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AN EMPIRICAL STUDY INVESTIGATING MATH PREPAREDNESS FOR UNIVERSITY STUDENTS WITH ENGINEERING CAREER GOALS: "SAVAGE INEQUALITIES" THIRTEEN YEARS LATER

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ABSTRACT

The purpose of this study was to examine the relationship between the type of high school math completed and the percent of variance in university math placement scores for 515 students enrolled in the College of Engineering at a large Research I university. By comparing the percent of variance in HSMATH to other independent variables that were used in this study—including gender, race/ethnicity, parent education level, percentage of students considered math proficient and economically disadvantaged, high school grade point average, and SAT math score—results indicated that high school math completed and high school grade point average contributed to 27% of variance in university math placement scores when loaded after gender and race/ethnicity (R square = .050) and parent education level, economically disadvantaged, and math proficiency (R square = .109), respectively. Research studies included in this study discuss the insignificance of SAT scores in relation to its predictability for later college academic success; however, when SAT math scores was used as a separate variable in this study, results indicated that SAT math scores (entered in the fourth block) accounted for 53% of the variance in university math placement scores. Implications and directions for future research and practice are also discussed.

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Chapter I

INTRODUCTION

Research related to the academic math preparation of U.S. students attending public high schools continues to grow yet the theoretical framework and methodologies used to guide such studies appear to limit the examination of how the variables incorporated within the studies interrelate. Much of the research has used hierarchical linear modeling in studying how students progress academically in math over time and more studies are needed that look at the interrelationships of variables, specifically with the use of hierarchical regression models. When specifically looking at research examining academic preparation for and graduation from engineering bachelor's degree programs for this study, theoretical models focusing on math self-efficacy (e.g., Social Cognitive Career Theory) were used more often than theories incorporating factors associated with academic preparation (e.g., The Social Learning Approach to Career Decision Making). Parental education level and its relation to academic preparation for engineering bachelor's degree programs is sparse and the need for additional variables to be explored, specifically in relation to preparation for engineering bachelor's degree programs, continues.

Forty-one percent of all undergraduates attending four-year public comprehensive institutions identify as first-generation college students (Warburton, Bugarin, & Nunez, 2001), that is students whose parents did not attend college (Terenzini, Springer, Yaeger, Pascarella, & Nora, 1996). Research indicates that first-generation college students are more likely to be low-income, have low levels of academic achievement, and have lower overall degree aspirations; and these characteristics were found to contribute to higher

college attrition rates for this student population (Terenzini et al., 1996). When considering career advancement in math intensive career fields, few first-generation college students were found to enter math intensive majors (Berkner & Chavez, 1997), inhibiting the ability of this population to advance toward math, science, and engineering career opportunities and higher salaries. Without further research examining various factors associated with advancement in engineering bachelor's degree programs, potential first-generation college students will continue to be excluded from these career fields, including those first-generation college students also identifying as students of color and women.

According to the National Science Board (2000), by 2008, jobs in science, mathematics, and engineering fields in the United States are expected to increase at four times the rate of all other employment opportunities. Whites currently make up 82.3% of the science, mathematics, and engineering workforce followed by Asian Americans, African Americans, Hispanics, and American Indians at 10.4%, 3.4%, 3.1%, and 0.3%, respectively (National Science Board, 2000). Despite national efforts over the past two decades to reduce this gap, engineering career fields continue to be dominated by majority populations. When considering the education level of the parents of current engineers, few would probably identify as first-generation college students. Not only are students of color and first-generation college students less likely to enter engineering bachelor's degree programs (Mau, 1995), women also lag behind their White male counterparts in regards to admission to and graduation from engineering bachelor's degree programs (Nauta, Epperson, & Waggoner, 1999). Even if admitted to engineering bachelor's degree programs, women and students of color are still more likely to disenroll

from engineering degree programs despite being considered as equally academically prepared as all other enrolled students (Clewell, Anderson, & Thorpe, 1992). By exploring the different factors associated with students' career decisions and educational attainment process researchers will be better able to develop a model of educational attainment for women, students of color, and first-generation college students tracking specific career fields, specifically engineering career fields. The Social Learning Approach to Career Decision Making serves as the theoretical framework for this study because it is a sociological model that incorporates factors that contribute to both educational attainment and students' career decisions.

Social Learning Approach to Career Decision Making

Herr (1999) contends that the freedom to choose not only requires knowledge about the available options, but also about the personal characteristics necessary to reach the desired goals. What adolescents choose to become later in life may be less important than the factors associated with influencing their choice.

We are born with physical traits including skin color, height, gender, and various cultural traits all of which combine and determine what we look like on the outside. These physical characteristics, according to Krumboltz (1979) are our genetic endowments and these traits can influence how we perceive others and ourselves. Because physical traits cannot form opinions, we rely on our environmental conditions and learning experiences to teach us about the world in which we live. Family members, friends and associates, the community around us, and teachers and the academic curriculum provide individuals with the opportunity to learn and form impressions

regarding race/ethnicity, physical appearance, and cultural understanding, however, not everyone experiences the same type of social and environmental conditions.

Genetic Endowment and Special Abilities

According to Krumboltz (1979) inherited traits are those characteristics with which an individual is born. These different genetic traits can negatively impact our decisions to aspire toward future career goals, specifically engineering. Of most importance to the current study was the discouraging number of women and students of color entering and graduating from engineering bachelor's degree programs. Much of the research incorporating gender and ethnicity as variables within their studies have not looked at variables that contribute to university math preparation and preparation for engineering bachelor's degree programs above and beyond the sample's genetic endowments. By exploring additional variables that relate to university math preparation, which occurred in the current study, researchers will be better able to build a model of career development for various populations tracking engineering degree programs.

This study includes gender and race/ethnicity and these variables were compared to other variables in this study. Gender and race/ethnicity is important to include because, as Sadler and Tai (2001) suggest, not accounting for these variables may inflate the relationship between academic preparation and later success in college.

This study is not suggesting that being female or a person of color genetically conditions one for later academic difficulty in engineering degree programs, however, these variables may influence how others may perceive the likelihood for future academic success in engineering fields for these groups. For example, parents and teachers may urge White male students toward environmental experiences related to math and science

fields more strongly than female children and children of color. This focus on White male students participating in math and science educational enrichment programs in elementary school, for example, would make it more likely that this student population would develop interests in math and science career fields more often than female students and students of color. This type of encouragement may also relate to the type of math courses students complete in high school.

Teachers and school counselors may encourage more White male students to complete algebra in 8th grade and then calculus in high school, for example, more often than female students and students of color. Due to stereotypes of Asian Americans as academically superior (Hsia, 1998), teachers may set higher expectations for this student population leading to increased numbers of Asian American students enrolled in algebra in 8th grade and calculus courses in high school as compared to other populations of students of color. For the purposes of this study, comparisons were made between gender and race/ethnicity related to examining possible relationships that may exist among these populations in relation to the type of math courses students chose to complete in high school and how these variables may relate to students' university math placement scores.

Environmental Conditions and Events

Social, cultural, political, economic, and natural forces impact career decision making of individuals (Mitchell & Krumboltz, 1990). Low-income families may be less knowledgeable about the type of high school math that is appropriate in relation to preparation for engineering bachelor's degree programs as compared to higher income students. Depending on opportunities to obtain necessary information, low-income students may be at a distinct educational disadvantage. Furthermore, students attending

schools in low-income neighborhoods may be less likely to receive adequate math training that appropriately prepares them for engineering degree programs (Oaks, 1990).

Our social environments help us form impressions of various populations of people, however race/ethnicity can be only explored on a surface level. By incorporating research that compares the social environments in which individuals are raised, a deeper understanding of individual differences can be attained.

Family encouragement (Cabrera & La Nasa, 2000; Hossler & Stage, 1992; Keith & Lichtman, 1994), peer relationships (Mau, 1995; Mau, Hitchcock, & Calvert, 1998), and school counselor roles (ASCA, 2003; Gysbers & Henderson, 2000) provide individuals with the opportunity to learn and form impressions regarding race/ethnicity, physical appearance, and also influence how students academically prepare for their future career goals. Not everyone, however, experiences the same type of social and environmental conditions. The social and environmental conditions that people experience strongly influence how socially and academically prepared they are to meet their future goals.

High school students whose families are less familiar with the relationship between high school curriculum completion and educational attainment, specifically families lacking a college degree, will be less likely to have high career aspirations or complete high school curriculum that will leave various career opportunities as an option. Similar studies examining these factors include parental education level (Nunez & Cuccaro-Alamin, 1998; Olenchak & Herbert, 2000; Ting, 1998; Useem, 1992) and socioeconomic status (Burbridge, 1991; Levine & Nidiffer, 1996; McDonough, 1997; Solorzano, 1992; Useem, 1992; Valadez, 1998). Unfortunately, students attending high

schools with large populations of low-income students of color may be less likely to have access to adequate math preparation. The environmental conditions that a student may experience may limit the possibilities of equal access to a quality math education, reducing the benefits of the students' potential learning experiences.

Learning Experiences

Past learning experiences influence what one chooses to become later in life (Krumboltz, 1979; Mitchell & Krumboltz, 1990). High school math curriculum completion has an impact on how academically prepared a student is for future career goals. In order for students to academically prepare for a math intensive bachelor's degree program, specifically engineering, students should complete a high school math curriculum that provides students with this opportunity. Information pertaining to the varying levels of preparation that may exist between those students who complete trigonometry as compared to those students who complete pre-calculus, for example, is important. Furthermore, the level of high school math a student completes prior to the SAT and ACT exam may relate to lower scores and fewer college acceptance rates. Parental education level and socioeconomic status were found to contribute to students' academic track placement (Useem, 1992). College educated parents were found to be more influential in helping their children schedule more rigorous middle school and high school courses, which leads to higher SAT scores (College Board, 2002).

