics skill areas, and problem solving.

Independent studies also reflect the need for United States education to focus on improvement in the math literacy of our students. The earnings gap over the past 30 years between young people who have a four-year college degree and those that don’t continues to widen (Trusty & Niles, 2003). The impact postsecondary education has on earning power, employability and job openings is well documented. Adelman (1999) found the two variables most important to college degree attainment were the intensity of a student’s high school curricula and the continuity of a student’s college enrollment. Of all courses taken within a student’s high school years, an intensive high school mathematics course had the strongest effect on degree completion. Trusty and Nile’s (2003) work examined how credits in intensive mathematics courses affect the completion of a bachelor’s degree. Algebra II, trigonometry, pre-calculus and calculus were considered intensive math courses; geometry was not held to be a
rigorous class. Using data from the National Educational Longitudinal Study: 1988-2000, Trusty and Nile’s found that there was a steady decrease in the number of students earning credit as the math courses progressed in difficulty from Algebra II to trigonometry to pre-calculus and calculus. Receiving one credit in Algebra II more than doubled the odds of earning a bachelor’s degree within eight years.

State Issues and Assessments

Even with increased accountability and rigorous mathematics reform, state and nationally initiated testing programs have not produced the desired increase in math achievement. The NCLB Act of 2001 requires every state to demonstrate adequate yearly progress (AYP), and all students are expected to be grade-level proficient in math and reading-language arts by 2013. In 2003, the Texas Assessment of Knowledge and Skills (TAKS) became Texas’ measure of AYP (Dougherty, Mellor & Smith, 2006). Students must pass the exit level state assessment in math, science, language arts and social studies in order to graduate. California, for the first time in 2006, will also require students to pass the exit level state assessment before graduating from high school. While Texas and California require students to pass exit level math exams in order to graduate, the level of accountability of the test varies with the legislative mandates of the state. Twenty-three percent of Texas high school students do not pass the math exit level state assessment, 50% of high school graduates must take a remedial course before enrolling in college credit courses, ACT and SAT math scores are decreasing (College Board, 2006), and U.S. students continue to score below the international level (National Center for Education Statistics, Trends in International Mathematics and Science Study 2003(a), n.d.). The state of Texas has mandated that the 9th grade class of 2007 must complete four years of mathematics for
high school graduation. These new requirements create a timely need to understand the impact 8th grade Algebra I will have on high school math course completion.

Currently the TAKS assesses Algebra I making algebra most critical to student success on the exit level math TAKS (Kilgo, 2006). That the most commonly failed sections of the TAKS are math and science forces educators to examine how the high school math and science curricula are preparing students for graduation. As more states require that students pass a standardized math assessment based on Algebra I, the successful completion of this course becomes increasingly significant.

For many students algebra is the major stumbling block to high school graduation (Schoenfeld, 2002). As part of the state and federal assessment program every 10th grade student in California takes the California High School Exit Examination, (CAHSEE). Thirty-six percent of the 80 CAHSEE items address grade 7 and Algebra I content standards. The state of California has declared early access to algebra is a key component to future academic success. The California Department of Education (2006) has identified Algebra I as the gatekeeper course to academic achievement in high school and beyond and has established Algebra I as the appropriate 8th grade math course.

A study by Taylor (2006) found that 99% of California students enrolled in 8th grade Algebra I successfully passed the CAHSEE and that a student’s 8th grade mathematics course level was the strongest predictor of CAHSEE scale score, proficiency status and pass/fail status. Completion of 8th grade algebra was a more significant predictor of CAHSEE mathematics scores than ethnicity, socioeconomic status and parents’ educational level. In 1999 16% of California 8th grade students completed Algebra I. By 2003 this number had grown to 32%.
Fewer than 33% of 8th grade students enrolled in a course below Algebra I scored at the proficient level on the 10th grade CAHSEE mathematics exam.

State and Federal Standards

Public school educators are faced with the ever-increasing challenge of meeting state and federal requirements. Above average performance is expected for all students. In math, Algebra I by 8th grade has become the holy grail of educational reform. But research has shown that mathematics educational reform has not produced many of the desired outcomes.

The National Assessment of Educational Progress found that certain subgroups of both 4th and 8th graders outperformed others in mathematics in 2005 (Rooney et al., 2006). White and Asian/Pacific Islander students earned higher scores than their Black, Hispanic, or American Indian peers. In 2005, the average score on the 4th grade mathematics assessment decreased as the percentage of students in the school who were identified as economically disadvantaged increased (Rooney et al., 2006). Mathematics education and equal access to rigorous mathematics education is not only an issue related to preparedness and ability to function in today’s world but also an issue of social justice.

An advanced math curriculum is the strongest indicator of bachelor’s degree attainment, an essential component of economic choice and freedom (Adelman, 1999). Completion of math and science courses in high school prepares students to study higher-level courses in college and to select math and science majors. Mathematics filters students out of programs leading to scientific and professional careers and areas of study and limits the career and college options of thousands of high school graduates. The low achievement of United States’ secondary students in the fields of engineering and other technology, when compared with other industrialized
countries, has become a matter of national concern (Singh & Ozturk, 2000). Whether or not students take advanced high school math courses also has serious implications for standardized testing, college readiness, future earnings, and careers in math and science.

Recognition of the need for math literate students prompted the National Council of Teachers of Mathematics (NCTM), the world’s largest mathematics education organization, to develop standards for the reform of mathematics curriculum, teaching and assessment in American schools. These guidelines, referred to as NCTM’s Principles and Standards for School Mathematics (2000), were designed to enable students to understand and be able to use mathematics in everyday life and in the workplace. Put into place six years ago, the guidelines for excellence in mathematics expanded access to significant mathematics for all students and discouraged the tracking of students into either college preparatory or basic mathematics course selections. NCTM purports that those who understand and can do mathematics well will have significantly enhanced opportunities and options for shaping their futures and recommends increased mathematics literacy for all students regardless of math ability (National Council of Teachers of Mathematics, n.d.).

Math Literacy and Cognition

Algebra I is the gateway course to math literacy. The Algebra I curriculum defines fundamental skills and knowledge needed for subsequent courses. The grade at which a student enrolls in Algebra I determines the number and rigor of higher-level math courses the student may access in high school. However, in order to access higher mathematics learning students must be ready to learn math at increasingly advanced cognitive levels at earlier ages. Some experts believe that the decision to teach or learn Algebra I in 8th grade, or even 7th grade in
certain situations, should be based on a child’s ability to think at an abstract level. Often, trying to teach Algebra I to a 13 or 14 year old student requires that an abstract concept be taught to a child who is still at the concrete operational state of development (Marshall, 2006).

Shayer and Wylam’s (1978) research showed that approximately 18% of 13 and 14 year old students and 25% of 14 and 15 year olds can be expected to function at the formal operational stage needed for understanding the abstract ideas that form the basis for algebraic thinking. Piaget’s theory of cognitive development emphasizes the link between a child’s developmental level and instructional strategy. This model when applied to adolescent learning can help explain at which developmental stage children might be more disposed to learning abstract math. Kamili (2001) found young children could represent numbers at a lower level of abstraction than their current functioning but not a higher level. Prevost (1985) concluded that students who take Algebra I before they are developmentally ready may have greater difficulty in advanced mathematics courses. Students who have not reached the abstract level of thinking might be able to complete the concrete math manipulations involved in algebra but will not be able to apply the abstract reasoning required. Only a small percentage of 8th grade students have developed this ability (Jensen, 1998).

Cognitive research takes into account the influence the acquisition of conceptual, procedural, and utilization competencies has on mathematics learning. The acquisition of procedural competencies requires extensive practice while acquisition of conceptual competencies can happen without practice. Understanding the influence cognition has on procedural and conceptual competencies in mathematics provides an important framework for utilizing math abilities. Learning to read, learning algebra, or learning scientific laws will not occur as automatically as language acquisition – the former represent unnatural domains for
human beings while the latter, language, represents a natural form of learning (Geary & Hamson, 2006).

The Algebra I course requires students to make connections between the concrete and abstract, solve difficult problems, and make sense of real world situations using mathematics (National Council of Teachers of Mathematics, 2000). By identifying patterns and expressing these patterns in some fashion, students begin to think mathematically and bridge the gap from arithmetic to algebra. An introduction to algebra is often the first exposure students have to higher level, abstract thinking about numbers. Algebra symbols and the procedures involved are critical to mathematics literacy (National Council of Teachers of Mathematics, 2000). According to Moses (2000), “Algebraic thinking is the vehicle for exploring the world and its irregularities” (p.5).

The National Council of Teachers of Mathematics (2000) recommends students learn algebra as a set of concepts and techniques tied to the representation of quantitative relations involving patterns, functions, and generalizations. With well-planned, informed math instruction, even young children can begin using algebraic reasoning as they study numbers and discover patterns and relations among sets of numbers.

Concerns Related to Algebra I

Early exposure to ideas related to algebra can significantly impact a student’s achievement in mathematics and ability to succeed in early access to an algebra course. NCTM believes that all students must problem solve, make connections, and learn to reason and prove. This process allows communication and representation to become a part of mathematics instruction in every classroom and students to be better prepared for algebra and the subsequent
higher level math required for math literacy. Results of the TIMSS (Mullis, 1998) also support early exposure to algebraic concepts. TIMSS students in every country studied reported that solving equations was an important component of mathematics in upper secondary school. The amount of time these students spent working equations was correlated with higher achievement on the TIMSS advanced mathematics test. Exposure to higher level mathematics benefits all students.

For the last 10 to 15 years policymakers have promoted programs that increase the number of 8th grade students taking Algebra I (National Center for Education Statistics (b), n.d.). What hasn’t been studied is the effect early access to algebra has on continued math course taking during the high school years and the resultant math literacy of the population. Data from TIMSS, NAEP, college entrance exams, and college readiness exams illustrate the overall decline in the math literacy of students and high school graduates. However, numerous studies point to the benefit of 8th grade completion of Algebra I.

Smith (1996) studied the relationship between 8th grade algebra and mathematics attainment. Using data from the High School and Beyond sample, students were divided into two groups; those who took Algebra I in high school and those who, by implication, had taken the course prior to high school. Smith concluded that students who had early access to algebra differed from their non-algebra peers by ethnic background and socioeconomic status and also had increased math achievement scores and higher educational aspirations in 10th grade. According to this research by Smith early completion of Algebra I led to completion of more advanced mathematics, including a math course taken in the senior year, and increased math achievement.
Many experts believe the positive effects of completing 8th grade algebra make access to this course essential for all students. Adelman (1999) found that students who completed Algebra I in 8th grade earned higher grade point averages and took more advanced math courses than students who completed algebra or pre-algebra in 9th grade.

A study conducted by Wilkins and Ma (2002) revealed that students who were on track to take algebra in or by the 8th grade exhibited significantly higher rates of growth in student learning than students who were not involved in algebra. This conclusion was based on data from the Longitudinal Study of American Youth (LSAY) that examined the development of mathematics and science achievement in American students in grades 7-12.

However there are also concerns related to the early acceleration of students into Algebra I courses. Issues like gaps in mathematics knowledge and skills, poor retention of knowledge, affective difficulties and the possibility of being burned out physically and mentally can result from an early acceleration in mathematics (Ma, 2003). Math anxiety, a general lack of comfort that someone might experience when required to perform mathematically, is a documented factor affecting many children’s math performance. Students accelerated to complete Algebra I in 8th grade may experience greater math anxiety when the acceleration does not match the learning needs or abilities of the student. Hall (2001) found enrollment in and completion of an algebra course at too early an age can undermine a student’s math confidence and mastery of mathematics. Mastery of mathematics is worthy of consideration since students who complete Algebra I in 8th grade lose one year of foundational mathematics. According to the National Council of Teachers of Mathematics the majority of math teachers believe that math is sequential and that basic ideas and foundational skills must be mastered before beginning an Algebra I course.
Along with readiness to learn there are other factors that impact a student’s mathematics achievement. According to Schreiber and Chambers (2003), there is a strong relationship between attitude and achievement in math. A positive self-concept and positive academic beliefs about mathematics were found to be related to achievement in math. Issues, including gender, socioeconomic status, and parental educational background have also been examined for their relationship to mathematics achievement.

Historically there has been a gap between females’ and males’ mathematics achievement and enrollment in advanced mathematics. However, in a 26 national study of 15 year olds male students scored higher in math knowledge but girls obtained higher math grades (Mau & Lynn, 2000). USA Today (Jones, 2008) reported that the math gender gap is less pronounced in countries where males and females have similar rights and opportunities. Forty countries were studied, in 12 of the countries females and males scored the same. The United States fell in the middle in terms of equity and the gender gap in mathematics. In a study of 2634 students in a southeastern school district, Speilhagen (2006) found that more females than males studied 8th algebra. This research also showed that access to 8th grade algebra was disproportionate by ethnicity. Black students comprised 20% of the population but less than 10% of 8th grade algebra takers.

Even though the benefits of early access to Algebra I have been well-documented, the opportunity to study Algebra I in 8th grade is often reserved for specific, selected students. These students are identified almost arbitrarily by ability, teachers, the student’s choice, and a parent’s influence. This process remains random despite research that shows early access to algebra has a sustained, positive effect on students that can lead to exposure to an advanced mathematics curriculum (Taylor, 2006). According to data from the 1990 National Assessment of Educational
Progress, less than 20% of United States 8th grade students complete an Algebra I course while another 20% complete a course labeled as PreAlgebra (Smith, 1996).