By exploring the relationships of the characteristics found within the Social Learning Approach to Career Decision Making researchers will be better able to include variables less likely to be found in research, specifically parent education level and family income level. Students' choice of career goal should be complimented with a high

school curriculum that prepares students for their future aspirations. Number of years of high school math may be less important than the specific content covered in a student's last high school math course in relation to university math preparation. Although students may be accepted into college with different levels of high school math completion, Trusty and Niles (2003) found that students who completed more rigorous high school math were more likely to enroll in and graduate from bachelor's degree programs.

Task Approach Skills

Our genetic endowments, environmental conditions, and learning experiences work together to develop our task approach skills, those skills necessary to help us academically prepare for our future careers (Mitchell & Krumboltz, 1990). Academic preparedness in relation to students' career decisions can be explored by examining those studies focusing on factors associated with task approach skills, specifically the success students have in preparing for university math classes.

Being academically prepared for engineering bachelor's degree programs strongly depends on the type of math students complete in high school, however genetic endowments, environmental conditions, and learning experiences strongly influence how students will proceed through the high school curriculum, which may make the difference between those students who enter in and graduate from bachelor's degree programs and those who do not.

Factors that Influence College Enrollment and Academic Preparation

Research studies have investigated various factors associated with middle school and high school adolescent occupational and educational aspirations including family influence (Hossler & Stage, 1992; Keith & Lichtman, 1994), parental education level

(Useem, 1992), peer relationships (Mau, 1995; Mau, Hitchcock, & Calvert, 1998), gender (Mullis, Mullis, & Gerwels, 1998; Rasinski, Ingels, Rock, Pollack, & Wu, 1993; Sewell, Haller, & Portes, 1969), ethnicity (Kao & Tienda, 1998; Mahoney & Merritt, 1993; Mau, 1995; Mau, et al., 1998; Paulson, Combs, & Richardson, 1990; Ramos & Sanchez, 1995; Solorzano, 1992), and socioeconomic status (Solorzano, 1992; Useem, 1992; Valadez, 1998). The income level of the parent as well as parent education level, plays a significant role in determining the level of high school curriculum a student will complete (Solorzano, 1992, Useem, 1992), which affects students decisions to attend college (Valadez, 1998).

Valadez (1998) compared the roles of individual, peer, parental, and educational variables in the decision to attend college for 24,599 students in grades 8, 10, and 12. The effects of race and gender were mediated by socioeconomic status. Students from low socioeconomic backgrounds were found to have less access to important resources and were less knowledgeable about available resources as compared to students from higher socioeconomic backgrounds. Other studies (Alsalam, 1996; Fenske, Porter, & DuBrock, 2000; Heller, 1997; Levine & Nidiffer, 1996) indicate that students' lack of knowledge related to financial aid and programs related to helping low-income students attend college hindered college application numbers of low-income students and contributed to the students' lower rates of academic preparation.

Rojewski (1997) found that students from low socioeconomic backgrounds complete vocational curriculum, rather than college preparatory curriculum, more often than students from middle and high socioeconomic backgrounds, supporting the need for a more structured high school curriculum. The National Commission on Excellence in

Education recommended that all high school graduation requirements nationally should include three years of high school math (Finn, Gerber, & Wang, 2001). Chaney (1995) found that math courses taken beyond the minimum high school math requirements relate to a stronger relationship with achievement in college mathematics. Contrary to this study, Chaney, Burgdorf, and Atash (1997) found that increased high school requirements resulted in increased numbers of math and sciences courses completed but not the level of courses. Although students completed more math and science coursework in high school, completion included introductory courses only.

Schmidt, McKnight, and Raizen (1996) described the typical U.S. high school curriculum as "a mile wide and an inch deep" (p. 34), suggesting that the math and science fields cover more topics yet are less intensive than those offered in other countries. These researchers contend that U.S. high schools with a "constrained academic curriculum" graduate higher percentages of mathematically superior students than those schools with a broad array of course selections. Unfortunately, depending on the predominate race and family income level of students attending U.S. high schools, students of color and low-income students may be at a distinct disadvantage.

The report *Multiplying Inequities* (Oakes, 1990) analyzed the survey results of approximately 6,000 teachers in 1200 public and private high schools. "As the proportion of low-income and minority students at a school increases, the relative proportion of college-preparatory and advanced course sections decreases" (p. 35). The number of calculus sections available per student in high-income schools was approximately four times that of low-income schools.

Various researchers (Holland, 1997; Hossler & Stage, 1992; Mau, 1995; Solorzano, 1992; Valadez, 1998) have looked at the occupational and educational aspirations of adolescents as separate processes. Research is needed that focuses on adolescent career interest and academic preparation for college degree programs simultaneously, specifically engineering degree programs. Students' choice of career goal should be complimented with a high school curriculum that prepares students for their future aspirations

Factors Associated with Graduation from Bachelor's Degree Programs

Previous studies (Mau, 2003; Muller et al., 2001; Trusty, 2002) focusing on characteristics that lead to successfully completing a college degree give extensive general findings based on national longitudinal data, the National Educational Longitudinal Survey of 1988 (NELS: 88), which was administered to a large sample of 8th grade students. Follow up surveys included students' 10th grade and 12th grade data. Individual student measures categorized on the NELS: 88 include student information regarding the number of high school Carnegie Units, which focuses on the number of years students spend per course, and high school program. High school program was determined by the students' high school track placement derived from NELS: 88 transcript data that coded students' high school academic program as nonacademic (general, vocational, or other) and academic. The NELS: 88 data also includes 8th grade student self-reports in relation to students' course completion and grades. Furthermore, the NELS: 88 data includes institutional degree outcomes for various colleges and universities (Mau, 2003). The factor that contributed most to graduation was a rigorous high school curriculum (Adleman, 1999; Altonji, 1992; Betz, 1994; Clewell, Anderson,

& Thorpe, 1992; Horn & Nunez, 2000; Kaufman, 1991; Trusty, 2002; Trusty & Niles, 2003).

High School Curriculum Completion

According to the College Board (2002), completing rigorous high school courses increased SAT scores in studies comparing gender, students of color, and first-generation college students. Horn and Nunez (2000) report that among high school graduates whose parents did not attend college, 64% who had completed advanced mathematics courses in high school, including trigonometry and pre-calculus, enrolled in a 4-year college, compared with 34% who had completed courses through Algebra II and 11% who had completed Algebra I and geometry. Comparable percentages for students with a parent who had a bachelor's degree were 85%, 63%, and 28%, respectively (Horn & Nunez, 2000). Although research (Adelman, 1999; Altonji, 1992; Betz, 1994; Clewell, Anderson, & Thorpe, 1992; Horn & Nunez, 2000; Kaufman, 1991; Trusty, 2002; Trusty & Niles, 2003) indicates students who complete higher levels of high school math are more likely to complete bachelor's degrees, it is not apparent if higher levels of high school math courses more adequately prepare students for college math courses, specifically university calculus, a course important for students enrolled in engineering degree programs.

Quality of High School Curriculum

Little research exists that empirically validates the inequality of the high school math curriculum across schools. Kozol (1991), in his book *Savage Inequalities: Children in America's schools*, exposes the large inequitable budgeting practices of cities with regard to per pupil spending that exist between low-income and high-income school

districts. Building facilities, average salaries, teacher qualifications in various subjects, lack of textbooks, and the inability of students to complete advanced high school coursework were compared across various cities in the country, including Camden, NJ; New York City; Chicago; East Saint Louis; and Washington D.C. (Kozol, 1991). Even if advanced coursework is completed, research focused on the intensity of the curriculum and how it prepares students for college is limited. This study will use the term quality to describe the intensity of the high school math courses in relation to the academic preparation of high school students for university math courses.

Because the intensity of high school and college math curriculum vary nationally, this study focused on the successful entrance of students to one institution. Students who complete math exams in high school (e.g., SAT math section, AP calculus exams) are completing math exams that may not adequately determine academic preparation for college math, specifically calculus (Juillerant, Dubowsky, Ridnour, McIntosh, & Caprio, 1997). High math SAT and AP calculus scores make general statements for future success, and college and university academic advisers use these scores to help students think critically regarding the appropriate math level for their specific institution. In addition, high school students' grade point averages do not necessarily relate to the quality of the students' school curriculum leading researchers to also question issues of grade inflation (Choy, Henke, Alt, Medrich, & Bobbit, 1993; Dillworth, 1990; Henke, Choy, Geis, & Broughman, 1996; Horn, Hafner, & Owings, 1992). To determine calculus readiness for college, it is important to include college and university calculus readiness exams as a predictor for adequate math preparation for engineering majors at the

institution for which the math will be completed, which supports the need for more research to be conducted at individual institutions.

Many colleges and universities require course placement exams after successful admission. At The Pennsylvania State University, the math, chemistry, and English departments develop specific sections of the exam, and test items are based on university curriculum content for that specific department. Placement in remedial math courses (math courses lower than what is required for a university major) may be caused by inadequate high school preparation for similar courses at that institution. For example, completing high school pre-calculus does not guarantee students are academically prepared to complete pre-calculus or calculus at the specific college for which the student was admitted, and low college placement scores do occur.

If students spend the first two years of college focusing on one major and then, due to academic difficulties or career indecision, change their major during their junior year, this career interest change can have a negative effect on the length of time it takes students to graduate from college. It is imperative for students to consider academic preparation and course content interest prior to college enrollment and especially during the first year of college. Similar studies conducted at individual institutions include women's persistence in engineering at individual colleges (Nauta, Epperson, & Waggoner, 1999); the association between high school grades, coursework, and standardized tests (Alters, 1995; Hart & Cottle, 1993); high school physics preparation for college (Sadler & Tai, 2001); and student background and college performance in physics (Champagne & Klopfer, 1982). Limited research exists that incorporates the use of similar variables in relation to academic preparation for engineering degree programs

and even fewer researchers have included theory, like the Social Learning Approach to Career Decision Making, as the framework of their studies.

Purpose of the Study

Previous studies using a national database have examined factors associated with college enrollment (Trusty, 2002) and persistence in science and engineering degree programs (Mau, 2003; Muller, Stage, & Kinzie, 2001). Additional studies focusing on individual institutions studied women's persistence in engineering (Nauta, et al., 1999); the association between high school grades, coursework, and standardized tests (Alters, 1995; Gifford & Harpole, 1986; Hart & Cottle, 1993); math preparation (Jackman, Goldfinch, & Searl, 2001); and high school physics preparation (Sadler & Tai 2001). How researchers determined whether students were equally academically prepared is questionable. High school grade point average, SAT scores, and number of years of high school math may not provide enough information regarding the academic preparation of students for engineering degree programs. Because the quality of high school math varies nationally, it is important to include other variables associated with university math preparation, specifically university math placement scores.

The purpose of this study was to examine the relationship between the type of high school math completed (HSMATH) and the percent of variance in university math placement scores (MATH140) for students enrolled in the College of Engineering at a large Research I university. Focusing on research examining quality of high school math will inform the Pennsylvania State Department of Education, math teachers within the state, and school counselors regarding the need to improve the quality of math curriculum content for all high school students and help students obtain more thorough information

pertaining to preparation for bachelor's degree programs, specifically engineering. Students in low-income school districts who are less likely to receive adequate quality math teaching and equally intensive math curriculum content will receive the most benefit.

Parameters of the Study

This study was limited to the 2003 Pennsylvania public high school graduating class admitted to The Pennsylvania State University, University Park College of Engineering during the Fall 2003 semester. Data was gathered from the University's student data warehouse system and included student admission data as well as the students' university math placement scores.

Statement of the Problem and Research Question

Students of color and women are less likely to be found in engineering bachelor's degree programs (Clewell, Anderson, & Thorpe, 1992). If these student populations are also first-generation college students, their chances of obtaining an engineering bachelor's degree is even more slim. Whether it is a result of lack of encouragement from school personnel or limited knowledge regarding how to appropriately plan for postsecondary education, students of color are less likely to complete a rigorous high school math curriculum (Horn and Nunez, 2000). School districts with higher percentages of low-income students typically receive lower levels of local and state financial support inhibiting the ability of these students to receive a rigorous high school curriculum (Horn, Haffner, and Owings, 1992). Although researchers have examined the importance of rigorous high school math completion, limited empirical research exists

that focuses on examining the relationship of the type of high school math completed in relation to students' academic preparation for engineering degree programs.

Research Question

1. Does completion of a specific level of intensive high school math course—including one half year of trigonometry, one year of trigonometry, one half year of pre-calculus, one year of pre-calculus, one half year of calculus, one year of calculus, one and one half years of calculus, two years of calculus, and three years of calculus—relate to university math placement scores for the Pennsylvania public high school graduation class of 2003 who enrolled in the Penn State University Park College of Engineering during Fall 2003 while controlling math placement scores by gender and race/ethnicity; parent education level (mothered and fathered), percentage of students in the school considered math proficient, and percentage of students in the school considered economically disadvantaged; high school grade point average at the end of 11th grade and highest level of high school math completed; and SAT math score?

Chapter II

REVIEW OF THE LITERATURE

This chapter will provide an overview of empirical studies related to the research question for this study. First, the Social Learning Approach to Career Decision Making and research related to the variables used in this study will be reviewed. Research related to factors associated with college persistence rates will be presented followed by research associated with student persistence rates specifically in math, science, and engineering majors. Due to the math intensity of majors requiring calculus, research related to whether students are entering engineering degree programs equally academically prepared is important.

The Social Learning Approach to Career Decision Making

Why people enter certain career fields and factors influencing change in career fields serve as primary questions in the Social Learning Approach to Career Decision Making (Krumboltz, 1979). The theory's premise is that career decision-making is a product of an individual's previous learning experiences and people make decisions based on faulty beliefs and unrealistic expectations. Derived from Bandura's Social Learning Theory (Mitchell & Krumboltz, 1990), Krumboltz (1979) identified four primary factors that influence the career decision-making process for individuals, including genetic endowment and special abilities, environmental conditions and events, learning experiences, and task approach skills. The theory is applicable regardless of race and gender (Krumboltz, 1996; Mitchell & Krumboltz, 1990).

Unruh (1979) contends that reinforcement theory and stimulus-response behaviorism serve as building blocks for social learning theory. As explored by Bandura

(1971) conditioning (stimulus-response behaviorism) will stimulate a response in animals. Humans, as Unruh (1979) explains, are more complex than animals and through personal awareness humans can be taught to interpret events and become responsible for her or his own actions. Not only does learning take place through observation, social learning contends that learning also takes place through direct experience (Unruh, 1979).

> The ability to predict the consequences of action, to integrate information, to provide self-reinforcement and to influence the range of available alternatives are examples of additional factors that might facilitate self-control in any comprehensive decision-making process (Unruh, 1979, p. 16)

A decision-the selection of an option from among two or more alternatives-may increase or decrease options available for future decisions (Krumboltz, 1979, p. 19). As Krumboltz (1979) states, individuals always have an option, even if the option is to not make a decision. Genetic endowments and special abilities; environmental conditions and events; learning experiences; and task approach skills interact in different ways which influence the decision an individual will make.

Genetic Endowment and Special Abilities

Genetic endowments and special abilities are those characteristics with which individuals are born and may set limits on educational and career preferences and skills (Mitchell Krumboltz, 1990). These traits include gender and ethnicity. The unique experiences of woman and persons of color as compared to their counterparts contribute to their world-view generalizations. If an individual feels that they will have a more difficult time in a rigorous math curriculum because of their gender or ethnicity, then this view may influence the type of high school math classes in which these populations will enroll. Furthermore, if teachers or school counselors set lower academic expectations for women and students of color, then these populations will be less likely encouraged to

complete a rigorous high school math curriculum. Special abilities relate to our intelligence, musical and artistic ability and muscular coordination. Important to this study are factors associated with academic preparation for bachelor's degree programs for women and students of color.

Researchers contend that few women (Mau, 1995) and students of color are less likely to enter engineering bachelor's degree programs (Nauta, Epperson, & Waggoner, 1999). Many researchers have examined self-efficacy in relation to choice of engineering career fields yet these studies did not compare the interrelationship of the included variables to the academic preparation of the students. This study is focusing on comparing the academic preparation of students already enrolled in an engineering bachelor's degree program.

Environmental Conditions and Events

Educational and occupational decision-making is largely influenced by factors outside of the control of any individual. Examples include number and nature of job and training opportunities, social policies and procedures for selecting individuals, rate of return for various careers, family training experiences and resources, educational systems, and neighborhood and community influences (Krumboltz, 1979).

The income level of a family impacts the type of career decisions an individual makes (Krumboltz, 1979; Mitchell & Krumboltz, 1990). Studies examining income level in relation to academic preparation for engineering degree programs did not incorporate a theoretical model within the study. Lee et al. (1998) found middle to high income students were more likely to progress to higher level math courses, which would provide these students with a better opportunity to leave various math intensive careers as an

option, specifically engineering bachelor's degree programs. Students living in higher income school districts may have a better opportunity to interact with math teachers certified in their subject as well as having the opportunity to enroll in calculus courses that academically prepare students for higher level university math courses.

This study included the percentage of economically disadvantaged students within the high school and not individual student family income levels. Furthermore, this study included the percentage of students considered math proficient within each of the students' high schools and examined the variance of change in MATH 140. Comparing the university math placement results of all students who completed calculus in high school and who have similar high school grade point averages and SAT math scores may suggest that students who placed lower on the university math placement exam, even with the same type of high school math completed, may have received lower quality math preparation while in high school.

Learning Experiences

The social and environmental conditions that people experience strongly influence how socially and academically prepared they are to meet their future goals (Krumboltz, 1979; Mitchell & Krumboltz, 1990). Different types of learning experiences have an impact on career decision making and include instrumental learning experiences and associative learning experiences (Krumboltz, 1979; Mitchell & Krumboltz, 1990). Instrumental learning experiences occur when an individual is rewarded or punished for a particular behavior. As Krumboltz (1979) explains, individuals tend to repeat those behaviors in which they are rewarded and reduce the behaviors for which they are punished. Individuals must have cognitive ability in order to interpret their rewards and

punishments in relation to their behaviors (Krumboltz, 1979; Mitchell & Krumboltz, 1990). Associate learning experiences occur when individuals make connections between external stimuli (Krumboltz, 1979; Mitchell & Krumboltz, 1990). For example, high school students may decide not to enroll in more rigorous high school math courses because their peers described the courses as too hard and then decided that their grade point averages were more important for college enrollment than math preparation. Furthermore, high school students may aspire to become engineers because they were told that engineers make a lot of money. Various research exists which relate to learning experiences.

Useem (1992) found that parental education level and socioeconomic status contribute to students' academic track placement. College educated parents were found to be more influential in helping their children schedule more rigorous middle school and high school courses (Useem, 1992), which leads to higher SAT scores (College Board, 2002). Because these parents were more involved in the course selection process, their students were more educationally advantaged than were students with non-college educated families (Useem, 1992).

Useem (1992) developed two scales, the Parental Education Index and the Parental Involvement in Education Scale, which rated parents as "high," "medium," and "low" on four dimensions. The dimensions included knowledge of the math tracking system; networking; volunteering activities and extracurricular activities; intervention on behalf of their child with teachers, counselors, or administration for a particular educational experience and finally, parental influence over their child's course selection. Results indicated significantly higher scores for mothers with advanced graduate degrees

than the scores for mothers with four-year degrees or less. Useem (1992) suggested that parents with advanced degrees were more knowledgeable about the importance of advanced math completion, participated more in school-related functions, and were more likely to influence their children's decisions regarding math course completion. This study incorporated the various levels of high school math that the students completed in high school as well as the grade point averages of the students. In relation to SAT scores, this study included only the SAT math scores and not the verbal scores in relation to academic preparation for a four-year engineering degree program.