Idiosyncratic school placement philosophy and practice limits many students’ opportunity to learn algebra in 8th grade (Useem, 1992). There are vast differences in entrance criteria across states, districts, and often even schools within a district. According to Useem (1992), “Students who would be deemed fully qualified for accelerated math in one system could easily find themselves rejected for that same track in an adjacent school district” (p. 346). Useem’s study of 26 school systems found that districts with highly educated parents have a larger proportion of students taking algebra in 8th grade. High school calculus enrollment followed this same pattern. This study also examined how school administrator’s philosophy affected advanced mathematics enrollment. Administrators who believed that calculus is best studied in college, not high school, restricted the enrollment of 8th grade students in Algebra I. Administrators who valued the study of calculus at the high school level were more likely to encourage 8th grade students to enroll in Algebra I. The 8th grade entrance criteria for Algebra I vary wildly. Current research does not identify effective placement criteria to make higher mathematics accessible and equitable.

According to Burris (2003), the most influential factor on 8th grade enrollment in Algebra I is parent insistence. Educated parents are more likely to insist on their 8th graders access to Algebra I than non-educated parents. Inconsistency in the selection process has resulted in inequitable access to higher level mathematics.

Most schools arbitrarily determine who will have access to algebra and when that access will be granted. California is an exception and has mandated the enrollment of 8th grade students in Algebra I. The California Department of Education (2006) has identified Algebra I as the
gatekeeper course to academic achievement in high school and beyond and has established Algebra I as the appropriate 8th grade math course. All public schools in California administer an algebra readiness test that measures mastery of pre-algebra skills to all 7th grade students. Students who score above a specified level are placed in an 8th grade algebra course. The long term effects of this enrollment process on college readiness, high school course completion, or success on the CAHSEE have yet to be analyzed.

Students who are fortunate enough to be enrolled in the fast-track of Algebra I often benefit from the most enthusiastic and highly motivated master teachers – in 8th grade and throughout their advanced math track in high school. At the same time beginning teachers or teachers not favored by administrators often teach the less academically motivated or capable (Useem, 1992). Moving from the low track to the high track is virtually impossible. Eighth grade Algebra I often sets the course for a positive high school math experience.

College Readiness

Nationally 50% of high school graduates are not prepared for college level work and are required to take non-college credit developmental courses in math and/or reading (Achieve, 2008). Even with the national emphasis on accountability, the measurement of adequate yearly progress and mandated state assessments and accountability many students are not able to meet the college readiness standard. This has become an increasingly critical problem in America. The knowledge-based, global economy requires that more than two-thirds of the American population to have some post-secondary education (Achieve, 2006). Yet major demographic shifts in the population of the United States, resulting in math achievement gaps by ethnic groups, is predicted to decrease the portion of the workforce with college skills over the next 15
years (Callan, Finney, Kirst, Usdan & Venezia, 2006). The need for improved math preparation
of high school students for college level work has come to a serious juncture.

Adelman (1999) found that higher-level high school math courses like pre-calculus and
calculus better prepare students for college entry and achievement in college level mathematics.
In the study, “Answers in the Tool Box” Adelman (1999) examined what contributed most to
bachelor’s degree attainment. He found that the academic intensity and quality of a student’s
high school curriculum counts most in preparation for bachelor’s degree completion. Completing
pre-calculus was found to be a stronger predictor of bachelor’s degree attainment that
socioeconomic status or parents’ educational background. Finishing any mathematics course
beyond Algebra II doubled the odds of attaining a bachelor’s degree. This one factor, completion
of a course beyond Algebra II, had more effect on college degree attainment than high school
grade point average, high school class rank, SAT or ACT score. Completion of a math course
beyond Algebra II diminishes the effects of socioeconomic status and race on college
completion. Trusty (2003) also found that math course taking in high school had the strongest
effect on bachelor’s degree attainment.

High school preparation for college entrance and completion has become a core factor for
public schools. Every college and university determines its own admission criteria. A relatively
small percentage of schools are very selective; most have some admission criteria; and a few
have an open admission policy. Once accepted to a particular college or university, a student
must meet additional requirements before enrolling in a college level math or English class.
These requirements include earning a minimum score on a college designated assessment or on
the SAT or ACT exam. The Texas Academic Skills Program, or TASP, represents the Texas
standard for college readiness. TASP measures competency in reading, writing and math. The
College Board produces two alternative TASP exams, the Measure of Academic Progress (MAPS) test and the Accuplacer exam measuring math, reading comprehension and sentence skills; ACT also produces an alternative TASP exam, the Computer Adaptive Placement Assessment and Support System exam (COMPASS). These three exams are used throughout the country as a measure of college readiness. Earning a minimum score on any one of these exams qualifies a student to enroll in a college level math or English course.

The Texas Higher Education Coordinating Board (THECB) has approved the use of the TASP exam and the alternative exams and has set a minimum score for mastery. In the 1999-2000 academic year, passing rates on the math section of the TASP exam, or one of the other alternative TASP exams, for students who were testing for the first time ranged from 19.4% to 51.8%. This passing rate on the math section was from 20 to 36 percentage points lower than the passing rate on the reading or writing section of the exam (Texas State Higher Education Coordinating Board, 2000).

The Texas Success Initiative (TSI) replaced the TASP in 2004. A student not eligible for an exemption must take a TSI approved placement test before enrolling in college courses. Students may be exempt from participation in TSI with:

1. A composite score of more than 1070 on the SAT and at least 500 on both the verbal and written math sections
2. A composite score of more than 23 on the ACT and at least 19 on both the English and math sections
3. A qualifying score on the Exit level Texas Assessment of Knowledge and Skills (TAKS) of 2200 on the math and English Language Arts sections and a writing sub score of 3 or higher (TSI, 2006)

Only six states’ standardized high school assessments may be used for college course placement decisions (Achieve, 2006). California and Texas are two of these six states whose high school test meets the rigor required to indicate whether or not a student is prepared for
college level math and English classes. Even though a Texas student may qualify to enroll a college algebra course by scoring well on the TAKS exam, a National Center for Educational Accountability report found that a college readiness score of 2200 on the TAKS math exam indicated only a 77% probability that a student would be successful in a college algebra course (Doughtery et al, 2005). The Thomas B. Fordham Foundation (Finn, Julian & Petrilli, 2006) examined state standards in five subjects; United States history, English/language arts, mathematics, science and world history, in an effort to establish useful, high quality standards necessary to clearly direct K-12 instruction. The Fordham Foundation’s State of State Math Standards 2005 report (Klein, 2005) graded state’s math standards based on content, clarity, reason, and negative qualities. Results showed that only three states, California, Indiana, and Massachusetts, earned a grade of A for their state math standards. Most states were assigned grades of D or F. According to this study, state standardized assessments have not accurately measured a student’s readiness for college level work. A rigorous, nationally recognized statewide testing program and increased high school graduation requirements has not produced Texas high school graduates prepared to take college level courses (Achieve, 2006).

According to recent reports from the College Board (2006), American students are scoring lower on the mathematics portion of the SAT exam than reported in previous years. Math scores on the ACT have also decreased in the last year (College Board, 2006). The decrease in college entrance exams brings the national average to the level of two years ago. Additional data collected by College Board shows that of students taking the SAT, 38% took pre-calculus during high school in 1996 and 50% took pre-calculus in 2006. Twenty-three percent of students taking the SAT in 1996 took calculus in high school; in 2006 28% took calculus in high school. This
means that less than one-third of college bound students are completing calculus in high school, and only one-half of students are completing a pre-calculus course.

In Texas, 55% of the 2006 high school graduates who took the SAT completed four years of math; 32% completed three years of math in high school. That less than 40% of students who plan and prepare for college take less than four years of math is an alarming indication of the current poor math preparation of most high school graduates.

Further indication that the mathematics education reforms led by state and national standards have not improved the college readiness of high school graduates is evidenced by the more than one-half of high school students in the United States who are required to enroll in remedial mathematics courses before taking college credit courses (Callan et al, 2006). In 2000, 66% of California’s high school graduates did not meet college level standards on at least one placement exam (Kirst & Venezia, 2001). In Texas, 50% of students satisfy the requirements to be college ready and are able to enroll in both college level math and English during their first semester of enrollment. Thirty percent of students must take a remedial English course and 44% of students must take a remedial math course. Forty percent of students enrolling in community or two year colleges and 20% of students enrolling in four-year universities are required to complete developmental education in math (Texas State Higher Education Coordinating Board, 2007).

Even with remedial college work, students are often not well-prepared for college completion. Two Minnesota studies that examined students enrolled in developmental college courses found that only 60% of students who took developmental mathematics courses in college passed the course and were prepared for college level work (Lundell, Higbee, Hipp & Copeland, 2005). Based on an 8th grade basic skills test, 46% of 1999 high school graduates participating in
the study were mathematically on track when they entered high school. Fifty-seven percent of the Minnesota students surveyed took math during their fourth year of high school. Poor math preparation and lack of high school exposure to mathematics affected a student’s ability to succeed in developmental college math courses. When faced with a large percentage of students who do not progress beyond developmental math at the college level preparing high school students for college becomes crucial to college success and achievement.

A tracking study conducted through the north Arkansas Community College system found that 34% of new college students were able to take a college level math course without requiring remedial math course work (Berry, 2003). Seventy-three percent of students who completed a course higher than Algebra II placed into college-level math but only 29% of high school graduates whose highest level of math was Algebra II were able to take college level math. The course-taking patterns and continuous exposure to math strongly influenced the remediation needed in college (Berry, 2003). According to Berry, students who complete a high school math course beyond Algebra II are more likely to be successful in college math even if remediation is required. This conclusion has been reached by multiple researchers (Adelman, 1999, Trusty & Niles, 2003).

While necessary for a specific population, the impact of taking remedial math courses for the vast majority of students is negative. First, the cost of remedial math courses is the same as college credit classes. Tuition costs at public universities across the nation are increasing at rates of up to 24% a year (Trombley, 2007). Tuition funding for most families and students is limited so paying for remedial college courses means there is less money available to repeat courses or to spend on college level courses. Having to complete a developmental college course forces a student to spend limited college tuition money on a course that will not earn college credit and
decreases the likelihood of college graduation. Remedial college courses cost parents, students, employers, and higher educational institutions more than $17 billion each year (Achieve, 2006). Fifty-three million dollars of the $93 million appropriated for developmental education in Texas in 2002 went to mathematics.

Students who take remedial courses must stay in college longer in order to complete a degree. A student who must take two remedial courses will not be able to earn the required number of credits to progress to sophomore classification after one year of college attendance. Research shows first year students who do not earn 20 credits severely damage their chances of earning a college degree (Adelman, 1999). The effect of poor high school math preparation has a direct impact on college degree attainment. Sixty-three percent of students who require one or two remedial mathematics courses fail to earn a college degree. Yet, 65% of students who do not require remediation complete an associate’s or bachelor’s degree (Achieve, 2006).

Course-taking Patterns

As a result of the national emphasis and accountability related to mathematics proficiency and the impact high school math has on college readiness and college completion, school administrators and curriculum specialists must rethink how Algebra I drives the mathematics pipeline. Algebra I is considered the gatekeeper to further academic opportunities but little is known about what courses are most strongly associated with math achievement. Mathematics courses at the secondary level are structured sequentially so success and understanding of higher level math courses like Algebra II or pre-calculus requires student mastery of Algebra I concepts. In order to continue learning math students must pass through a regimented sequence of early mathematics courses (Smith, 1996). Early high school difficulty in mathematics severely limits
higher level math learning and without remediation has a detrimental effect on high school math course completion and college readiness.

Kirst and Venezia (2001) attributed the low level of readiness for college math to the absence of a fourth year of high school math. Hall (2001) found that 23% of male students and 30% of female students who began algebra in 8th grade were not taking a math course in grade 12. Forty-nine percent of those who began algebra in grade eight did not complete Calculus in high school. While most experts would agree early exposure to rigorous mathematics is required to improve math literacy, eighth grade enrollment in Algebra I has not seemed to result in the completion of more math at the high school level.

A study led by Walker (2001) examined how likely students who enroll in Algebra I in 8th or 9th grade are to persist in taking advanced mathematics courses throughout high school. Walker used data from the National Educational Longitudinal Study (NELS) in which 24,599 students who were in 8th grade in 1988 where followed for four years. Walker found that the course–taking pattern of students past Algebra I is largely unknown and that 8th graders who complete Algebra I are less likely to be from minority groups and tend to come from more affluent families. White and Asian high school graduates earn a greater percentage of high school credits in math than Black and Hispanic students. Walker concluded that students, regardless of race or whether they completed Algebra I in 8th grade, are most likely to stop taking math courses during their fourth year of high school. Based on the NELS data, about 65% of the original groups of students who entered Algebra I in 8th grade were predicted to take a fourth year of high school math. Only 40% of students who completed Algebra I in 9th grade continued math through their senior year.
There are several possible explanations for an early exit from high school math: students could have earned the math credits required for graduation, additional advanced math courses might not be offered at their school, or they may not want, or be encouraged to continue in a course like Algebra II, pre-calculus, or calculus.

When they looked at reasons for the lack of mathematics course enrollment in high school, Singh and Ozturk (2000) identified part-time work as a significant factor. This study found that even after the effect of socioeconomic status and previous achievement in mathematics has been controlled for, part-time work had a significant negative effect on math course work. The indirect effect of part-time work on student math achievement in Grade 12 is larger than the direct effect suggests.

The Third International Mathematics and Science Study (TIMSS 2003 Results, n.d.) found that in nine of the 42 participating countries 85% of students took a mathematics course during their final year of secondary school. In the United States, Canada, Iceland, the Netherlands, and Switzerland as many as one-third of final year students did not take a mathematics course. Students who did not take a final year of math performed less well in mathematics literacy than those who were still studying the subject (Mullis, 1998). TIMSS evaluated advanced mathematics course enrollment and found that less than 20% of the sample student population took an advanced course covering calculus, geometry and equations and functions. Six countries, including the U.S., were classified as low performing.