Task Approach Skills

The interactions among learning experiences, genetic characteristics, and environmental influences result in performance outcomes or task approach skills (Mitchell & Krumboltz, 1990), including high school grade point average, grades on math exams, and SAT scores. To examine these characteristics, this study examined gender, race/ethnicity, percentage of students considered math proficient and economically disadvantaged within the school, parental education level, high school math curriculum completion and grade point average, and SAT math score to determine how these variables may differentially relate to a student's university math placement score. Parent education level, for example, may relate to the level of math a student may begin in college more so than the ethnicity of the enrolling student. Students who have parents with a high school diploma may be more likely to be enrolled in remedial math courses in college, courses lower than university calculus I, as compared to those students who have parents with college degrees possibly enrolling in university calculus I more frequently.

Horn and Nunez (2000) found that parental involvement in curricular decisions related to higher rates of rigorous high school math completion and bachelor's degree enrollment even after controlling for both parents' income and education level and for students' high school math curriculum and academic preparedness for college. Academic preparedness was determined by the use of a college qualifications index developed by Berkner and Chavez (1997). The index included students' high school grade point average, senior class rank, the NELS 1992 composite test score, and the SAT and ACT scores. Much of the research focusing on academic preparation for bachelor's degree enrollment focused on bachelor's degrees in general and not specifically engineering bachelor's degree programs. Furthermore, previous studies incorporating high school math completion as a variable within their studies did not focus on the relationship of individual high school math courses in comparison to others and the possible affect of the math class on university math preparation. Just the completion of a rigorous high school math curriculum does not guarantee students will enroll in and graduate from bachelor's degree programs, specifically engineering programs.

The previous sections highlighted the importance of social interactions and learning experiences regarding how to appropriately prepare for college. The role of the middle school and high school counselor in helping students understand the relationship of their secondary courses to future career goals, especially for potential first-generation college students, continues to be of extreme importance. Task approach skills, specifically in relation to university math preparation, is important to study in the context of college persistence.

Persistence in College

Various research exists that focuses on factors related to persistence in college (Adelman, 1999; Bennett & Okinaka, 1990; Choy, 2002; Clewell, Anderson, & Thorpe, 1992; Sewell, Haller, & Portes, 1969). Much of the research incorporating variables similar to this study emphasized the importance of high school curriculum completion in relation to preparation for college and university curriculum, and this research highlighted the discouraging numbers of students of color who are not completing college. Much of the research focusing on high school curriculum completion focused on the type of math students completed in high school.

Adelman (1999) used the phrase "highest level of high school mathematics completed" and labeled the variable HIGHMATH. According to Adelman (1999), HIGHMATH was a better predictor for bachelor's degree completion as compared to socioeconomic status (SES). His focus on degree completion and admission rates strays from the typical data that appears to be regularly requested, that is, what is the percentage of women who enter college, what is the ethnic/racial breakdown of students who enter four-year research universities, and more specifically still, have colleges and universities opened the door wider for those populations previously locked out? The current study, like Adelman's (1999), focused on the question of academic preparation for college. Now that the students are in college, what is the likelihood that the students admitted have legs strong enough to walk them through their first semester in an engineering degree program?

This research is not suggesting that the issue of access is a closed case but after decades of studies following the legislative policy changes and admission practices

nationally, more research is needed to determine if the U.S. secondary education system has improved for persons of color and low-income students in order to determine if these student populations have a fair chance of bachelor degree completion, specifically from engineering degree programs. Completing high school graduation requirements and meeting the characteristics for college admission does not guarantee all students received the same quality high school experience and then entered colleges equally academically prepared. Adelman (1999) brings up an assumption regarding high school preparation and college admission criteria, noted below, that this study must now question.

Adelman (1999) made an excellent point regarding the difficulty of using high school transcripts to make inferences about how they relate to bachelor's degree completion. He made reference to using Carnegie units (the number of years of high school curriculum) to determine the numbers of years students spend in a particular type of curriculum and in his research he assumed that because the student's high school transcript stated the student completed six Carnegie units of high school curriculum and then earned a B + in calculus during the first semester of college enrollment, he determined that the student completed pre-calculus and a foreign language in high school (an admission criteria for many colleges). Not discussed was the possibility that this student had a very strong trigonometry course in high school that helped that student place into calculus in college (not academically prepared for, but placed into).

Furthermore, many colleges and universities waive certain admission criteria with the understanding that students must complete those requirements while enrolled in college. If a student did not complete foreign language in high school a college can still admit the student, granted that the student meets other necessary requirements. The

student would then be required to complete foreign language in college even if it is not part of the academic requirements for the specific bachelor's degree program, which can lengthen the time students take to complete college degree requirements. This example sheds light on the problem associated with not comparing individual high school math classes in relation to university math preparation, similar to how colleges and universities use academic transcripts. This student may have had two years of calculus in high school yet was not academically prepared to move beyond the first year of calculus in college, possibly because the student's high school curriculum did not incorporate a rigorous enough calculus curriculum to prepare the student for that college's calculus course. More research is needed that specifically identifies the type of high school math completed and its relationship to university math preparation. Making general statements regarding the importance of completing a rigorous high school math curriculum makes identifying the specific type of high school math that may better prepare students for admission to and graduation from engineering programs more difficult.

Adelman (1999) goes on to discuss the difficulties of using student self-reports and third party information related to college remedial course completion. Access to college transcript information is sparse and colleges and universities, with all good intentions, must maintain a high level of confidentiality that protects the rights of their enrolled students. But how do researchers obtain accurate information in regards to high school and college curriculum completion that adequately allows them to make predictions regarding the factors associated with bachelor's degree completion, specifically engineering degree programs? How do researchers know what type of math classes student actually completed in high school when relying on the number of years of

high school math classes (e.g., three high school Carnegie units of math)? Did the student complete two years of algebra and one year of geometry, or did the student begin algebra in 8th grade and then complete the second year of algebra in high school, geometry, and one-half year of trigonometry and one-half year of pre-calculus? Researchers can begin by following studies that have incorporated specific information related to the types of high school math courses students complete in relation to college mathematics performance.

Lee et al. (1998) found that specific types of high school math courses are strongly associated with college mathematics performance (e.g., academic math courses). Lee et al. hypothesized that a constrained math curriculum, a math curriculum that requires students to complete the same type of math classes, would more evenly distribute student characteristics (e.g. low-income students and students of color) across math classes. Research questions posed in Lee et al.'s study focused on the interrelationship of high school math structure and its influence on student math course choice, math achievement, and equitable distribution of student background characteristics. By using hierarchical linear modeling, a statistic best used for tracking student improvement in one subject over time, researchers found that Black and Hispanic students, low-income students, female students, and students who received lower grades in earlier math courses resulted in these student populations not progressing on to more intensive math courses in high school as did their counterparts. In relation to school size, students who attended smaller high schools progressed more than students who attended large high schools, as did students who attended private schools in comparison to public school attendance. Lee et al explains that the study did not take into consideration the

interrelationships of these variables. The researchers contend that a constrained curriculum is more advantageous to students than having a high school curriculum that offers a wide array of math courses, noting that student background characteristics, as posited in the Social Learning Approach to Career Decision Making, influenced the type of math classes in which students would enroll. This wide math distribution unknowingly set the students up for later slow math progression. This current study focused on the interrelationship of the variables used in this study and how they relate to university math placement scores. Central to students' academic success in college is the type of curriculum students complete in high school and the quality of completion (Lee et al., 1998).

SAT and ACT Scores

College and university admission practices vary nationally (Cabrera, La Nasa, & Burkum, 2001) and despite high grades and strong SAT scores received by high school students, graduation from a bachelor's degree cannot be guaranteed. Research suggests SAT and ACT scores are not good predictors for bachelor's degree attainment and as a result of the recommendation by the President of the University of California system to stop requiring high school students to take the SAT I, colleges and universities have been working toward developing better admission evaluation criteria (Adelman, 1999).

Subsections of the SAT and ACT tests require students to have some high school background knowledge to have a better chance to perform well on the exams. For example, the SAT's math section requires arithmetic, algebra, and geometry, and the ACT's math section requires pre-algebra, algebra, geometry, and trigonometry (Adelman, 1999). Students who do not complete a high enough math level prior to exam completion

may be less prepared for the exams compared to those students who complete trigonometry or higher prior to exam completion. In order for students to have the opportunity to complete geometry or algebra II prior to exam completion, for example, students would need to complete algebra I in the 8th grade in most instances because many students complete the SAT at the beginning of 11th grade. Fewer students, however, have the opportunity to complete algebra I in the 8th grade. Even if students complete a rigorous high school math curriculum, the curriculum completed by students in high school may not have academically prepared them for their future goals, specifically bachelor's degree programs. Missing from Lee et al.'s (1998) study was information pertaining to how the students in their study did on their SAT math exams. Understanding how the school math curriculum may have an effect on student outcomes on SAT math exams is crucial if we are to better understand factors associated with later academic math success.

Quality of High School Math

Research investigating the quality of high school math preparation (Adelman, 1999; Boaler, 1997; Choy, Henke, Alt, Medrich, & Bobbitt, 1993; Dillworth, 1990; Henke, Choy, Geis, & Brougham, 1996; Horn, Haffner, & Owings, 1992; National Center for Education Statistics, 1995; Weiss, Matti, & Smith, 1994) contends that students are completing levels of high school math assumed equally comparable to other schools, however, depending on the socioeconomic status of the school district, some students may not be as well prepared. Although students may complete a math course titled trigonometry or calculus, math course enrollment in high school does not guarantee that the student attended a high school that has a high quality math curriculum.

Horn, Haffner, and Owings (1992) detail the discouraging numbers of less qualified teachers who are more likely to instruct students from the lowest academic and socioeconomic backgrounds. As noted in the researchers' study, not everyone agreed on a definition of teaching quality, however, highly cited terms of teacher quality refer to the academic knowledge and preparation of a teacher in a specific subject. A noted problem with the use of teacher certification as a primary determinate of teacher quality is the inconsistency of state standards for teacher certification programs nationally. Important in Horn et al's study is the comparison of the student populations and the type of 8th grade math completed by each student group. Forty-seven percent of high-income students were enrolled in 8th grade mathematics as compared to 15.2% of low-income students. Furthermore, low-income students (50%) were more likely to have math teachers that majored in general education bachelor's degree programs as compared to high-income students (39%; Horn et al., 1992). Despite being admitted to a bachelor's degree program, students may be competing on an unequal playing field. Because information could not be obtained regarding teacher certification comparisons for this study, information pertaining to how high schools perform as a whole in relation to state standard math assessments will aid researchers in beginning to explore issues of overall math preparation for students attending various public high schools.