Measuring Up 2000, a project of the National Center for Public Policy and Higher Education, gathered and analyzed data available statewide related to higher education and each state’s preparation, participation, affordability, completion, and benefits of college education (Measuring Up, 2000). The project awarded a letter grade from A to F to each state. The grade
awarded for preparation for education beyond high school was based on high school completion, K-12 course taking, and K-12 student achievement. Results of the project indicate that across the nation there has been an increase in the number of high school students taking upper level math courses. The number of students taking one or more high school courses in geometry, Algebra II, Trigonometry, pre-Calculus or calculus ranged from 46% in Alabama to 100% in Nebraska, North Carolina, and Massachusetts. Sixty-one percent of students in California and 78% of students in Texas take one or more of the identified courses. Data on the number of students who complete Algebra I in 8th grade was available from 27 states, not including Texas. The best-performing states included Connecticut, Massachusetts, Michigan, North Carolina and Utah. These states had the highest percentage of students completing Algebra I in 8th grade. States where the fewest students, less than 30%, completed Algebra I in 8th grade included Arkansas, Indiana, Louisiana, and Oklahoma.

Recognizing the need for a rigorous high school curriculum and high standards for all students, the Southern Regional Education Board (SREB) (Southern Regional Education Board, 2001) identified secondary math course-taking patterns as one of the 14 student needs associated with college readiness. The SREB recommended that all students take mathematics courses beyond Algebra I and use the senior year to fully prepare for college and careers. The National Council of Teachers of Mathematics states that all students should study mathematics for each of the four years that they are enrolled in high school.

The powerful, predictive value that time spent studying math and completing math courses has on math achievement makes mathematics course taking patterns in junior high important. But few studies have examined the effect completion of 8th grade Algebra I has on high school math course-taking patterns. In a 2002 study by Ma, mathematics achievement and
attitude towards mathematics were found to be the most important factors affecting participation in advanced mathematics courses. Studying six waves of data from the Longitudinal Study of American Youth, LSAY, Ma (2000) also found that taking a pre-algebra, algebra or algebra honors course in Grades 7 and 8 positively affected math achievement. However, mathematics course work in Grades 9 and 10 did not appear to affect mathematics achievement. But positive effects of advanced mathematics course work were widespread in Grades 11 and 12. This study also revealed that the effects of math course work on math achievement were stronger than the effect of a student’s academic background or other individual characteristics.

Research shows that students who master Algebra I perform better in higher level mathematics (Horn & Bobbitt, 2001; Lundin, 2005). Scheiber and Chambers (2003) attributed the higher mathematics performance of advanced students over general math students to the difference in course participation in high school. Overall the general math student had not completed as many mathematics courses as the advanced student.

Rock’s (1994) findings indicate that mathematics course taking between 8th and 10th grade can explain increased math proficiency at the 10th grade level. Thirty-five percent of students who completed math courses lower than Algebra I between 8th and 10th grade increased one or more proficiency levels. Forty-six percent of students who completed Algebra I between 8th and 10th grade also increased one or more proficiency levels. Of the students who completed geometry and/or Algebra II between 8th and 10th grade 70% increased one or more proficiency levels.

A 2003 study of 3100 9th grade students by Cooney and Bottoms found that many students who expect to go to college are not enrolled in the necessary courses in high school. Some schools enroll many more students in college preparatory courses than other schools. The
variance in enrollment is not explained by differences in students or demographics. The study also found enrollment in more rigorous courses does not result in more failures and that taking algebra in 8th or 9th grade did lead to enrollment in higher-level mathematics courses in high school and did not increase failure rates.

One reason for the low number of students studying advanced mathematics may be the early and rigid ability grouping that is widespread in United States’ middle and secondary schools (Useem, 1992). Students who do not have access to Algebra I in 8th grade are often unable to complete advanced mathematics courses in high school. Results from a longitudinal study by Ma and Willms (1999) indicate that a student’s socioeconomic status impacts the students’ course taking patterns. Students from higher socioeconomic backgrounds were found to take more advanced high school math courses. Higher achieving students continued taking math courses longer than students with lower achievement scores. Access to 8th grade algebra may be limited by prior math instruction, parents’ ability to intervene and the social class of the student and community (Spade, Colomba & Vanfossen, 1997). California determines who has access to Algebra I in 8th grade by administering a 7th grade math assessment. This one test either limits or enhances a student’s opportunity to study advanced mathematics in high school (California Department of Education, 2006).

One program with documented success increasing the number of 8th grade students taking Algebra I is the Advancement via Individual Determination (AVID) program. Developed by Mary Katherine Swanson 14 years ago, AVID is a college preparatory middle and high school program designed to serve students in the academic middle as they take advanced courses and prepare for college (AVID(c), 2006). Several of the Texas high schools that adopted AVID as a school reform model report increased test scores, higher rates of advanced math course.
completion, and university acceptance (Watt, Powell, Medioha, & Cossio, 2006). Fifty-one percent of AVID 8th grade students complete Algebra I; a 29 point increase over the national average (AVID(a), 2006). Eighty-one percent of AVID students pass the Exit level Math TAKS exam compared to a statewide passing rate of 73% (AVID(b), 2006).

Changes in State Graduation Requirements

Changes in the graduation requirements in each state are occurring and will have an influence on math course taking patterns. Generally an Algebra I course completed in the eighth grade is awarded a high school credit. Students who take Algebra I in eighth grade enter high school with one credit of the math required for graduation complete.

Beginning with the graduating class of 2008, New York students must take three years of math, one an integrated algebra class, and must pass at least one level of the New York Regents math exam in order to graduate (Burris, 2003). California also requires students to complete three years of high school math (California Department of Education, 2006). In order to earn a recommended diploma in Texas students must complete three credits of math, Algebra I, geometry, and Algebra II. A student who completes algebra in 8th grade may take only two math courses in high school and be able to graduate on the recommended graduation plan. Beginning with the 2007 freshmen class, four credits of math will be required for high school graduation.

Many states are now focusing on increasing the math required for graduation. In 1998, 23 states required more than two credits of math for graduation compared to 13 states in 1989. In 1996, 51% of United States students attended schools that required three years of math while 46% of students had to take two years of math for high school graduation (Hawkins, Stancavage & Dossey, 1998).
Because each state may require a particular number of math credits for graduation without specifying the rigor of each of the courses (Chaney, Burgdorf & Atash, 1997) the mathematics requirements for graduation may still leave a student unprepared for college and the workforce. Students in many states can often choose to complete basic, general, or business math courses rather than more mathematically rigorous courses like Algebra I, geometry, or pre-calculus. Schools may offer basic courses in order to meet the mandated graduation requirements.

An increase in the number of mathematics courses required for high school graduation does not always result in improved math proficiency. Often an increase in the number of required high school math credits also creates an increase in the number of low-level math courses offered to students. A study by Hoffer (1997) concluded that requiring three years of math for high school graduation did not increase math achievement scores and did not reduce the impact of socioeconomic status on learning outcomes. This study, conducted before the implementation of the National Council of Teachers of Mathematics curriculum and instruction standards, showed that increasing the number of mathematics graduation requirements was not sufficient to raise math achievement scores. Ma and Willms (1999) concluded that a policy to raise mathematics standards for high school graduation combined with improved course content would improve students’ preparation in high school mathematics.

Chaney et al. (1997) found that 64% of the student group examined in the 1990 National Assessment of Educational Progress took more high school math courses than were required for graduation. He concluded graduation requirements may not dramatically affect high school math course taking. However, Hawkins et al. (1998) attributed requiring three years of math credits for graduation to an increase in the number of students completing geometry. Eighty-five percent of
students completed geometry when three years of math were required compared to 76% when there was only a two year requirement. In schools that required three years of math, 24% of students did not complete an additional year of math. If graduation requirements were increased to four years of math, math course taking patterns would change for many more students. In 1996, 54% of the nation’s 12th grade students attended schools that required three years of math course completion for graduation (Hawkins, et al, 1998). The influence of graduation requirements on math course taking patterns becomes significant since course taking is the most powerful factor under the school’s control that affects students’ math achievement (Spade, et al., 1987).

In February of 2005, Achieve, Inc. sponsored the National Education Summit on High School focusing on the alignment of high school academic standards, course requirements, assessment data, and accountability systems with postsecondary and workplace expectations. Only two states, Texas and Arkansas, will require four years of mathematics, the recommendation for college success, for students who enter high school in 2007. Surveying each of the 50 states, the Summit also found that only five states report that they have established the standards, rigor, and quality required in high school for alignment with the demands of college and business.

8th Grade Algebra I

The Middle Grades Assessment, a 2000 study by Cooney and Bottoms (2003), found that taking either Algebra I or pre-algebra in the 8th grade led to enrollment in higher-level math courses in high school. Students placed in higher-level courses in 8th grade had a lower failure rate than students with similar characteristics placed in lower level courses. This study,
conducted through the Southern Regional Education Board to measure readiness for high school, examined the grades that a group of 3100 8th grade students earned in 9th grade college preparatory courses, including Algebra I and pre-algebra. Data revealed that students who succeeded in their first year of high school math had one or more of the following factors: (1) they had studied a course with “algebra” in its title in 8th grade, (2) read more than 11 books in 8th grade and/or (3) expected to graduate from high school. Researchers concluded that students who begin algebra earlier are more likely to succeed in an accelerated math curriculum – only if high schools choose to enroll them in the curriculum. The issue in question then is whether or not high schools chose to enroll students in an accelerated curriculum.

Nationally 20% of 8th grade students were enrolled in Algebra I in 1990. Of these 20% of students, only 4 to 8% persist in advanced mathematics and complete a calculus course in high school (Useem, 1992). Across school districts the methods for determining who may or may not enroll in 8th grade algebra have been vague and inconsistent. There are no clear guidelines or criteria suitable for identifying entry into the math pipeline via Algebra I. Most schools arbitrarily determine who will have access to algebra and when that access will be granted. However, the state of California is an exception by enacting a state wide process for determining algebra readiness. An algebra readiness tests is administered to 7th grade students to determine mastery of pre-algebraic concepts and processes. Students who have mastered the required foundational skills are enrolled in Algebra I in 8th grade (California Department of Education, 2006).

The trend towards moving high school math courses like Algebra I into middle and junior high school gives some students the opportunity to complete a calculus course in high school, if they chose. High school calculus can prepare students for college and careers by providing a
more thorough and understandable version of calculus than a college calculus course and by making mastery of the college course possible. High school calculus completion provides a distinct advantage on college entrance exams and the college admission process. We would expect that all high-achieving students selected for 8th grade algebra would continue to achieve in the high school mathematics sequence. Yet, only 4 to 8% of students take high school calculus (Useem, 1992).

Enrolling in high school math courses in junior high school makes well-informed, expert guidance imperative. Little work has focused on the precursors to student’s high school course choices. Cooney and Bottoms (2003) found schools are inconsistent in who they enroll in college preparatory courses and that enrollment in these courses is not explained by differences in students or demographics. Often enrollment in intensive mathematics courses becomes elitist, serving only the best behaved, highest achieving students with families who are well informed and involved in directing their child’s education (Trusty, 2003). The complicated planning process that enables students to complete advanced math requires that parents are well informed and guidance counselors and teachers thoroughly understand mathematics education. Students must begin planning for early completion of algebra in the 6th and 7th grades. Forcing students into an inflexible track, without the proper preparation early in middle school can result in students who are not prepared for the rigor of an early Algebra I course.

In many studies, Algebra I and pre-algebra were treated equally; a differentiation was not made between whether a student completed pre-algebra or algebra in 7th or 8th grade (Ma, 2000; Cooney & Bottoms, 2003). While preparation for the rigor of Algebra I is of paramount importance, it is difficult to determine whether taking Algebra I in 8th grade is the key to math literacy and college readiness. Ma (2000) found that not all advanced mathematics courses
improve a student’s mathematics achievement. For example, pre-algebra in 7th grade had a stronger effect than Algebra I. Trigonometry, a lower level course than analytical geometry or pre-calculus, had a greater effect on mathematics achievement than the more advanced courses. Ma concluded that lower level courses are more strongly correlated with mathematics achievement than the relatively more advanced courses. One possible explanation involves the sequential feature of mathematics learning. Advanced math courses like pre-calculus and calculus demand a solid mastery of basic mathematics and of the curriculum and concepts taught in lower level math courses. Without mastery students may go through the motions of completing advanced work but not reap the benefits of increased understanding that can result in higher standardized math scores and better preparation for college level math. Eighth grade students scored below the international average in mathematics among 41 countries (Ma, 1999). One explanation may be that a student who is fast-tracked into advanced courses lacks exposure and mastery of basic math concepts required for math literacy.

There are many factors affecting mathematics education yet no definitive practice or program has resulted in improved mathematics literacy. NCLB prompted states to replace or revise mathematics curriculum standards yet only 50% of states require completion of an Algebra II course for high school graduation (Reys, Dingham, Nevels and Teuscher, 2007). Smith (1996) found less than 20% of the nation’s 8th grade students complete an Algebra 1 course thus limiting higher level course taking options in high school. Twenty-three percent of Texas high school students do not pass the math exit level state assessment, 60% of high school graduates must take a remedial course before enrolling in college credit courses, ACT and SAT math scores are decreasing and U.S. students continue to score below the international level. In Paek’s (2008) analysis of the National Educational Longitudinal Study (NELS), 83% of students
taking algebra and geometry attend college within two years of graduating while only 36% of students who do not complete algebra and geometry in high school continue to college. Paek concluded that “understanding the factors that affect and thereby improve student learning in Algebra I is the critical first step toward increasing the number of postsecondary science, technology, engineering, and mathematics related opportunities available to students” (p. 10).

According to Taylor (2006), research is needed to explore the effects of 8th grade algebra for all students. While there are countless variables associated with successful math learning and ability, the quantitative analysis of the effects of early access to Algebra may have one of the strongest effects on math literacy and secondary and postsecondary mathematics achievement. In an attempt to identify the factors that impact math learning this study will examine how 8th grade Algebra I, along with gender, ethnicity, socioeconomic status, and AVID enrollment, affects high school math course completion and college readiness. Chapter 3 will describe the methodology of the study, including, a description of the demographics and the organizational structure of the district, data collection and data analysis process.
CHAPTER 3
RESEARCH METHODOLOGY AND PROCEDURES

Background and Purpose

Efforts to improve math achievement in public schools have demonstrated to be ineffective at the secondary level. In 2007 31% of 8th graders nationally were enrolled in 8th grade algebra (Loveless, 2009) yet 44% of high school graduates are required to take a developmental math course before enrolling in a college level mathematics course (Achieve, 2006). While national and international assessments show that United States’ children in grades three through eight continue to score higher in mathematics proficiency in relation to other countries studied, the increase diminishes at the high school level. It is clear that the mandated programs and new initiatives have not produced the desired results.

Public schools are facing increased parental, community and political pressure to insure that high school graduates possess the math literacy necessary for college and the work force. It is important that school decision makers and educators have knowledge of the factors that contribute to a student’s math literacy and ability to complete a college level mathematics course after graduation. The research conducted through this study informs educators and delineates factors that affect the math literacy of high school graduates.

Another compelling concern prompting this research stems from the conclusions reached by Adelman (1999). He found that students who complete any mathematics course beyond Algebra II doubled the odds of attaining a bachelor’s degree. In fact, completing advanced mathematics in high school was a stronger predictor of college degree completion than socioeconomic status, ethnicity or parents’ educational level. Since completion of a higher level
high school mathematics course makes college degree completion likely then our public school system is obliged to examine the factors that impact high school mathematics course completion.

Current research and literature does not address how high school mathematics course completion and college mathematics readiness is affected by taking 8th grade algebra, by gender, ethnicity or socioeconomic status or by enrollment in an Advancement Via Individual Determination (AVID) program in high school. Independent studies have evaluated mathematics achievement related to gender, ethnicity or socioeconomic status but there is a gap in research related to the affect the multiple factors of 8th grade algebra, AVID enrollment, gender, ethnicity, and socioeconomic status has on high school math course completion and college mathematics readiness.

The purpose of the study is to evaluate the relationship between completion of 8th grade algebra, gender, ethnicity, socioeconomic status, and AVID enrollment and a students’ high school mathematics course taking patterns and college readiness in mathematics.

One factor evaluated in this study, early access to Algebra I, has been identified as the portal to higher-level mathematics course completion and math achievement. Adelman (1999) found that students who completed Algebra I in 8th grade earner higher grade point averages and took more advanced math courses. Wilkins and Ma (2002) concluded that students who took Algebra I in 8th grade exhibited significantly higher rates of growth in student learning than students who were not involved in algebra. This study seeks to explore the relationship of early access to Algebra I and high school mathematics course completion and college readiness.

Another factor, enrollment in an AVID program, gained relevance based on the particular sample population studied in this research. AVID prepares underserved students for four-year college eligibility and makes college-preparatory curricula accessible to all students. AVID was
implemented in the school district selected for this study in 2002. Since 2002 AVID has become well-established with positive results (AVID, 2006).

Finally, research has demonstrated that the factors of race, gender and socioeconomic status at times serve as indicators for academic performance. Therefore, the relationship of student background characteristics and math course completion and college readiness was examined.

Context

The study was conducted at the school district level, in north central Texas. The school district is located approximately 15 miles north of Dallas, Texas and serves 19,534 students in kindergarten through twelfth grade (Texas Education Agency, 2006). The community has been identified as the fastest growing city of its size in the United States (City Mayors Statistics, n.d.). The median income is $94,000 and 48% of residents have a college degree. At the time of the study there were two comprehensive 9th through 12th grade high schools, a third high school with only 9th and 10th grade students and an alternative school serving students in Grades 1 through 12. In 2006 the district was rated a Recognized school district by the Texas Education Agency (2006).

One of the unique characteristics of the educational program in the district is its commitment to establishing and supporting AVID. AVID is a college preparatory program for students in the academic middle and those who have typically been underserved (AVID, 2006). These students in the middle typically have “B” or “C” grade averages and are academically capable but underachieving. AVID students may also come from a low socio-economic background or under-represented racial group. The students are most often the first in their
family to attend college. AVID students are provided support to succeed in a rigorous academic curriculum so that they are prepared for enrollment in a four-year college or university. High school AVID students enroll in an elective course and learn organization, goal setting, critical thinking, Cornell note taking and many other skills necessary for success in Advanced Placement classes and in college courses. Well-defined, explicit curriculum is provided by the AVID program. The goal of the AVID program is to prepare students for admission to a four-year university and completion of a bachelor’s degree. According to AVID (2006) 86.2% of students nationally applied for admission to a four-year university. Of these students, 76% were accepted to a four-year college or university.

Population

The participants in this study were the 841 2006 high school graduates from the district. The 2006 graduates attended one of two comprehensive high schools, both similar in demographics and alike in curriculum, or the district alternative school. The sample population was 65% white, 18% Hispanic and 9% African American. Twenty-three percent of the students were economically disadvantaged and 35% of students complete Algebra I in 8th grade. The subjects were chosen because they have a completed high school transcript and can provide data that have been analyzed and are accessible. Of the 841 students, those identified as receiving special education accommodations, requiring a reduction of the defined state curriculum, were excluded from the study.

Students who graduated in 2006 were required to complete three years of high school level math and to pass each section of the Exit level Texas Assessment of Knowledge and Skills. The high school math course selection included: Algebra I, geometry, Algebra II, math models,
pre-calculus, Algebra III, calculus, and statistics. The district level mathematics curriculum specialist defines and directs the mathematics curriculum that is taught at each level of instruction.

Information for each of the variables was provided through the school district’s database. Permission from the Institutional Review Board was granted for the study. Data collection was approved by the school district superintendent’s designee.

Research Questions

Overall, the questions guiding this research seek to define the factors that affect high school math course completion and college readiness in a Texas suburban public school district. Specifically, it asks,

1. What is the relationship between Algebra I completion in 8th grade to completion of four years of high school mathematics classes and college readiness?

2. What relationship is there between race, gender, socioeconomic status and AVID enrollment to college math readiness and high school mathematics course completion?

Research Design

The descriptive study quantifies the relationship between the independent variables and the dependent variables. The independent variables, also known as the predictor variables, include 8th grade math course completed, gender, ethnicity, socioeconomic status and AVID enrollment. Each of these factors is included to measure the relationship with the number of years a student takes high school math and college readiness, the dependent or criterion variables.
As an observational case control study a comparison between students with identifying characteristics was made to students without the identified characteristics. The first identifying characteristic, or case, is completion of an Algebra I course in 8\textsuperscript{th} grade. These cases were compared to the control group who did not complete Algebra I in 8\textsuperscript{th} grade in order to examine high school mathematics course completion and college math readiness. Comparisons were also made to evaluate how differences in gender, ethnicity, socioeconomic status and AVID enrollment may relate to high school math course completion and college readiness. The research questions sought to answer whether or not there was a relationship between 8\textsuperscript{th} grade Algebra I completion, gender, ethnicity, socioeconomic status and AVID enrollment and high school math course completion and college readiness.

The sample selected for study was the 2006 high school graduates of a large, suburban school district. The sample is representative of the population in the community but may not be representative of all 2006 graduates in Texas. In Texas 20\% of students complete Algebra I in 8\textsuperscript{th} grade; and the Texas population of students in 2006 was 36.5\% White, 45.3\% Hispanic and 14.7\% African American (Texas Education Agency, 2006). Fifty-five percent of the school children in Texas are identified as economically disadvantaged.

With a sample size of 841 participants, detection of the relationship between the independent and dependent variables was possible. Statistical significance was determined with 95\% confidence. The large sample size allowed for acceptable confidence intervals to insure statistical significance. The relationship between the independent and dependent variables were examined through descriptive statistics, chi-square analysis and multiple regression analyses (Hopkins, 2000). Formal permission was received from the district superintendent’s office and descriptive data was collected from the two Grade 9-12 campuses. Data consists of the complete
Academic Achievement Record, A.A.R., also referred to as the high school transcript, of every 2006 high school graduate in the school district. The transcript provides course enrollment information, in addition to: TAKS, SAT, and ACT scores and gender identification data. Socioeconomic status was derived from the list of 2006 free and reduced lunch recipients. Descriptive statistics are illustrated in tables and the data was recorded in a spreadsheet format and analyzed using SPSS software (Trochim, 2006). Multiple statistical methods were used to evaluate relationships between the independent and dependent variables. Conclusions based on the data analysis and recommendations for further study are made in Chapter 5.

Data Collection

The dependent variables examined in this study include the number of high school mathematics courses completed and college readiness as measured by exemption from the Texas Success Initiative (TSI) placement exam. The TSI represents the Texas standard for college readiness. Students are exempt from the TSI exam and are ready to take a college level mathematics class if they meet certain criteria. Included in these criteria is a score higher than 2200 on the Exit level Mathematics section of the TAKS exam. Students may also be exempt from taking the TSI if they score 500 or higher on the math portion of the SAT exam and earn a composite score of 1070 or score 19 or higher on the Mathematics section of the ACT exam and earn a composite score higher than 23.

The independent variables are: (1) each student’s 8th grade mathematics course, either Algebra I, general 8th grade math or in a few cases geometry, (2) gender, (3) ethnicity, (4) socioeconomic status, and (5) enrollment in and awarding of one credit for the AVID program.
District level data was obtained from the high school transcripts, also known as Academic Achievement Records (AAR). Permission for data collection was given by the district superintendent’s designee. Each student’s transcript provided information about whether or not a student completed 8th grade algebra, the number of high school level mathematics courses completed, AVID enrollment, gender, and ethnicity. Socioeconomic status was determined by eligibility for the National Free or Reduced Lunch program. For the purpose of defining college readiness TAKS, SAT and/or ACT scores was also collected from the high school transcript data.

A unique student identification number was assigned to the data record of each student. The identification code was randomly assigned and not connected with the school assigned identification number, student name or other individually identifiable information. The data file containing the transcript information and socioeconomic status was imported into the Statistical Package for the Social Sciences software to perform the recommended statistical analysis.

Data Analysis

The first step in the analysis of data was to summarize information about the variables in the data set. Descriptive statistics provide a description of the basic features of the data and a simple summary of the sample and measures. The variables explained through descriptive statistics included race, gender, enrollment in 8th grade math course and AVID, socioeconomic status, high school math course completion, and college readiness. Concerned primarily with reporting the condition of the data, the data were summarized and organized using descriptive statistics. The descriptive measures provide a snapshot of the sample population and set the stage for further statistical analysis.
Descriptive statistics, while informative, do not allow control for or interaction of student characteristics (Trochim, 2006). Chi-square and Cramer’s V analyses were conducted to evaluate the relationship between the dependent variable, college readiness and number of high school math courses completed, and each independent variable. Chi-square tests determined whether there is a significant relationship between the dependent variables, college readiness and the independent variables, 8th grade math course, gender, ethnicity, socioeconomic status and AVID enrollment. Chi-square analyses were also conducted using the dependent variable the number of high school math courses completed. Cramer’s V was a post-test that provided information about the strength of the relationship.

Multiple regression was employed as an advanced statistical analysis. The general purpose of multiple regression is to learn more about the relationship between several independent or predictor variables and a dependent or criterion variable (Statsoft Electronic Textbook, 2008). Multiple regression assesses how the independent variables work together to influence the dependent variables and allows the researcher to learn more about the relationship between several independent variables and the dependent variable (Statsoft Electronic Textbook, 2008). This statistical analysis computes the amount of variance predicted in each criterion variable and identifies the best set of predictor variables. Multiple regression identified how much of the variance in college math readiness can be explained by early access to Algebra I, gender, ethnicity, socioeconomic status or AVID enrollment.

**Summary**

This research was designed to identify student characteristics that relate to high school mathematics course completion and college math readiness. The demographic attributes of
students in this study are reflective of the population of students in many Texas suburban schools, especially those school districts that struggle most with efficient mathematics preparation.

Results of this study provided local, state and national math educators and decision makers with additional information regarding the relationship between 8th grade Algebra I completers and their later success. Studying the relationship between gender, ethnicity, socioeconomic status or AVID enrollment and math literacy also provides insight for policy makers and administrators when they address mathematics needs of secondary school students. The findings could potentially assist public school decision-makers as they address approaches to improve the mathematics literacy and college readiness of high school graduates.

Chapter 4 will present the findings of the data analyses used to explore the two research questions.
CHAPTER 4
PRESENTATION AND ANALYSIS OF DATA

Introduction

This chapter presents findings of the study designed to identify whether a relationship exists between the dependent variables, college readiness and the number of math courses completed in high school, and the independent variables, 8th grade completion of Algebra I, socioeconomic status, gender, ethnicity, and enrollment in the high school course Advancement via Individual Determination (AVID). Data was collected from the Texas school district’s 2006 high school graduates. The two research questions addressed were:

1. If a student takes Algebra I in 8th grade, is the student more likely to complete four years of high school math courses and also be ready to take a college level mathematics course after high school graduation?

2. What effect does race, gender, socioeconomic status, and enrollment in the Advancement Via Individual Determination (AVID) have on college math readiness as measured by college and university standards and high school mathematics course completion?