In the state of Pennsylvania, for example, 11th grade students are required to complete the Pennsylvania System of School Assessment (PSSA). Percentage rates of students scoring proficient or above in math and reading is reported for public school students enrolled in grades 5, 8, and 11. The School Matters (n.d.) website lists, by state, all public schools nationally and background information pertaining to each school. This

site includes information pertaining to the percentage of students who scored high enough to be considered math proficient, the number of students who were enrolled for a minimum of one year at that school, the percentage of students considered economically disadvantaged, the ratio of students per teacher, and an ethnic breakdown of students enrolled in the school. This factor may contribute to later student enrollment in university remedial math courses.

Remedial Course Completion

In 1995, 29% of first-year students attending four-year institutions enrolled in at least one remedial course (Lewis & Farris, 1996). Twenty-two percent of students who enrolled in remedial courses enrolled in math remediation and 14% enrolled in writing remediation (NCES, 2003). According to Hoyt and Sorenson (2001), despite the numbers of students enrolling in remedial education courses some state education departments have tried to reduce or eliminate remedial course offerings due to cost. Although it may take students longer to complete a degree, the elimination of remedial education courses would further hinder the ability of student populations found in remedial courses from completing bachelor's degree programs. Missing from this data are comparison studies focusing on students' high school math completion and other high school background information including the percentage of students considered math proficient and economically disadvantaged at each of the student's high schools and its impact on remedial course completion in college. The level of university courses in which a student begins may affect the length of time a student takes to complete a math intensive bachelor's degree program. Research including university math placement scores will

add to the breadth of knowledge related to academic preparation for college, specifically engineering.

Persistence in Math, Science, and Engineering Programs

Most prevalent in studies focusing on factors associated with persistence in and graduation from bachelor's degree programs is the success students have in high school math and science courses (Trusty, 2002). Comparisons were made between level of math and science courses in relation to students choosing a math or science major in college and Trusty (2002) found that the effects of course-taking on choice of science and math majors were stronger for women than for men.

High School Curriculum

Various studies have compared high school course completion in relation to success in college courses including college level math and science completion (Spade, Columba, & Vanfossen, 1997), science completion (Kahle, 1990; Neuschatz & McFarling, 1999; Reynolds & Walberg, 1992), success in college physics courses (Halloun & Hestenes, 1985; Hart & Cottle, 1993), and gender differences in college physics (Sadler & Tai, 1997, 2000; Tai & Sadler, 2001). Other studies (Hewitt & Seymour, 1991; Huang, Taddese, Walter, & Peng, 2000) focusing on success in science and engineering degrees incorporated similar variables including high school curriculum and the relationship to success in college courses. Missing from this data is information pertaining to the characteristics of student populations enrolled in the students' high schools, specifically the percentage of students considered math proficient and economically disadvantaged in the high schools. This data may affect the likelihood that students will be academically prepared for college level math.

Parental Education Level

As stated earlier, parental education level is an important factor contributing to higher success rates in college (Terenzini et al., 1996). Studies specifically focusing on parents' education level and success in math, science, and engineering degree programs indicate that students with parents who completed postsecondary degrees are more likely to graduate from these degree programs (Keohler & Burke, 1996; Leppel, Williams, & Waldauer, 2001; Valadez, 1998). Other research (Bassinger, 1985, 1990; Benbow & Arjmand, 1990; Schaefers, Epperson, & Nauta, 1997) also included standardized test scores in relation to success in math, science, and engineering degree programs. Schaefers et al. (1997) found that standardized test scores and high school GPA positively related to persistence in nontraditional majors. High school GPA and SAT scores were the only variables used to describe students as equally academically prepared. Why those students with similar high school GPAs and SAT scores disenrolled from college is unknown.

Persistence in Engineering Degree Programs

Hilton and Lee (1988) indicate that engineering degree programs have a 40% loss of student enrollment by the end of the first two and a half years of school. Unknown from this study is information pertaining to academic preparation comparisons of entering students as well as information related to the percentage of students enrolled in remedial level math courses during the students' first semester.

Both high school students and teachers may have misperceptions related to factors associated with successful completion of engineering bachelor's degree programs and these misperceptions promote stereotypes that marginalize both women and students of

color from pursuing engineering career paths (Yauch, 1999). Factors associated with these misperceptions may include a lack of realistic expectations related to preparing for and graduating from engineering degree programs.

Various studies have focused on factors related to persistence in engineering degree programs in general (Astin, 1993; Baillie, 1998; Hammath, 2000; McGuire & Halpin, 1995; Muller, Stage, & Kinzie, 2001), while other studies have focused on how teaching practice in engineering degree programs may affect persistence rates (Cabrera, Colbeck, & Terenzini, 2001; Ingersoll, 2001; NCES, 2003). Studies with similar variables as used in the current study include Black students with engineering career goals (Good, Halpin, & Halpin, 2001-2002), gender and ethnicity comparisons among students with science and engineering goals (Brown, 1994; Grandy, 1994; Hernandez, 2000; McJamerson, 1992; Mickelson, 1990; Portes & Wilson, 1976), and ethnicity in general (Daempfle, 2003/04; Sondgeroth & Stough, 1992). The following sections describe the results of studies focusing on the relationship between ethnicity and gender on academic preparation for engineering degree programs.

Ethnicity

Muller et al. (2001) used hierarchical linear modeling to study the effects of science course taking on pre-college science achievement. The researchers found that SES and previous grades positively related to students' eighth-grade achievement across all ethnicities and SES was found to relate to the quantity of science units completed in high school. Furthermore, high school track placement had strong effects for students of color. Those students of color who enrolled in higher level math and science courses

continued to complete higher levels of math and science courses through high school (Muller et al., 2001). Other researchers have found dissimilar results.

Various studies (Kao & Tienda, 1998; Mahoney & Merritt, 1993; Valadez, 1998) exist that focus on the mismatch between engineering career aspirations and inadequate academic preparation for engineering degree programs among students of color. Research studies (Kao & Tienda, 1998; Valadez, 1998) have suggested that students of color with high educational aspirations lack realistic information about college. Although students of color may aspire to become engineers, these student populations may be less likely to be encouraged by school personnel to complete a rigorous high school math curriculum, which would include completing algebra in the 8th grade, in order to successfully prepare for four-year engineering degree programs.

Gender

Studies specific to gender include women, minorities, and persons with disabilities in science (Oaks, 1990), curriculum integration techniques (Mills & Ayre, 2003), and gender comparisons in general (Adelman, 1998; Arnold, 1993; Astin & Sax, 1996; National Research Council, 1991; NSF, 1996; Schaefers, Epperson, & Nauta, 1997; Yauch, 1999). These studies suggest that women were coming to four-year degree programs equally academically prepared as their male counterparts, however high school background variables such as SAT scores that include both verbal and math scores and high school GPA may not adequately determine if the students were equally academically prepared. Although academic preparation may have a very strong association with graduation from bachelor's degree programs (Trusty & Niles, 2003), high school grades do not guarantee that a student is prepared (Choy, Henke, Alt, Medrich, & Bobbit, 1993;

Dillworth, 1990; Henke, Choy, Geis, & Broughman, 1996; Horn, Hafner, & Owings, 1992).

Nauta, Epperson, and Waggoner (1999) conducted a persistence study that included examining attributional styles associated with female students who, upon admission to the university, were enrolled in the College of Engineering at a large Midwestern university. According to Nauta, Epperson, and Waggoner (1998), attribution refers to the interpretation an individual makes in regards to a particular event, for example, why the students did poorly in engineering or math courses. Results indicated that non-persisters were more likely to attribute failure to their ability and less likely to correlate success to their effort. Nauta et al. (1998) found that the opposite was indicated for persisters.

Nauta et al. (1998) included the female students' math ACT scores and cumulative college grade point averages across all courses taken as indicators for ability and left out high school academic variables, such as high school math curriculum completed and high school grade point average, as indicators for academic preparation for engineering. Successfully enrolling in engineering degree programs does not guarantee that all students are equally academically prepared. Without this type of information, students may unknowingly blame academic ability as reasons for leaving engineering without understanding that with the appropriate high school curriculum preparation they may have had a stronger chance for success. Including university math placement scores, that is, what math level the students will be suggested to begin with in college, would have helped shed light on how equally academically prepared the students were. Furthermore, Nauta et al.'s. study included female students beyond the first-year.

First-year students and seniors, for example, may have different types of attributional styles that may influence questionnaire results. First-year students, for example, may be more likely to have unrealistically high self-evaluations in regards to academic ability than those students who have completed one or two years of college.

Conclusions

By briefly reviewing the various factors incorporated within the Social Learning Approach to Career Decision Making, researchers can better account for variables missing from similar research. Furthermore, by accounting for missing variables, researchers may be able to develop a better model of career and educational attainment for persons less likely to be found in various research samples, specifically women, persons of color, and first-generation college students.

Chapter 3

METHODOLOGY

The purpose of this study was to examine the relationship between the type of high school math completed and the percent of variance in university math placement scores for first-year Pennsylvania public high school attendees enrolled in the Pennsylvania State University, University Park College of Engineering. Given the interrelationship of various factors on the choice of high school math completed and its effect on university math placement scores, as posited by the Social Learning Approach to Career Decision Making, it is necessary to examine what variables most contribute to university math placement scores, those scores which determine math level placement in Penn State's math courses. This chapter will describe the demographics of the population that was used in this study as well as information pertaining to the variables and the instrument used. Furthermore, the research design and analysis that was used in this study will be presented.