Data Selection

This study was completed to examine the relationship between college readiness and completion of high school mathematics courses and the completion of 8th grade algebra, gender, ethnicity, socioeconomic status, and AVID enrollment. A north Texas school district’s 2006 high school graduates were selected as data subjects. Each of the factors listed above were gathered and then used in multiple statistical analyses. Students who received special education services and a reduced or modified state required curriculum (the Texas Essential Knowledge and Skills)
based on the student’s qualifying disability were removed from the study. For this particular sample of students, 54 of the total 841 high school graduates in 2006, or 6.4% of the total population, did not receive the state required instructional curriculum and were removed from the sample participants. This left 787 total students in the sample population.

Descriptive Statistics

With written permission from the district the data collected from the 2006 high school graduates included: gender, ethnicity, socioeconomic status, AVID enrollment, 8th grade Algebra I completion, SAT and ACT scores, and TAKS scores. Ethnic groups included American Indian/Alaskan Native, Asian/Pacific Islander, Black/Not of Hispanic origin, Hispanic, and White/Not of Hispanic origin. Socioeconomic status was determined by qualification for the free/reduced national school lunch program. Students were coded as receiving free lunch, receiving a reduced price lunch, or not eligible for the free/reduced lunch program. Students who received at least one credit for the AVID course were coded as enrolled in AVID. College entrance exams and TAKS scores determined whether a student was college ready. To be scored as college ready a student must:

(1) Earn a composite SAT score of more than 1070 and at least a 500 on both the verbal and math sections; or

(2) Earn a composite ACT score of more than 23 and at least a 19 on both the verbal and math sections; or

(3) Earn a 2200 on the math and English Language Arts section of the TAKS exam and at least a 3 on the written section of the exam.
Table 1 describes demographic characteristics of the 787 high school graduates.

**Table 1**

*Demographic Description of Subjects*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>379</td>
<td>48.2</td>
</tr>
<tr>
<td>Female</td>
<td>408</td>
<td>51.8</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amer Ind/ Alaskan</td>
<td>3</td>
<td>0.4</td>
</tr>
<tr>
<td>Asian/ Pac Isl</td>
<td>20</td>
<td>2.5</td>
</tr>
<tr>
<td>Black</td>
<td>52</td>
<td>6.6</td>
</tr>
<tr>
<td>Hispanic</td>
<td>117</td>
<td>14.9</td>
</tr>
<tr>
<td>White</td>
<td>595</td>
<td>75.6</td>
</tr>
<tr>
<td><strong>Economic Status: Free/Reduced Lunch Program</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free</td>
<td>54</td>
<td>6.9</td>
</tr>
<tr>
<td>Reduced</td>
<td>16</td>
<td>2.0</td>
</tr>
<tr>
<td>None</td>
<td>717</td>
<td>91.1</td>
</tr>
<tr>
<td><strong>8th Grade Algebra</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>367</td>
<td>46.6</td>
</tr>
<tr>
<td>No</td>
<td>420</td>
<td>53.4</td>
</tr>
<tr>
<td><strong>College Ready</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>461</td>
<td>58.6</td>
</tr>
<tr>
<td>No</td>
<td>326</td>
<td>41.4</td>
</tr>
<tr>
<td><strong>Number of Years of High School Math</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two</td>
<td>11</td>
<td>1.4</td>
</tr>
<tr>
<td>Two and One-Half</td>
<td>11</td>
<td>1.4</td>
</tr>
<tr>
<td>Three</td>
<td>354</td>
<td>45</td>
</tr>
<tr>
<td>Three and One-Half</td>
<td>74</td>
<td>9.4</td>
</tr>
<tr>
<td>Four</td>
<td>337</td>
<td>42.8</td>
</tr>
<tr>
<td><strong>AVID</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>56</td>
<td>7.1</td>
</tr>
<tr>
<td>No</td>
<td>731</td>
<td>92.9</td>
</tr>
</tbody>
</table>
Forty-six percent of the students completed algebra in 8th grade while 53.4% of students did not complete algebra until 9th grade. Of these 787 high school graduates 58.6% were ready to take a college level math class after graduation. Forty-one percent of the graduates did not meet the standard required to take college level math.

Table 2 illustrates the characteristics of students who completed 8th grade Algebra, and students who did not complete 8th grade Algebra, completed a regular 8th grade math course, and then enrolled in Algebra I in 9th grade.

Table 2

Descriptive Statistics for Dependent Variable: Algebra I Enrollment

<table>
<thead>
<tr>
<th>Variable</th>
<th>8th Grade Algebra</th>
<th>No 8th Grade Algebra</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Percent</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>176</td>
<td>22.3</td>
</tr>
<tr>
<td>Female</td>
<td>191</td>
<td>24.2</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amer Ind</td>
<td>2</td>
<td>0.3</td>
</tr>
<tr>
<td>Asian</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td>Black</td>
<td>13</td>
<td>1.7</td>
</tr>
<tr>
<td>Hispanic</td>
<td>25</td>
<td>3.2</td>
</tr>
<tr>
<td>White</td>
<td>311</td>
<td>39.5</td>
</tr>
<tr>
<td>Economic Status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free Lunch</td>
<td>2</td>
<td>0.3</td>
</tr>
<tr>
<td>Reduced Lunch</td>
<td>5</td>
<td>0.6</td>
</tr>
<tr>
<td>Not Eco Dis</td>
<td>360</td>
<td>45.7</td>
</tr>
<tr>
<td>AVID</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>No</td>
<td>359</td>
<td>45.6</td>
</tr>
</tbody>
</table>

(table continues)
Thirty-eight percent of students who completed 8th grade algebra were college ready; 20% of students who did not complete algebra in 8th grade were college ready. Table 2 also reports that 8.3% of students who completed 8th grade algebra were not college ready; 33.2% of students who did not complete algebra in 8th grade were also not ready for college after high school graduation.

Table 3 shows the characteristics of students who were college ready at the time of high school graduation and students who were not college ready at graduation.

Table 3

Descriptive Statistics for Dependent Variable: College Readiness

<table>
<thead>
<tr>
<th>Variable</th>
<th>College Ready</th>
<th></th>
<th>Not College Ready</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Percent</td>
<td>n</td>
<td>Percent</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>232</td>
<td>29.5</td>
<td>147</td>
<td>18.7</td>
</tr>
<tr>
<td>Male</td>
<td>229</td>
<td>29</td>
<td>179</td>
<td>22.7</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Am Ind/</td>
<td>2</td>
<td>0.3</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Asian/Pac Isl</td>
<td>18</td>
<td>2.3</td>
<td>2</td>
<td>0.3</td>
</tr>
<tr>
<td>Black</td>
<td>18</td>
<td>2.3</td>
<td>34</td>
<td>4.3</td>
</tr>
<tr>
<td>Hispanic</td>
<td>44</td>
<td>5.6</td>
<td>73</td>
<td>9.3</td>
</tr>
<tr>
<td>White</td>
<td>379</td>
<td>48.2</td>
<td>216</td>
<td>27.4</td>
</tr>
</tbody>
</table>

(table continues)
Table 3 (continued)

<table>
<thead>
<tr>
<th>Variable</th>
<th>College Ready</th>
<th></th>
<th></th>
<th>Not College Ready</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td></td>
<td>n</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Free</td>
<td>14</td>
<td>1.8</td>
<td></td>
<td>40</td>
<td>5.1</td>
<td></td>
</tr>
<tr>
<td>Economic</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduced</td>
<td>4</td>
<td>0.5</td>
<td></td>
<td>12</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Status</td>
<td>Not Eco</td>
<td>443</td>
<td>56.3</td>
<td>274</td>
<td>34.8</td>
<td></td>
</tr>
<tr>
<td>8th Grade</td>
<td>Yes</td>
<td>302</td>
<td>38.4</td>
<td>65</td>
<td>8.3</td>
<td></td>
</tr>
<tr>
<td>Algebra</td>
<td>No</td>
<td>159</td>
<td>20.2</td>
<td>261</td>
<td>33.2</td>
<td></td>
</tr>
<tr>
<td>AVID</td>
<td>Yes</td>
<td>18</td>
<td>2.3</td>
<td>38</td>
<td>4.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>443</td>
<td>56.3</td>
<td>288</td>
<td>36.6</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>461</td>
<td>58.6</td>
<td></td>
<td>326</td>
<td>41.4</td>
<td></td>
</tr>
</tbody>
</table>

Fifty-six percent of students in the study were not economically disadvantaged and were ready for college while 2.3% of students were economically disadvantaged and ready for college. About 35% of students were not economically disadvantaged and were not ready for college; 6.6% of students were economically disadvantaged and were not ready for college.

Table 4 shows the characteristics of students based on the number of high school math courses completed.

Table 4

Descriptive Statistics for Dependent Variable: Number of Years of High School Math

<table>
<thead>
<tr>
<th>Number of Math Courses Completed in High School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>Gender</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
</tbody>
</table>
Table 4 (continued)

<table>
<thead>
<tr>
<th>Variable</th>
<th>2%</th>
<th>2.5%</th>
<th>3%</th>
<th>3.5%</th>
<th>4%</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Am. Ind.</td>
<td>1</td>
<td>0.1</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0.3</td>
</tr>
<tr>
<td>Asian</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0.3</td>
</tr>
<tr>
<td>Black</td>
<td>1</td>
<td>0.1</td>
<td>0</td>
<td>0</td>
<td>24</td>
<td>3.0</td>
</tr>
<tr>
<td>Hispanic</td>
<td>2</td>
<td>0.3</td>
<td>1</td>
<td>0.1</td>
<td>64</td>
<td>8.1</td>
</tr>
<tr>
<td>White</td>
<td>7</td>
<td>0.9</td>
<td>10</td>
<td>1.3</td>
<td>264</td>
<td>33.5</td>
</tr>
<tr>
<td><strong>Eco. Status</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0.1</td>
<td>32</td>
<td>4.1</td>
</tr>
<tr>
<td>Reduced</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>11</td>
<td>1.4</td>
</tr>
<tr>
<td>None</td>
<td>11</td>
<td>1.4</td>
<td>10</td>
<td>1.3</td>
<td>311</td>
<td>39.5</td>
</tr>
<tr>
<td><strong>8th Grade</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Algebra</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>8</td>
<td>1.0</td>
<td>10</td>
<td>1.3</td>
<td>122</td>
<td>15.5</td>
</tr>
<tr>
<td>No</td>
<td>3</td>
<td>0.4</td>
<td>1</td>
<td>0.1</td>
<td>232</td>
<td>29.5</td>
</tr>
<tr>
<td><strong>AVID</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1</td>
<td>0.1</td>
<td>0</td>
<td>0</td>
<td>33</td>
<td>4.2</td>
</tr>
<tr>
<td>No</td>
<td>10</td>
<td>1.2</td>
<td>11</td>
<td>1.4</td>
<td>321</td>
<td>40.8</td>
</tr>
<tr>
<td><strong>College Ready</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>6</td>
<td>0.8</td>
<td>8</td>
<td>1.0</td>
<td>159</td>
<td>20.2</td>
</tr>
<tr>
<td>No</td>
<td>5</td>
<td>0.6</td>
<td>3</td>
<td>0.4</td>
<td>195</td>
<td>24.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>11</td>
<td>1.4</td>
<td>11</td>
<td>1.4</td>
<td>354</td>
<td>45</td>
</tr>
</tbody>
</table>
Forty-five percent of students completed three high school math courses and 42.8% of students completed four high school math courses. Of the students who completed three or more high school math courses, 56.8% were ready for college and 40.4% were not ready for college.

Analysis of Data

Research Questions and Presentation of Statistics

Due to the characteristics of the scores and data collected, three methods of data analysis were used for the study. Chi-square test and Cramer’s $V$ tests were conducted to evaluate the relationship between one dependent variable and one independent variable per each group studied. Multiple regression was included as an advanced statistical analysis. The explanation of and rationale for the selection of each of these analyses are discussed.

*Chi-Square test and Cramer’s V*

Both research questions involved college readiness, a categorical measurement, and required analysis with the chi-square test and Cramer’s $V$. The first research question, “If a student takes Algebra I in 8th grade, is the student more likely to complete four years of high school math courses and also be ready to take a college level mathematics course after high school graduation?”, sought to examine the relationship between college readiness and completion of 8th grade Algebra I. The second research question, “What is the relationship between race, gender, socioeconomic status, and enrollment in the AVID program have on college math readiness as measured by college and university standards and high school mathematics course completion?”, looked at the relationship between college readiness and gender, ethnicity, economic status and AVID enrollment. Since the data consists of frequencies
in discrete categories, the chi-square test was chosen to determine the significance of differences between two independent groups (Siegel & Castellan, 1998).

To perform a chi-square test the cases from each group are counted and then a comparison of the proportion of cases from one group in the various categories is made with the proportion of cases from the other group. The chi-square determined whether the differences in the proportions exceed those expected as chance or random deviations from proportionality. A statistically significant chi-square results in the rejection of the null hypothesis that group membership in the row variable (i.e. ethnicity) is unrelated to group membership on the column variable (i.e. college readiness).

Cramer’s V calculates the correlation in tables that have more than two rows and two columns. It is used as a post-test to determine the strengths of association after the chi-square has determined significance. The chi-square test determines whether there is a significant relationship between variables, using the Cramer’s V as a post-test provides information about the strength of the relationship. Cramer’s V can also report effect size for the chi-square analysis. It is a symmetrical index of association; either variable can be arbitrarily chosen as the independent variable. The Cramer’s V statistic varies between zero and one. A Cramer’s V close to zero indicates there is little association between the variables. A statistic close to one indicates there is a strong association. Cramer’s V is a recommended correlative technique with nominal data (Rayward-Smith, 2006). Siegel and Castellan (1988) use Cramer’s coefficient to measure the degree of association or relation between two sets of attributes when only categorical or nominal information is provided for one or more of the variables.

The chi-square test was used to determine how ethnic groups differ in their level of college readiness. Because there were only three American Indian students in the sample
population the American Indian ethnic group was deleted from the analysis. Without American Indian students included the total population for the chi-square analysis became 783. The chi-square requirement of independence was met and the results could be interpreted. Table 5 shows the results of the chi-square analysis between college readiness and ethnicity.

Table 5

*Chi-Square Analysis Summary for Ethnicity and College Readiness*

<table>
<thead>
<tr>
<th>College Ready</th>
<th>Ethnicity</th>
<th>Count</th>
<th>Expected Count</th>
<th>% within Ethnicity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Asian/ Pac Islander</td>
<td>2</td>
<td>8.3</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Black</td>
<td>33</td>
<td>21.1</td>
<td>64.7</td>
</tr>
<tr>
<td></td>
<td>Hispanic</td>
<td>73</td>
<td>48.4</td>
<td>62.4</td>
</tr>
<tr>
<td></td>
<td>White</td>
<td>216</td>
<td>246</td>
<td>36.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>Asian/ Pac Islander</td>
<td>18</td>
<td>11.7</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Black</td>
<td>18</td>
<td>29.9</td>
<td>35.3</td>
</tr>
<tr>
<td></td>
<td>Hispanic</td>
<td>44</td>
<td>68.6</td>
<td>37.6</td>
</tr>
<tr>
<td></td>
<td>White</td>
<td>379</td>
<td>349</td>
<td>63.7</td>
</tr>
</tbody>
</table>

Table 5 reveals that the actual number of college ready graduates for White, Black, or Hispanic students is less than the expected number of Asian graduates who are ready for college. The actual number of Asian college ready graduates (18) is greater than the expected value of Asian college ready graduates (11.7). The Pearson chi-square statistic, $\chi^2(3)=47.18$, $p<.05$, reported in Table 5 indicates that there is a statistically significant difference between college readiness and ethnicity. The analysis indicates that differences in ethnicity are related to differences in college readiness.
Expected cell frequencies were examined to determine whether there were any frequencies less than five; the smallest expected cell frequency was 8.23. Table 5 shows the observed cell frequencies for ethnicity and college readiness. Of 20 Asian students, 2 students (10%) were not ready for college and 18 students (90%) were ready for college. Of 51 Black students, 33 students (64.7%) were not ready for college and 18 students (35.3%) were ready for college. Of 117 Hispanic students, 62.4% of students \( (n=73) \) were not ready for college and 37.6% \( (n=44) \) were ready for college. Of 595 White students, 216 students (36.3%) were not ready for college and 379 students (63.7%) were ready for college.

A Cramer’s \( V \) coefficient was calculated to assess the strength of the relationship between college readiness and ethnicity (Cramer’s \( V = .245 \)). A Cramer’s \( V \) of .245 corresponds to a small-to-medium effect size according to Cohen’s definition of effect size (1988, p. 224). Cohen states that a small effect size =.10, a medium effect size =.30, and a large effect size = .50. The Asian group of students had a significantly higher proportion of being ready for college after high school graduation (90%) than Black students (35.3%), Hispanic students (37.6%), and White students (63.7%).

A chi-square test was also used to determine how economic groups differ in their level of college readiness. Economic groups were labeled as receiving free lunch, receiving a reduced price lunch, or not receiving free or reduced lunch. The chi-square requirement of independence was met and the results are interpreted in Table 6.

As shown in Table 6 a significant difference \( (p=0.00) \) was also found between college readiness and socioeconomic status at the .05 level of significance.
Table 6

*Chi-Square Analysis Summary for Economic Status and College Readiness*

<table>
<thead>
<tr>
<th>College Ready</th>
<th>Economic Status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Free Lunch</td>
</tr>
<tr>
<td>Count</td>
<td>273</td>
</tr>
<tr>
<td>No</td>
<td>Expected Count</td>
</tr>
<tr>
<td></td>
<td>Percent within economic group</td>
</tr>
<tr>
<td>Count</td>
<td>443</td>
</tr>
<tr>
<td>Yes</td>
<td>Expected Count</td>
</tr>
<tr>
<td></td>
<td>Percent within economic group</td>
</tr>
</tbody>
</table>

Table 6 reveals that the number of students labeled as economically disadvantaged and ready for college is less than the expected number of non-economically disadvantaged students. Students who were not economically disadvantaged had a significantly higher proportion of being ready for college (61.9%) than those who received free lunch (25%) and those who received reduced lunch (25.9%). The Pearson chi-square statistic, $\chi^2=34.379$, $p<.05$, indicates that there is a statistically significant difference between college readiness and economic status. The analysis indicates that differences in economic status are related to differences in college readiness.

Expected cell frequencies were examined to determine whether there were any frequencies less than five; the smallest expected cell frequency was 6.62. Table 6 shows the observed cell frequencies for economic status and college readiness. Of 716 students who were
not economically disadvantaged, 443 students (61.9%) were ready to take college level courses after graduation and 273 (38.1%) were not ready to take college level courses after graduation. Of 54 students receiving free lunch, 14 students (25.9%) were ready for college and 40 students (74.1%) were not ready for college. Of 16 students receiving reduced lunch, 4 students (25%) were ready for college and 12 students (75%) were not ready for college.

In Table 6, a Cramer’s $V$ coefficient was calculated to assess the strength of the relationship between college readiness and economic status (Cramer’s $V = .209$). A Cramer’s $V$ of .209 corresponds to a small-to-medium effect size according to Cohen’s (1988, p. 224) definition of effect size. The not economically disadvantaged group of students had a significantly higher proportion of being ready for college after high school graduation (96.1%) than economically disadvantaged students receiving free lunch (3%) and economically disadvantaged students receiving reduced lunch (.9%).

Table 7 illustrates the results of the analysis between college readiness and AVID.

Table 7

*Chi-Square Analysis Summary for AVID Enrollment and College Readiness*

<table>
<thead>
<tr>
<th>College Ready</th>
<th>AVID Enrollment</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Count</td>
<td>287</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Expected Count</td>
<td>301.8</td>
<td>23.2</td>
</tr>
<tr>
<td></td>
<td>Percent within AVID group</td>
<td>39.3</td>
<td>67.9</td>
</tr>
<tr>
<td>Yes</td>
<td>Expected Count</td>
<td>428.2</td>
<td>32.8</td>
</tr>
<tr>
<td></td>
<td>Percent within AVID group</td>
<td>60.7</td>
<td>32.1</td>
</tr>
</tbody>
</table>
Table 7 reveals that the actual number of students enrolled in AVID who were ready for college level courses after high school graduation (18) is less than the number of AVID students (32.8) who are expected to be ready for college. The Pearson chi-square statistic, $\phi=-.149$, $p<.05$, indicates that there is a statistically significant difference between college readiness and AVID enrollment. There is a small negative relationship between college readiness and AVID enrollment ($\phi=-.149$). The analysis indicates that differences in AVID enrollment are related to differences in college readiness.

Expected cell frequencies were examined to determine whether there were any frequencies less than five; the smallest expected cell frequency was 23.16. Table 7 shows the observed cell frequencies for AVID enrollment and college readiness. Students who enrolled in AVID had a significantly lower proportion of being ready for college (32.1%) than those who did not enroll in AVID (60.7%). Of 56 students enrolled in AVID, 18 students (32.1%) were ready to take college level courses and 38 students (67.9%) were not ready to complete college level courses.

A significant relationship also exists between enrollment in 8th grade algebra and college readiness. Table 8 shows the results of the chi-square analysis between college readiness and 8th grade algebra completion.
Table 8

Chi-Square Analysis Summary for 8th Grade Algebra and College Readiness

<table>
<thead>
<tr>
<th>College Ready</th>
<th>No 8th Grade Algebra</th>
<th>8th Grade Algebra</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>260</td>
<td>65</td>
</tr>
<tr>
<td>No</td>
<td>Expected Count</td>
<td>173.3</td>
</tr>
<tr>
<td></td>
<td>Percent within 8th grade algebra group</td>
<td>62.1</td>
</tr>
<tr>
<td></td>
<td>Count</td>
<td>159</td>
</tr>
<tr>
<td>Yes</td>
<td>Expected Count</td>
<td>245.7</td>
</tr>
<tr>
<td></td>
<td>Percent within 8th grade algebra group</td>
<td>37.9</td>
</tr>
</tbody>
</table>

Table 8 reveals that the actual number of students who did not complete 8th grade algebra and are ready for college is less than the expected number of students who did not complete Algebra I in 8th grade and are ready for college. For students who did not complete algebra in 8th grade 159 were ready for college; the analysis predicted that 246 would be ready for college. The phi statistic, $\phi = .449$, $p < .05$, indicates that there is a strong positive relationship between college readiness and completion of 8th grade Algebra I. The analysis indicates that whether or not a student completes algebra in 8th grade is related to differences in college readiness.

Expected cell frequencies were examined to determine whether there were any frequencies less than five; the smallest expected cell frequency was 151.71. Table 8 shows the observed cell frequencies for 8th grade algebra completion and college readiness. Of 367 students who completed algebra in 8th grade, 302 students (82.3%) were ready for college and 65 students (17.7%) were not ready for college. Of 419 students who did not complete algebra in 8th grade,
159 students (37.9%) were ready for college and 260 students (62.1%) were not ready for college.

The last relationship examined was between gender and college readiness. A chi-square analysis (phi = -0.052) found no relationship between gender and college readiness.

Both research questions asked how college readiness is affected by each of the independent variables, completion of 8th grade algebra, ethnicity, gender, socioeconomic status, and AVID enrollment. Chi-square analyses were also performed to measure the relationship between the number of math courses completed in high school and each of the variables, 8th grade algebra completion, economic status, gender, ethnicity, and AVID enrollment. If a significant chi-square analysis was found a Cramér’s $V$ analysis was conducted to measure the strength of the relationship.

The chi-square test was used to determine how ethnic groups differ in the number of high school mathematics courses completed. Because there were only three American Indian students in the sample population the American Indian ethnic group was deleted from the analysis. Without American Indian students the total population for the chi-square analysis became 783. The chi-square requirement of independence was met and the results could be interpreted. Table 9 shows the results of the chi-square analysis between the number of high school math courses completed and ethnicity.
Table 9

Chi-Square Analysis Summary for Ethnicity and the Number of High School Math Course Completed

<table>
<thead>
<tr>
<th>Number of Math Courses</th>
<th>Ethnicity</th>
<th>Asian/ Pac Islander</th>
<th>Black</th>
<th>Hispanic</th>
<th>White</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>2                  Expected Count</td>
<td>.5</td>
<td>1.4</td>
<td>3.1</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>% within Ethnicity</td>
<td>0</td>
<td>2</td>
<td>2.6</td>
<td>2.9</td>
</tr>
<tr>
<td></td>
<td>Count</td>
<td>5</td>
<td>31</td>
<td>78</td>
<td>311</td>
</tr>
<tr>
<td></td>
<td>3                  Expected Count</td>
<td>10.9</td>
<td>27.7</td>
<td>63.5</td>
<td>323</td>
</tr>
<tr>
<td></td>
<td>% within Ethnicity</td>
<td>25</td>
<td>60.8</td>
<td>66.7</td>
<td>52.3</td>
</tr>
<tr>
<td></td>
<td>Count</td>
<td>15</td>
<td>19</td>
<td>36</td>
<td>267</td>
</tr>
<tr>
<td></td>
<td>4                  Expected Count</td>
<td>8.6</td>
<td>22</td>
<td>50.4</td>
<td>256</td>
</tr>
<tr>
<td></td>
<td>% within Ethnicity</td>
<td>75</td>
<td>37.3</td>
<td>30.8</td>
<td>44.9</td>
</tr>
</tbody>
</table>

Table 9 reveals that more Asian and White students completed four years of math in high school than was expected through the statistical analysis. The actual number of Asian students completing four years of math (15) is greater than the expected count of 8.6. The actual number of White students completing four years of math (267) is greater than the expected count of 256. The actual count of Asian students who completed either two or three years of high school math was less than the expected count. More Black students (31) completed three years of math than what was expected (27.7) and fewer Black students (19) completed four years of math than what
was expected (22). The actual count of Hispanic students completed three years of math (78) was more than the expected count (63.5) and the actual count of Hispanic students completing four years of math (36) was less than the expected count (50.4). Seventeen White students completed two years of math; the expected count was 16. The actual number of White students completing three years of math (311) was less than the expected count (323). The Pearson chi-square statistic \( \chi^2(6)= 17.718, p<.05 \), indicates that there is a statistically significant difference between the number of high school mathematics courses completed and ethnicity.

Expected cell frequencies were examined to determine whether there were any frequencies less than five; three cells (25%) had expected counts less than five. The minimum expected count was 0.54. Table 9 shows the observed cell frequencies for ethnicity and the number of high school math courses completed. Of 20 Asian students, 5 students (25%) completed three years of math in high school and 15 (75%) completed four years of math in high school. Of 51 Black students, 1 student (2%) completed two years of high school math, 31 (60.8%) of students completed three years of math, and 19 (37.3%) completed four years of math in high school. Of 117 Hispanic students, 2.6% of students \((n=3)\) completed two years of high school math, 66.7% of students \((n=78)\) completed three years of high school math, and 30.8% of Hispanic students \((n=36)\) completed four years of high school math. Of 595 White students, 17 students (2.9%) completed two years of high school math, 311 (52.3%) completed three years of high school math, and 267 (44.9%) completed four years of math in high school.