Participants

The sample included 515 first-year students enrolled in the College of Engineering at The Pennsylvania State University, University Park who entered the University during the Fall 2003 semester. These students were first-time, full-time degree seeking students who graduated from a Pennsylvania state public high school in 2003. Although 1,663 students were enrolled during the Fall 2003 semester, 1,078 of the students attended out of state high schools and 70 students attended in state private high schools. This study focuses on the academic experiences of students who attended public high schools in Pennsylvania. Of the 515 students in the sample, 79% (n = 407) were

men and 21% (n = 108) were women. In regards to ethnicity, 2% identified (n = 8) as Hispanic/Latino, 2% (n = 9) of the students identified as African American, 6% (n = 32) identified as Asian American/Pacific Islander. Although proportionally higher than both Hispanic/Latino and African American student populations, Asian American/Pacific Islander student enrollment was substantially lower than that of White students (84%, n = 434). No students identified as Native American. These enrollment statistics equally compare to overall university enrollment as well as enrollment of all students in the College of Engineering.

According to the *Penn State Fact Book* (PSU, n.d.) enrollment data, during the Fall 2003 semester 35,002 undergraduate students were enrolled at The Pennsylvania State University, University Park. Of these students, 47% were women and 53% were men. In terms of ethnicity and country of origin, 84% of students were identified as White, 4% as African American, 3% as Hispanic (as described by the university), 5% as Asian American, and 2% were international students. Native American percentages were too low to report.

Of the 35,002 undergraduate students enrolled, 5,793 (17%) of the students were enrolled in the College of Engineering at the University Park location. Of these students, 17% were women and 83.% were men. In terms of ethnicity and country of origin, 83% of students were identified as White, 2% as African American, 2% as Hispanic (as defined by the university), 7% as Asian American, and 4% were international students. Native American percentages were too low to report.

To enroll in the College of Engineering as a first-year student, students must have completed an equivalent of one half year of high school trigonometry. Because students

do not directly enroll in an Engineering major who are entering the College with four-year degree aspirations, the College has specific entrance to major requirements for each of the majors within this college, including Math 140, which is the equivalent of university Calculus I. Even if students began at the university in the College of Engineering, for example, unsuccessful completion of minimum requirements necessitates removal of students from that college. As long as students have a 2.00 GPA at that time, as well as meeting other academic requirements necessary for the specific major, students may apply to other majors.

These requirements are only entrance to major requirements and not the suggested course sequencing that would allow students to complete the program within a four-year time-period.

Depending on university math placement scores, students may be beginning in the College of Engineering unequally academically prepared. Placement into math courses lower than Math 140 could extend students' graduation time-line or, possibly, prevent students from successfully entering an Engineering major at the beginning of their Junior year.

Data Collection Method

All student data was gathered from the University's data warehouse. The data warehouse includes various records for all Penn State students including undergraduate and graduate students. Information includes high school course curriculum information, SAT scores, ethnicity, gender, parent education level, high school grade point average, and major of interest, to name a few. Furthermore, this data system categorizes students by college of enrollment and documents students' university placement exam scores. The

only known error that could occur with this system is human error. If information is coded incorrectly in the system, department corrections can quickly occur. No known errors have ever been associated with the data warehouse system.

Although access to student background variables, high school information, and university math placement scores was easy to obtain due to this researcher's academic advising position at this institution, obtaining research approval was still necessary. To obtain university research approval a research proposal for secondary data was submitted to the Penn State Institutional Review Board (IRB) that explained the purpose and the participants, as well as the variables that would be used in this study. Of most importance was the confidential nature of the students' records and making sure that confidentiality would not be breached.

Instrument

A math placement exam is required for all entering university students who plan to complete calculus and the score is used for suggested placement into an appropriate level of math. The test covers various math subjects including algebra and trigonometry and is designed by faculty in the University's Math Department. Specific test topics include factoring and algebraic fractions, exponents and radicals, graphing, fractional equations, graphing of trigonometric functions, trigonometric identities, laws of sines and cosines, trigonometric equations, and inverse trigonometric functions to name a few. The results of the math placement test were used as the dependent variable in this study and will be explained in the dependent variable section. It is unknown how the instrument was constructed.

Independent Variables

Genetic Endowments. Variables were coded including gender (0 = men, 1 = women) and race/ethnicity. Separate race/ethnicity variables were created from the identified population (African American, Asian American/Pacific Islander, Hispanic/Latino, and White) as reported by the students on their admissions' applications. No Native American students were identified in this study.

Environmental Conditions and Events. Students in the state of Pennsylvania are required to complete the Pennsylvania System of School Assessment (PSSA). Data reported on the School Matters (n.d.) http://www.schoolmatters.com/ website include the percentage of students considered math proficient (MP) and economically disadvantaged (ED) in the school. These variables were used to determine if high school background variables relate to university math placement scores.

Parent education level served as the final variable included within environmental conditions and events. This variable was examined by individually comparing the results for both mothers' and fathers' education level. Entering students complete an educational planning survey (EPS). Students report the education level of their parents. Separate analysis was run for mother's education level (mothered) and father's education level (fathered). A range of education levels includes 1 = no high school diploma, 2 = high school diploma/GED, 3 = courses completed beyond high school, 4 = bachelor's degree, 5 = graduate school completion, and 6 = non identified. To determine the percentage of students entering the College as first-generation students I created a dichotomous variable by coding parents' education level into first-generation status using 1 = both parents had

a high school diploma or less and 0 = at least one parent had above a high school diploma.

Learning Experiences. High school GPA is used for university admission purposes. The GPA represents the student's grade point average at the end of 11th grade. The University's admission's office enters the students' GPAs based on their high school transcript.

I used the type of high school math completed to determine if the course relates to Penn State math placement score. Because all students will have completed a minimum of high school trigonometry, the type of high school math relates more closely to intensity of math curriculum completed as compared to number of years of high school math. The University's admission's office documents high school course curriculum completion according to the students' high school transcripts. This data was coded, creating separate variables for each high school math course (e.g., trig = htrg; one year trig = onetrig; half year pre-calc = hpcalc; one year pre-calc = precalc; half year calc = hcalc; one year calc = calc; one and one half year calc = oohcalc; two years calc = twocalc; three years calc = threecalc). The calc variable was used as the reference group when coding.

All full-time, degree seeking Penn State students are required to complete the SAT or ACT for university admission purposes. SAT and ACT send scores to designated institutions based on students' requests. The University's admissions office recalculates ACT scores to SAT scores. SAT math scores range from 200 to 800. For this study, I could not obtain information pertaining to the type of test students completed (i.e., ACT vs. SAT) nor could I determine the effect of the recalculated SAT scores in comparison to

students who completed the SAT exam. The mean of each independent variable was calculated. I loaded SAT math scores in the fourth block of the regression analysis to determine whether SAT math scores contributed to variance in university math placement scores above and beyond other independent variables.

Dependent Variable

Task approach skills. Specific math placement scores determine the math placement level for which students are suggested to begin. Scores range from 0 to 34. These are the actual placement scores and not percentage rates. A minimum score of 19 would place a student directly into Math 140. I coded all students as 1 = student placed into Math 140 and 2 = student did not place into Math 140. This dichotomous variable was created for descriptive analysis purposes only.

Research Design

I coded all data warehouse information into SPSS and ran correlational statistics methods. An archival data set from The Pennsylvania State University's Data Warehouse was used to study preexisting student data. A brief description of correlational design studies, the use of archival data, and analysis methods that was used in this study will be presented next.

Asher (1983) indicates that researchers can make inferences that a causal relationship exists by examining the patterns observed in the data and assumptions made regarding the relationships of the variables. To determine a relationship between X and Y, Asher contends that a researcher can claim a causal relationship if the covariation between X and Y does not vanish when the effects of the confounding variables are

removed. Since there is no manipulation when using preexisting data, results are more objective.

Elder, Pavalko, and Clipp (1993) state that, when working with archival data, “the investigator seeks to maximize the fit between the research question and the data” (p. 5). Because The Pennsylvania State University predetermined variables considered most important to capture, the research questions used for this study were selected based on data available within the archive. Elder et al. consider this an appropriate form of archival data use.

Independent variable information was gathered for Pennsylvania public high school students who graduated in 2003 and entered the University Park College of Engineering in Fall 2003. Although the study utilized archival data, its structure was closely aligned with quantitative descriptive field studies employing correlational research design. Previous research used similar variables including gender (Kahle, 1990; Maple & Stage, 1991), race (Maple & Stage, 1991), school course offerings (Neuschatz & McFarling, 1999), and prior coursework taken by students (Kaufman, 1991). Sadler and Tai (2001) suggest that not accounting for demographic variables can unknowingly inflate the relationship between academic preparation and later success in college courses. The use of the intended variables appears supported in research.

Data Analyses

This study incorporated the use of hierarchical regression analysis because previous studies (Cohen & Cohen, 1975; Jaccard & Turissi, 2003; Leong & Austin, 1996) contend that this type of analysis is best used in studies incorporating one dependent variable and various independent variables. Furthermore, this study did not focus on

following students' math grades from high school through college, which hierarchical linear modeling would analyze.

Using the Social Learning Approach to Career Decision Making as the theoretical framework guiding this study, variables associated with this theory were loaded in a predetermined order into a multiple regression model, specifically, genetic endowments, environmental conditions and events, and learning experiences served as independent variables. Learning experiences were separated into two separate blocks to determine if SAT math scores (entered in the fourth block) were related to university math placement scores (task approach skills) above and beyond earlier entered variables. Task approach skills served as the dependent variable. All categorical variables were dummy coded and separate variables were created for those variables that had three or more categories. The independent variables ethnicity and highest high school math course completed required the creation of separate variables for each of their categories.

After dummy coding, univariate analysis was conducted to determine if a normal distribution occurred with the values of the independent variables. To determine whether the variables were empirically associated, a bivariate analysis was conducted prior to the hierarchical regression analysis. It is important to conduct both univariate and bivariate analysis prior to conducting the regression analysis. Univariate analysis is useful in terms of determining if a normal distribution occurred with the values of the independent variables and bivariate analysis can then be used with the normally distributed independent variables to assess whether the variables were empirically associated (Leong & Austin, 1996).

I determined the size of the relationship between the dependent variable (university math placement score) and the independent variables. This analysis helps determine how much each independent variable contributes to the relationship of the dependent variable. I entered all independent variables in a predetermined, four block model and then determined R squared after each addition.

Research Question and Hypothesis

Research Question

Does completion of a specific level of intensive high school math course—including one-half year of trigonometry, one year of trigonometry, one-half year of pre-calculus, one year of pre-calculus, one-half year of calculus, one year of calculus, one and one half years of calculus, two years of calculus, three years of calculus—relate to PSU math placement scores for the Pennsylvania public high school graduation class of 2003 who enrolled in the Penn State, University Park College of Engineering Fall 2003 while controlling math placement scores by gender and race/ethnicity; parent education level (mothered and fathered), percentage of students in the school considered math proficient, and percentage of students in the school considered economically disadvantaged; high school grade point average at the end of 11^{th} grade and highest level of high school math completed; and SAT math score?

Null Hypothesis: Highest high school math course completed (HSMATH) does not relate to the university math placement score.

Statistical Analysis: Hierarchical multiple regression analysis

Chapter IV

RESULTS

This chapter describes the results of the analyses conducted in this research study. The organization of Chapter IV emphasizes the main research objectives of this study, which was to determine if the level of high school math courses students complete relate to the university math placement score of entering Penn State engineering students. Furthermore, this section will describe the main characteristics of the sample, including descriptive data of the research variables, and where applicable, research related to the results will be highlighted.

High school students who graduated from Pennsylvania state public high schools in 2003 and who were admitted to the College of Engineering at The Pennsylvania State University, University Park Fall 2003 were assessed to determine if their high school math curriculum had an effect on their university math placement scores, the university test that suggests the math level in which a student will begin. Because this study focused on students who attended public high schools in the state of Pennsylvania, all out of state students and those in state students who attended private high schools and students who were home schooled were removed from the analysis. Only those students who had just graduated from high school were included in order to obtain more accurate information regarding students' readiness for college math, specifically calculus. Adult students who would have had a longer break between high school and the university math placement exam would be less likely to retain as much high school math information so they were excluded from this study. This study included 515 participants.

Univariate Analysis

Genetic Endowments and Special Abilities

Descriptive data pertaining to the gender and race/ethnicity of the participants is listed in chapter 3. The results showed that 21% of the students enrolled were women and 79% were men. When describing race/ethnicity of the enrolled students 84% identified as White.

Environmental Conditions and Events

The percentage of students considered math proficient (MP) and educationally disadvantaged (ED) within a particular high school was also examined in this study. Information pertaining to each of the students' high schools was obtained from the School Matters web site (n.d.) and coded as continuous variables. The results showed that the average of MP was 58.54, which means that the participants in this study came from high schools that, on average, rated 58.54% of the students enrolled in their high schools as math proficient. The results for ED showed that these same students graduated from high schools that, on average, reported 14.94% of the students enrolled in their high schools were economically disadvantaged.

The variable of parents' education level was examined by individually comparing the results for both mothers' and fathers' educational level (Table 1). Terenzini et al. (1996) defined first-generation college students as students whose parents did not attend college. To determine the total percentage of students identified as first-generation college students, I followed the definition as posed by Terenzini et al. (1996) and coded all students who reported both parents as receiving a high school diploma or no high school diploma as 1 and for those students who reported at least one parent receiving

training and/or college degrees beyond high school as 0. Results showed for reported education levels that 10% (n = 51) of students identified as first-generation and 90% (n = 464) as non-first-generation college students.

According to Warburton, Bugarin, and Nunez (2001), 41% of all undergraduates attending four-year public comprehensive institutions identify as first-generation. This study, however, focused on first-year students enrolled in the College of Engineering at one institution and found that the percentage of first-generation students enrolled in this math and science intensive four-year program was significantly less.

The study showed that most parents completed a graduate degree, a college program that includes coursework beyond a bachelor's degree program. Results showed that 27% of mothers and 33% of fathers completed college degrees beyond a bachelor's degree program. Of the students who did not report parents' education level, 2% of mothers' education level and 2% of fathers' education level were not reported**.**

Table 1

Frequency Distribution Scores for Mothers' and Fathers' Educational Level (N = 515)

	Mother		Father	
Parents education level	Frequency	Percent	Frequency	Percent
Less than high school	14	2.7	15	2.9
High school	99	19.2	76	14.8
Four-year degree completed	140	27.2	147	28.5
Graduate degree completed	141	27.4	171	33.2
Not reported	9	1.7	11	2.1

Learning Experiences

Descriptive data was also obtained to examine the level of math students completed prior to entering the College of Engineering. The results of the study showed that 86% of students completed one year of calculus or more prior to being admitted to the College. African American male students were less likely to complete calculus than all other student populations.

When examining SAT math scores and high school grade point averages of the enrolled students (Table 2), results indicated that the average SAT math score for all entering Pennsylvania public high school Fall 2003 admits was 664.14 and the average HSGPA of these students was 3.89. When comparing race/ethnicity and first-generation status, both African American male and female first-generation students had the lowest SAT math means among all students.

The mean SATMATH for first-generation African American males was 477 and non-first-generation African American males was 510. First-generation African American females had a mean SATMATH of 500 and non-first-generation African American females mean SATMATH was 540. Consistent in this study was that the SATMATH scores were lower for all first-generation students as compared to non first-generation students, as was HSGPA. Furthermore, African American males had lower SAT math scores and lower high school grade point averages than all student populations, including first-generation and non first-generation students. The fact that African American males were less likely to complete calculus in high school may have inhibited the ability of this student population to receive higher SAT math scores.

Table 2

SAT math scores and high school grade point average Mean (N = 515)

Gender	First-generation	Ethnicity	SAT math scores	HS GPA
Male	Yes	African American	477	2.98
		Asian American	595	3.87
		Hispanic/Latino	590	3.36
		White/non Hispanic	656	3.86
	No	African American	510	3.11
		Asian American	705	3.95
		Hispanic/Latino	625	3.40
		White/non Hispanic	674	3.90
Female	Yes	African American		
		Asian American	500	3.41
		Hispanic/Latino		
		White/non Hispanic	602	3.84
	No	African American	540	3.30
		Asian American	665	4.07
		Hispanic/Latino	605	3.74
		White/non Hispanic	654	3.98

Task Approach Skills

This study showed that the average score for the university math placement exam was 24.98 and the standard deviation was 6.89. The maximum score for the university math exam was 34. The minimum score necessary for students to register for Math 140 for this population of students was a 19. To determine the average number of students who placed into Math 140, I coded all math placement results. I gave those students with a minimum score of 19 a 1 and students with lower scores were coded as 2. The results showed that 82% of the Pennsylvania state public high school students admitted to the

College of Engineering in Fall 2003 placed directly into Math 140. The percentage rate of students able to directly enroll in Math 140, Calculus I could have been due to the high percentage of students who completed one year of calculus or more during high school. Of the admitted students, it was suggested that 18% complete a math review course during their first semester. Three students did not complete the math placement exam at the time of enrollment. These students may have completed a calculus equivalent course prior to test completion.

Research Question, Hypotheses, Analyses, and Results

Research Question

With the descriptive data serving as context, this next section will provide the results of the original research question posed for this study, which focused on whether the level of high school math course completed related to university math placement scores. More specifically, the question sought to address whether a specific level (measured in terms of curriculum content) of high school math courses related to university math placement scores more than other high school math courses, and not the number of years of high school math courses. Furthermore, with the use of hierarchical regression methods, this study was interested in determining which variables had a stronger effect on the percentage of variance of university math placement scores.

Analysis and Results

Continuous variables were analyzed using univariate analysis and the skewness statistic for each variable was determined. This was determined by dividing the skewness statistic by the standard error of the skewness greater than or equal to 2. Normal distributions will have a value of approximately zero. Right-skewed distributions will have a positive skewness value and left-skewed distributions will have a negative skewness value. Results indicated that SATMATH had a skewness score of -.710. For those independent variables with a skewness outside the range of -.2 to .2 variables were first squared, reassessment of the skewness was determined and the independent variables transformed. By squaring SATMATH, the variable was transformed. The skewness was then -.138, a number within the desirable range. Results indicated that MATH140 had a skewness of -.901. After squaring MATH140 and transforming the variable, the skewness was -.311, still above the desirable range. Only by cubing MATH140 and transforming the variable again did the skewness reach the desirable range of .2 to -.2. The final skewness of MATH140 was .064. After the variables were transformed a bivariate analysis was conducted. Collinearity statistics were also conducted. Results indicated that tolerance levels were well above 0.2 and VIF results were well below 10. Multicollinearity was not observed.

A bivariate correlation matrix of all included variables is presented in Table 3. African American males had a significant negative correlation at the .01 level with high school grade point average (-.36). The percentage of students considered math proficient within a high school was positively correlated with SAT math scores (.31). The percentage of students considered economically disadvantaged within a high school had a

negative correlation with SAT math scores (-.36). High school grade point average had a positive correlation with both SAT math scores (.33) and university math placement scores (.41).