A Cramer’s \( V \) coefficient was calculated to assess the strength of the relationship between the number of math courses completed and ethnicity (Cramer’s \( V = .106 \)). A Cramer’s \( V \) of \( .106 \) corresponds to a small effect size. The Asian group of students had a significantly higher proportion of taking more high school math than White, Black, or Hispanic students.
A chi-square analysis was also employed to determine how economic groups differ in the number of math courses completed. Students where classified as economically disadvantaged or not economically disadvantaged. Not economically disadvantaged students did not receive either free or reduced lunch. Economically disadvantaged students received free or reduced lunch through the national free lunch program. The chi-square requirement of independence was met and the results are interpreted in Table 10.

Table 10

Chi-Square Analysis Summary for Economic Status and the Number of High School Math Courses Completed

<table>
<thead>
<tr>
<th>Number of High School Math Courses</th>
<th>No Free/Reduced Lunch</th>
<th>Received Free/Reduced Lunch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>21</td>
<td>1</td>
</tr>
<tr>
<td>2 Expected Count</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>Percent within economic group</td>
<td>2.9</td>
<td>1.4</td>
</tr>
<tr>
<td>Count</td>
<td>377</td>
<td>50</td>
</tr>
<tr>
<td>3 Expected Count</td>
<td>389</td>
<td>38</td>
</tr>
<tr>
<td>Percent within economic group</td>
<td>52.7</td>
<td>71.4</td>
</tr>
<tr>
<td>Count</td>
<td>318</td>
<td>19</td>
</tr>
<tr>
<td>4 Expected Count</td>
<td>307</td>
<td>30</td>
</tr>
<tr>
<td>Percent within economic group</td>
<td>44.4</td>
<td>27.1</td>
</tr>
</tbody>
</table>

Table 10 reveals that the actual number of students labeled as economically disadvantaged who completed either two or four years of math in high school was less than the
expected number. The actual number of students who were not economically disadvantaged and completed two or four years of high school math was more than the expected number. Nineteen students (27.1%) who were economically disadvantaged completed four years of high school math, the expected number of students was 30. For students who were not economically disadvantaged 318 (44.4%) completed four years of math and the expected number of students was 307. Of the students who completed three years of high school math fewer than the expected number of non-economically disadvantaged students and more than the expected number of economically disadvantaged students completed three years of math. The Pearson chi-square statistic, $\chi^2 (2)=9.089, p<.05$, indicates that there is a statistically significant difference between the number of high school math courses completed and economic status. The analysis indicates that differences in economic status are related to differences in the number of high school math courses completed.

Expected cell frequencies were examined to determine whether there were any frequencies less than five; one cell (16.7%) had an expected count less than five. The minimum expected count was 1.96. Table 10 shows the observed cell frequencies for economic status and the number of high school math courses completed. Of 716 students who were not economically disadvantaged, 21 students (2.9%) completed two years of high school math, 377 (52.7%) completed three years and 318 (44.4%) completed four years of high school math. Of 70 students receiving free or reduced lunch, one student (1.4%) completed two years of high school math, 50 (71.4%) completed three years of high school math, and 19 (27.1%) completed four years of high school math.

In Table 10, a Cramer’s V coefficient was calculated to assess the strength of the relationship between college readiness and economic status (Cramer’s $V = .108$). A Cramer’s V
of .108 corresponds to a small effect size. The not economically disadvantaged group of students had a significantly higher proportion of completing more math courses in high school than the economically disadvantaged students.

A significant relationship also exists between 8th grade algebra and the number of mathematics courses completed in high school. Table 11 shows the results of the chi-square analysis between the number of math courses completed and 8th grade algebra completion.

Table 11

<table>
<thead>
<tr>
<th>Number of High School Math Courses</th>
<th>8th Grade Algebra</th>
<th>No 8th Grade Algebra</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>18</td>
<td>4</td>
</tr>
<tr>
<td>Expected Count</td>
<td>10.3</td>
<td>11.7</td>
</tr>
<tr>
<td>Percent within 8th grade algebra group</td>
<td>4.9</td>
<td>1.0</td>
</tr>
</tbody>
</table>

| Count                              | 150               | 277                  |
| Expected Count                     | 199.4             | 227.6                |
| Percent within 8th grade algebra group | 40.9          | 66.1                 |

| Count                              | 199               | 138                  |
| Expected Count                     | 157.4             | 179.6                |
| Percent within 8th grade algebra group | 54.2          | 32.9                 |

Table 11 reveals that the actual number of students who were enrolled in 8th grade algebra and completed two or four years of high school mathematics was more than the expected number. The actual number of students who were not enrolled in 8th grade algebra and completed
two or four years of math was less than expected and the actual number of students who completed three years of math was more than expected. For students who completed four years of math in high school the actual number of students who did not take 8th grade algebra was 138 and the expected count was 179.6; and for students who did take 8th grade algebra, those who completed four years of high school math (199) was more than the expected count of 157.4. However, the actual number of students who completed only two years of high school math was more than the expected number for students who completed 8th grade algebra and less than expected for students who did not complete 8th grade algebra. The Pearson chi-square statistic, $\chi^2(2)=54.522$, $p<.05$, indicates that there is a statistically significant relationship between the number of high school math courses completed and the completion of 8th grade Algebra I. The analysis indicates that whether or not a student completes algebra in 8th grade is related to how many math courses are completed in high school.

Expected cell frequencies were examined to determine whether there were any frequencies less than five; the smallest expected cell frequency was 10.27. Table 11 shows the observed cell frequencies for 8th grade algebra completion and the number of math courses completed in high school. Of 367 students who completed algebra in 8th grade, 199 students (54.2%) completed four years of math in high school and 150 students (40.9%) completed three years of high school math. Of 419 students who did not complete algebra in 8th grade, 138 students (32.9%) completed four years of high school math and 277 students (66.1%) completed three years of high school math.

A chi-square analysis found no statistical significant relationship ($\chi^2(2)=3.134$, $p<.05$) between gender and the number of math courses completed. There was also not a statistically
significant relationship between AVID enrollment and the number of high school math courses completed in high school ($\chi^2(2)=4.457, p<.05$).

The Spearman rho correlation coefficient was used to analyze the relationship between the number of high school math courses a student completes and college readiness. Spearman rho, a variation of the Pearson $r$, is appropriate because the number of math courses is a ranking, or interval, variable (Hinkle, Wiersma, & Jurs, 2003). There is a significant relationship between the number of math courses taken and college readiness (Spearman rho=.269, $p<.01, N=787$). The Spearman rho analysis shows that students who complete more high school math courses are more likely to be ready for college level courses after graduation.

*Regression Analysis*

Multiple regression analysis is a general statistical technique used to analyze the relationship between a single dependent variable and several independent variables (Hair, et al, 2006). Regression analysis is most often used with naturally occurring variables instead of experimentally manipulated variables. Causal relationships can not be determined from a regression analysis; the regression analysis may allow prediction or identify a relationship between variables. When conducting a regression analysis the ratio of cases to independent variables should be 20:1 (Princeton University Data and Statistical Services, 2009). With 787 cases, five independent variables, gender, 8th grade algebra completion, socioeconomic status, ethnicity and AVID enrollment, and one dependent variable, college readiness, the study meets the required ratio. The multiple regression analysis also met the assumption of linearity, that there is a straight line relationship between the independent and dependent variables, and the assumption of homoscedasticity, that the residuals are approximately equal for all predicted dependent variable scores. The normality assumption was met by checking the skewness
coefficient (.084) and kurtosis coefficient (-.511) which were in the range of negative one to one. The data also meet the requirements for multicollinearity and singularity, namely that the independent variables are not highly correlated and the independent variables are not perfectly correlated with one independent variable.

The independent variable ethnicity was a categorical variable with five unranked categories: White, American Indian, African American, Hispanic, Asian American. This variable was dummy-coded into four variables with White as a reference group. The independent variable economic status was also a categorical variable with three unranked categories: None, Free Lunch, and Reduced Lunch. None is the reference group while the other two variables were dummy-coded. The multiple regression analysis was conducted to quantify the relationship between the dependent (criterion) variable, the number of high school math courses a student completes and the independent (predictor) variables, 8th grade algebra, economic status, gender, ethnicity, and AVID enrollment. An adjusted $R^2$ squared value measured the proportion of the variance in the criterion variable, number of math courses completed, which is accounted for by the regression model. $R^2$ squared is a measure of how good a prediction of the criterion variable can be made by knowing the predictor variables (SPSS for Psychologists, 2006). This value takes into account the number of variables and the number of observations to give the most useful measure of the success of the model when applied to the real world. An $R^2$ squared value of .044 indicates that about 4.4% of the variance in the number of math courses a student completes in high school can be explained by the combination of the predictor variables. Beta weights allow for direct comparison of the relative strengths between variables. The combination of variables in this model statistically significantly predicted the number of math courses completed with a
small effect size \((F(9,787)=4.998, p=.000)\). A summary of the multiple regression analysis is displayed in Table 12.

Table 12

*Multiple Regression Summary for the Number of High School Math Courses Completed*

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE</th>
<th>t</th>
<th>Sig</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td>8\textsuperscript{th} Grade Algebra</td>
<td>.155</td>
<td>.038</td>
<td>4.023**</td>
<td>.000</td>
<td>.148</td>
</tr>
<tr>
<td>Gender</td>
<td>-.050</td>
<td>.037</td>
<td>-1.361</td>
<td>.174</td>
<td>-.048</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Ref=White)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American Ind</td>
<td>-.813</td>
<td>.297</td>
<td>-2.736</td>
<td>.006</td>
<td>-.096</td>
</tr>
<tr>
<td>Asian</td>
<td>.330</td>
<td>.117</td>
<td>2.829*</td>
<td>.005</td>
<td>.099</td>
</tr>
<tr>
<td>Black</td>
<td>.008</td>
<td>.078</td>
<td>0.097</td>
<td>.923</td>
<td>.004</td>
</tr>
<tr>
<td>Hispanic</td>
<td>-.048</td>
<td>.059</td>
<td>-.811</td>
<td>.417</td>
<td>-.033</td>
</tr>
<tr>
<td>Economic Status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Ref=None)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free</td>
<td>-.034</td>
<td>.083</td>
<td>-0.406</td>
<td>.685</td>
<td>-.016</td>
</tr>
<tr>
<td>Reduced</td>
<td>-.100</td>
<td>.133</td>
<td>-0.752</td>
<td>.453</td>
<td>-.027</td>
</tr>
<tr>
<td>AVID</td>
<td>-.034</td>
<td>.079</td>
<td>-0.430</td>
<td>.668</td>
<td>-.017</td>
</tr>
<tr>
<td>Constant</td>
<td>3.421</td>
<td>.035</td>
<td>98.182**</td>
<td>.000</td>
<td></td>
</tr>
</tbody>
</table>

Adjusted R                  | 0.044 |      |      |      |     |

| 0                         | 787    |      |      |      |     |

Note: *\(p<.01\), **\(p<.001\)

_B_ refers to the individual contribution of each predictor to the model. _B_-values tell us to what degree each predictor affects the outcome if all other predictors are held constant. SE, the standard error, is associated with the coefficients used to test whether the coefficient is
significantly different from zero. The standard error reports to what extent the $B$-value would vary across different samples. The $t$-value used in testing the null hypothesis stating that the coefficient is equal to zero is listed in the $t$ column. The sig column reports to what extent the $t$-value is significant, in other words, whether or not the $b$ value differs significantly from zero. If the value listed is less than 0.05 then the predictor is making a significant contribution to the model. Beta, $\beta$, is the standardized version of the $b$-value. Beta measures how strongly each predictor variable influences the criterion variable. It is easier to interpret because the beta measurement is not dependent on the units of measurement of the variable. The higher the beta value the greater the impact of the predictor variable on the criterion variable.

With a Beta value of .148 at the .00 significance level, completion of 8th grade algebra was found being the strongest predictor to contribute to the number of high school math courses completed. Asian students took more high school math courses than white students ($\beta=.099$, $p=.005$) and American Indian students completed significantly fewer high school math courses ($\beta=-.096$, $p=.006$) than white students. The level of the completed school courses for Asian students is .099 higher than White students.
CHAPTER 5
SUMMARY, DISCUSSION, AND RECOMMENDATIONS

Introduction

This study was designed to examine the relationship between the dependent variables, college readiness and high school math course completion, and the independent variables, 8th grade completion of Algebra I, gender, ethnicity, economic status, and enrollment in the Advancement Via Individual Determination (AVID) program. AVID serves as a support program for students who are typically underserved in the Pre-Advanced Placement program. Teachers recommend students for enrollment in AVID, students may also self-select enrollment. Hallmarks of the AVID program include college preparation and enrollment upon high school graduation. College readiness was determined using the Texas Success Initiative (TSI) criteria. To be deemed ready to enroll in college level mathematics high school graduates must meet minimum score requirements on the TAKS exam, the SAT or the ACT college entrance exams.

A sample size of 787 2006 high school graduates from a large 4A school district in North Texas provided the data for this study. Data were collected from the students’ Academic Achievement Records (AAR). About 47% of the students in this sample completed Algebra I in 8th grade. Economic status was determined by enrollment in the National School Lunch Program, a federally assisted meal program sponsored by the United States Department of Agriculture. The State of Texas required 2006 high school graduates to complete three mathematics credits, including Algebra I, geometry, and Algebra II. Students who complete Algebra I in 8th grade earn one of the high school math credits required for graduation.

The following sections include a review of the statistical analyses and results for each research question, consideration of the limitations of the study, contributions this study made to
the current research in the area of mathematics literacy and college readiness, and recommendations for future research.

Discussion of Results

Research Question 1

The first research question examined whether a student who completed Algebra I in 8th grade took more high school math courses and was more college ready than a student who did not take Algebra I in 8th grade. The statistical analysis found a significant relationship between completion of Algebra I in 8th grade and college readiness, at the p<.05 level. As shown in Table 8 of the 367 students who completed Algebra I in 8th grade, 302 met the standards to be classified as ready for a college level mathematics course, 65 were not college ready. Of the students who completed Algebra I in 8th grade 82.3% were college ready while 17.7% of students who completed 8th grade Algebra I were not college ready. Four hundred and twenty students did not complete Algebra I in 8th grade. Of these 420 students, 159, or 37.9%, were college ready and 261, or 62.1%, were not college ready. These results imply that there is a positive relationship between 8th grade Algebra I and college readiness.

There was also a statistically significant relationship between the number of high school math courses completed and completion of 8th grade algebra. The actual number of students who were enrolled in 8th grade math and took three years of math (150) was less than the expected count of 199.4. However, the actual number of students who were enrolled in 8th grade algebra and took four years of math (199) was more than the expected count of 179.6. The opposite relationship was found for students who did not take Algebra I in 8th grade. Of these students, 227 students were expected to complete three years of math in high school and 277 completed
three years of high school. Of the students who did not complete 8th grade algebra 179 students were expected to complete four years of high school math and 138 actually completed four years of high school math. For students who completed 8th grade algebra 40.9% completed three years of math and 54.2% completed four years of math. For students who did not complete 8th grade algebra 66.1% completed three years of high school math and 32.9% completed four years of high school math. The chi-square and Cramer’s V analysis indicates that there is a statistically significant relationship between the number of high school math courses completed and 8th grade algebra enrollment.

The multiple regression analysis reports that the completion of 8th grade algebra was found to be the strongest predictor to contribute to the number of high school math courses completed. These results substantiate the assumption that completion of 8th grade Algebra I interacts with the number of high school mathematics courses completed.

**Research Question 2**

Research question 2 investigates how race, gender, socioeconomic status, and enrollment in the Advancement Via Individual Determination (AVID) relates to college math readiness and high school mathematics course completion. Multiple statistical analyses were conducted to evaluate this question.

The first chi-square analysis addresses the relationship of each independent variable, race, gender, economic status, AVID enrollment, and completion of 8th grade Algebra I, individually, to college readiness. A significant statistical relationship was found between college readiness and ethnicity, economic status, completion of 8th grade algebra, and AVID enrollment. No significant relationship was found between college readiness and gender.
In terms of race, the statistical analysis showed that of the 595 white students, 379 graduates were college ready. Sixty-four percent of white students were ready to take a college level math course after high school graduation. There were 117 Hispanic students; 44, or 37.6% of the total population of Hispanic students, were prepared to take a college level math course after high school graduation. Of the 52 black students, 18, or 34.6%, met the requirements to take a college level math course after high school graduation.

Students classified as economically disadvantaged were not as ready to enroll in a college level math course after graduation as students who were not economically disadvantaged. Of the 54 students who received free lunch (the most economically disadvantaged students), 14, or 26% of students receiving free lunch, was college ready. Sixteen students received the reduced lunch program; 4, or 25%, were ready for college mathematics. Of the 717 students who were not economically disadvantaged, 443, or 61.7%, were ready for college level mathematics after high school graduation.

The relationship between college readiness and AVID enrollment proved to be the opposite of what might be expected. Fifty-six total students earned a credit for AVID enrollment, 18 of these students, or 32.1%, were college ready while 38 of the students (67.9%) were not college ready. Given that AVID seeks to prepare students for success in college, this relationship warrants further investigation.

Chi-square analyses also found significant relationships between the number of high school math courses completed and ethnicity, economic status, and the completion of 8th grade algebra. No significant relationship was found between the number of high school math courses completed and gender or AVID enrollment.
In terms of ethnicity, the statistical analysis showed that 75% of Asian students, 37.3% of Black students, 30.8% of Hispanic students and 44.9% of White students completed four years of math. Most Hispanic students (66.7%), most White students (52.3%) and most Black students (60.8%) completed three, rather than four, years of high school math. Asian students were more likely to take more math courses in high school than Black, White, or Hispanic students. The multiple regression analysis also showed that Asian students took more high school math courses than white students.

Students who were economically disadvantaged did not complete as many high school math courses as students who were not economically disadvantaged. Of the 70 students who were economically disadvantaged, 71.4% completed three years of high school math and 27.1% completed four years of math. Of the 717 students who were not economically disadvantaged, 52.7% completed three years of high school math and 44.4% completed four years of high school math.

Completion of 8th grade algebra significantly related to the number of high school math courses a student completed. Of 367 students who completed algebra in 8th grade, 199 students (54.2%) completed four years of math in high school and 150 students (40.9%) completed three years of high school math. Of 419 students who did not complete algebra in 8th grade, 138 students (32.9%) completed four years of high school math and 277 students (66.1%) completed three years of high school math.

Implications of the Study

Research has been conducted to explore the effects of early entrance to Algebra I. Many studies (Smith, 1996, Adelman, 1999, & Wilkins & Ma, 2002) found that early access to algebra
increased grade point averages and the likelihood of a student completing higher level math and also led to increased rates of growth.

Results for the research questions presented here suggest that a student who completes 8th grade algebra is more likely to be ready for college after high school graduation and to complete more mathematics courses while in high school. Although other factors were found to be related to college readiness and completion of high school math courses, access to early algebra is the only factor that can be altered or influenced by educators, parents, and policy makers.

The findings of this study also indicate that early access to Algebra I can positively affect the number of high school math courses a student completes and the likelihood that the student will be college ready after high school graduation. Given the implied benefits of 8th grade Algebra I it is important to consider how to grant access to early Algebra I to any student. Many factors influence a student’s access to algebra in 8th grade.

Students who may benefit from early algebra must be identified. As the research shows, clearly defined standards for admittance are rarely followed. Students are identified almost arbitrarily by ability, teacher recommendations, the student’s choice, or a parent’s influence. This process remains random despite research that shows early access to algebra has a sustained, positive effect on students that can lead to exposure to an advanced mathematics curriculum (Taylor, 2006). Useem (1992) found that idiosyncratic school placement philosophy and practice limits many students’ opportunity to learn algebra in 8th grade. There are vast differences in entrance criteria across states, districts, and often even schools within a district. Research shows that early access to Algebra I is often reserved for specific, selected students based on arbitrary practices (Taylor, 2006, Smith, 1996, Useem, 1992). Eighth grade algebra enrollment criteria for the students involved in this study were also arbitrary. A standard for enrollment was not
established by the school district. Any student could request the course but teachers made the final recommendations. Teacher recommendations could be overruled by a parent’s request.

The results of this study challenge educators to examine how the early and rigid ability grouping for mathematics education may impact a student’s access and ability to complete higher level mathematics. From 1996 to 2005 the number of students completing 8th grade algebra increased from 27% to 34% (Cavanagh, 2008) yet enrollment criteria and equitable access continue to be inconsistently applied.

Early access to Algebra I positively relates to college readiness and high school mathematics course taking patterns; however, early access by itself will not be enough to improve mathematics literacy for all students. California mandated a requirement that all qualified 8th graders complete Algebra I. However, experts on the National Mathematics Advisory Panel state that the California mandate is a mistake (Cavanagh, 2008). According to these experts forcing 8th graders to complete algebra is shortsighted and confuses taking a course with learning and mastering the curriculum. Algebra is crucial to a student’s academic success but simply enrolling 8th grade students may not result in improved math literacy.

Federal and state accountability standards mandate that improvement is made in mathematics education and compels educators to seek answers to improve student mathematics performance. Early access to Algebra I may be one key to improvement. However, all students will not have access to early algebra or be able to experience math success without significant foundational preparation. This one factor – providing early, high quality mathematics education to all students – may allow all students to successfully complete Algebra I in 8th grade and experience the benefits of completing more high school math courses and increased college readiness.
Public school education can prepare students to complete more high school mathematics courses and be ready to take college level math by offering the Algebra I curriculum to 8th grade students. In order for 8th grade students to be prepared to take Algebra I educators, parents and policy makers must consider the following factors: (1) early math education based on sound, thorough, fundamental concepts incorporating problem solving and number sense and (2) equitable access to higher level mathematics for all students and (3) a cohesive plan that insures high school graduates who complete four years of math courses in high school are well-prepared for college.

Specific levels of economic status and ethnicity were shown to be related to mathematics course taking patterns and college readiness. These factors are predetermined; however, regardless of ethnicity or economic status every student can be allowed the opportunity to complete 8th grade algebra and experience the potential benefits. To improve the math literacy of all students, educators, parents, and policy makers together can insure quality mathematics education that prepares all students for early access to advanced mathematics.

The findings of this study support the prevalent research relating ethnicity to math course completion. Research has shown that Asian students take significantly more high school math than other ethnic groups. Bowman (2004) found that half of Asian students and 45% of white students had completed high school mathematics coursework beyond Algebra II. Only 19% of African American students, 28% of Hispanic students, and 21% of American Indian students had completed higher level mathematics courses. Results obtained from the Nation’s Report Card (2009) show that 12th grade Asian students score higher on the 2005 National Assessment of Educational Progress (NAEP) exam than students in the other four racial/ethnic groups. The
study conducted here supported the research. In the sample population of 787 students the 20 Asian students completed significantly more high school math than other ethnic groups.

Black students were 50% less likely to be ready for college at graduation than White students. This finding is also supported through the research and literature. A U.S. Department of Education study reported by House (2006) states that 12\textsuperscript{th} grade African American students’ mathematics performance is equivalent to the average level of math performance of 8\textsuperscript{th} grade White or Asian students. To address the inequity in college readiness educators must intentionally provide programs and strategies for high school graduates most at risk to be unprepared to take college level courses.

AVID strives to prepare students for college but may be missing the mark. The findings of this study indicate that the majority of AVID students are not prepared for college after high school graduation. While the AVID organization reports that 78% of students enrolled in AVID are accepted to a four year university (AVIDonline, 2009), whether the students are well-prepared for college is worthy of further research. AVID reports that a high percentage of students enroll in college but does not report how many take developmental classes in math or English prior to beginning college level courses.

There was a significant difference between the number of high school math courses economically disadvantaged and economically advantaged students completed. Larsen (2007) reports that course taking patterns widens the achievement gap and that the more math courses a student completes in high school, the more likely the student is to be college ready. A commitment to narrowing the achievement gap between poor and advantaged students compels math educators and policy makers to provide a strong, equitable, rigorous, foundational mathematics education to all students.
Additional Considerations

Although the percentage of students in this study who were ready for college level mathematics after high school graduation compares favorably to state and national percentages of students who are college ready at graduation there may be other characteristics of the sample population that are not easily compared to the general population of high school graduates.

The relatively small number of students included in the economically disadvantaged group and the ethnic groups Asian and American Indian may limit the appropriateness of applying the statistical findings in the sample population to the general population. This study found that Asian students took significantly more high school math courses than other ethnic groups. In this particular study the Asian population comprised 2.5% of the population, there were 20 total Asian students included in the research. There could be some high school students who may have qualified as economically disadvantaged through the National School Lunch Program in earlier grades but may not apply for the lunch program in high school and thus, not be identified as economically disadvantaged.

Recommendations for Further Study

This study, as well as research by Ma (2000) implores further study to investigate how school policies and practices mediate students’ access to early algebra and advanced mathematics coursework and the effect of these policies on mathematics literacy and college readiness. Other recommendations for further study include:

(1) Investigating how the new Texas graduation plan requiring that all students complete four years of high school mathematics will affect college readiness, math aptitude, and enrollment in 8th grade algebra.
(2) Expanding this study to include math aptitude as a factor that may be related to 8th grade algebra enrollment, high school mathematics course taking patterns, and college readiness.

(3) Using longitudinal data to evaluate how completion of 8th grade algebra may relate to completion of a bachelor’s degree.

Recommendations for further research include examination of how to revise and recreate the traditional mathematics curriculum in Grades K – 12 so that more students are able to access high level mathematics in high school and college. The policies, practices and procedures for granting students access to higher level mathematics is also worthy of further study. Research that identifies how to standardize students’ access to early algebra and geometry will result in improved placement practices that could eventually lead to improved math literacy.

Conclusion

The purpose of this study was to determine whether or not there was a relationship between completion of 8th grade algebra and high school mathematics course taking patterns and college readiness. The study also evaluated the relationship between gender, ethnicity, economic status, and AVID enrollment and high school mathematics course taking patterns and college readiness. The results support the connection between early access to algebra and increased high school math completion and improved college readiness. Relationships were also found between ethnicity and economic status and high school mathematics course taking and college readiness. Asian students completed more high school math than other ethnicities and White students were twice as likely as Black students to be college ready. Students who were not economically
disadvantaged were more likely to be college ready than students who qualified for the free lunch program.

The economic status and ethnicity of students are permanent factors that can be addressed through educational practices, programs and policies; but these factors can not be changed. However, regardless of a student’s ethnicity or economic status, every student can be prepared for and allowed the opportunity to complete high level mathematics at an early age. There are two factors that inhibit all students from receiving the educational benefits of early access to high level math. The first factor is the foundational mathematics education program that is implemented in the elementary and middle school grades. The other significant factor relates to the policies and guidelines established by educators that control the access of students to higher level mathematics. These two factors can and should be addressed by educators and policy makers so that equitable, advanced and appropriate mathematics opportunities are provided to all students.
REFERENCES


High school mathematics: State-level curriculum standards and graduation requirements. Center for the Study of Mathematics