Table 3

Bivariate Correlation matrix for all variables (N=509)

	1	2	3	4	5	6	7	8	9
1 m140cu		-.159	.076	-.090	-.105	.200	-.263	-.092	.399
2 afric			-.033	-.016	-.026	.025	.185	.064	-.370
3 asian				-.033	-.033	-.050	.027	.159	.029
4 lat					.013	-.131	.115	.064	-.185
5 Gender						.045	.051	-.055	.118
6 MP							-.594	-.178	.042
7 ED								.255	-.206
8 FG									-.113
9 HSGPA									
10 trig									
11 onetrig									
12 hpcalc									
13 precalc									
14 hcalc									
15 oohcalc									
16 twocalc									
17 threecalc									
18 SATsq									

10	11	12	13	14	15	16	17	18
-.116	-.143	-.139	-.132	-.050	.140	.185	.115	.660
.249	-.022	-.016	.046	-.011	-.013	.012	-.013	-.234
.093	-.045	.032	.019	-.023	-.026	.053	-.026	.030
.068	.071	-.016	-.028	-.011	-.013	.012	-.013	-.092
.046	.025	-.026	-.023	.064	-.002	-.085	.047	-.136
-.067	-.034	.044	.005	-.045	-.043	.048	.092	.296
.194	.117	-.027	.012	.074	-.024	-.083	-.066	-.357
.054	.021	.064	.082	.045	-.033	-.108	-.033	-.157
-.191	-.179	-.062	-.048	-.028	.063	.055	.037	.320
	-.031	-.023	-.040	-.016	-.018	-.059	-.018	-.212
		-.022	-.039	-.016	-.017	-.057	-.017	-.148
			-.028	-.011	-.013	-.041	-.013	-.068
				-.020	-.022	-.073	-.022	-.013
					-.009	-.029	-.009	-.018
						-.033	-.010	.031
							-.033	.159
								.125

Note. * Correlation significant at the 0.05 level (2-tailed); **Correlation significant at the 0.01 level (2-tailed)

Hierarchical Regression Model

As a general rule, independent variables are entered in a particular order (according to a the study's hypothesis and research) and the variables entered in later blocks should not have an affect on previously entered variables. Variables were entered into a four block model (table 4). Genetic endowments and special abilities, including gender and race/ethnicity, were entered into Block 1. Because race/ethnicity were assessed as dummy variables, the variables Hispanic/Latino, African American, and Asian American were included. Environmental conditions and events, which included the percentage of students considered math proficient and economically disadvantaged within a school and parent education level, were entered into Block 2. Learning experiences were separated into two different blocks. Block 3 included high school math completed and high school grade point average while SAT math scores were separately entered into Block 4. High school math courses were dummy coded and one year of calculus completed served as the comparison variable.

Genetic Endowments

Results were most significant for African American students although gender also significantly contributed to the percentage of variance in university math placement scores when gender and ethnicity were entered into the regression equation alone. After the percentage of students considered math proficient and economically disadvantaged and parent education level were incorporated, gender and African American students were both still significant. Gender remained significant after high school math courses and high school grade point average were entered but African American students were no

longer significant and effects were stronger for this population. Once SAT math scores were entered in the fourth block, gender and ethnicity were no longer significant.

Environmental Conditions and Events

The percentage of students considered math proficient within a high school remained significant when high school grade point average and high school math courses were entered into the regression model. The percentage of students considered math proficient and economically disadvantaged within a school were both more significant than parent education level. This could be attributed to the low number of first-generation students in this study.

Learning Experiences

High school grade point average as well as various math courses above one year of trigonometry were significant within this regression model, however, when SAT math scores were included high school grade point average remained significant and high school math courses become less significant. One year of trigonometry and one and one half year of calculus remained very significant. The large range of math scores needed to place into Math 140 may have accounted for these results (e.g., 19-34 required for Math 140 placement).

Task Approach Skills

Although previous research stated SAT scores are not related to success students have in college, this study included SAT math scores in relation to preparation for university math course preparation specifically. This study found that SAT math scores have a significant relation to university math placement scores above and beyond previously entered variables for students enrolled in the College of Engineering.

Regarding effect size (R^2s), genetic endowments alone explained only .05% of the variability in university math placement scores. When adding environmental conditions and events in Block 2, together genetic endowments and environment conditions and events accounted for 11% of the variability in university math placement, indicating that the percentage of math proficient students and economically disadvantaged students found within a high school along with parent education level increases the variability of university math placement scores. Block 3 included learning experiences, and when combined with earlier entered variables, all variables accounted for 30% of the variability in university math placement, which is a significant increase as compared to earlier entered variables, indicating that the level of high school math course taking strongly contributes to the variability in university math placement scores. Finally, SAT math scores were entered in Block 4 and all entered variables attributed to 53% of the variability in university math placement scores. This significant increase could be due to the number of students who completed calculus and SAT math scores and the university math placement scores are both measuring student math ability.

Since the null hypothesis stated that there would be no relation between the high school math variables and MATH140 the null hypothesis is rejected. The histogram (Figure 1) shows the normal distribution curve of the independent variables after transformations of the independent variable were conducted.

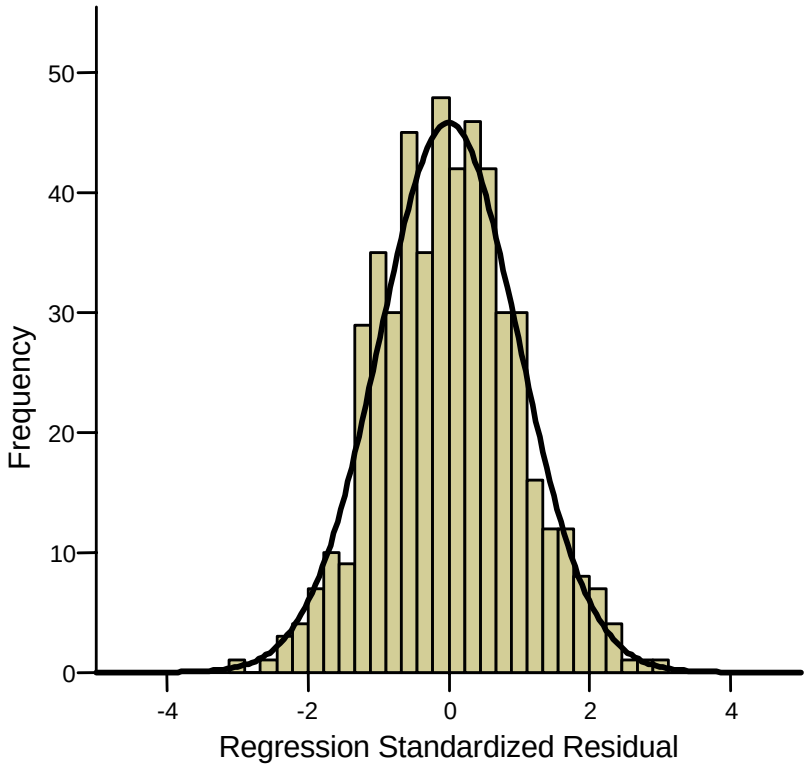
Table 4

Hierarchical regression effects of independent variables on university math placement scores

Variable and R^2	B	Std. Error	Beta	t	Sig.
Block 1					
Gender	-2924.286	1204.974	-.105	-2.427	.016
African American	-14621.144	3934.100	-.162	-3.717	.000
Asian American	2997.990	2017.168	.065	1.486	.138
Hispanic/Latino	-8077.108	3932.942	-.089	-2.054	.041
R^2 = .050					
Block 2					
Gender	-2869.904	1180.762	-.104	-2.431	.015
African American	-1189.025	3952.449	-.131	-3.010	.003
Asian American	3842.838	1986.906	.083	1.934	.054
Hispanic/Latino	-4869.780	3862.854	-.054	-1.261	.208
Math proficient	80.488	41.034	.105	1.961	.050
Econom dis.	-125.545	44.516	-.156	-2.820	.005
First-generation	-1525.713	1676.763	-.040	-.910	.363
R^2 = .109					
Block 3					
Gender	-3916.380	1073.962	-.141	-3.647	.000
African American	-1657.846	3846.197	-.018	-.431	.667
Asian American	3371.829	1792.996	.073	1.881	.061
Hispanic/Latino	456.761	3528.241	.005	.129	.897
Math proficient	116.595	36.972	.152	3.154	.002
Econom dis.	-54.030	40.769	-.067	-1.325	.186
First-generation	545.834	1515.865	.014	.360	.719
HS grade pt.av.	1322.810	1689.255	.341	7.839	.000
Half year trig	-1462.294	2587.796	-.023	-.565	.572
One year trig	-4008.403	2593.481	-.060	-1.546	.123
Half year pre-calc	-11832.404	3442.411	-.131	-3.437	.001
One year pre-calc	-6041.362	2025.060	-.114	-2.983	.003
Half year calc	-2287.108	4839.937	-.018	-.473	.637
One/one half year of calc	14211.650	4324.394	.125	3.286	.001
Two years calc	4856.559	1471.658	.127	3.300	.001
Three years calc	10554.037	4328.116	.092	2.438	.015
R^2 = .303					

Block 4					
Gender	-1393.855	900.411	-.050	-1.548	.122
African American	4422.399	3194.848	.049	1.384	.167
Asian American	2276.154	1479.488	.049	1.538	.125
Hispanic/Latino	302.486	2907.917	.003	.104	.917
Math proficient	26.787	31.033	.035	.863	.388
Econom dis.	-5.374	33.752	-.007	-.159	.874
First-generation	1653.873	1251.447	.044	1.322	.187
HS grade pt.av.	8641.603	1424.463	.223	6.067	.000
Half year trig	2075.555	2145.345	.032	.967	.334
One year trig	-905.152	2147.124	-.014	-.422	.674
Half year pre-calc	-8282.333	2846.664	-.092	-2.909	.004
One year pre-calc	-6168.407	1669.031	-.116	-3.696	.000
Half year calc	-3546.229	3989.822	-.028	-.889	.375
One/one half year of calc	12757.739	3565.342	.112	3.578	.000
Two years calc	2715.742	1220.980	.071	2.224	.027
Three years calc	4341.455	3590.253	.038	1.209	.227
Sat math scores	.071	.005	.563	15.274	.000
R^2 = .527					

Figure 1. Histogram of Dependent Variable Math 140 (n = 509)



Note. Mean = -6.12E-16; Std. Dev. = 0.983

Chapter V

DISCUSSION

Incorporated within this chapter are a summary of this study and an interpretation of the results. Highlighted within this chapter are implications of the results, the limitations of the study, and suggested future research.

Summary of the Research Study

The primary goal of this researcher was to conduct a study incorporating variables missing from previous studies in order to better examine factors associated with academic preparation for first-year students admitted to bachelor's degree programs, specifically engineering. With the inclusion of the Social Learning Approach to Career Decision Making as the theoretical framework of this study, the incorporation of variables previously excluded from earlier studies helped shed light on other possible factors related to math preparedness for engineering bachelor's degree programs, those variables being parent education level and the percentage of students considered math proficient and economically disadvantaged within a high school. Furthermore, by using hierarchical regression methods, exploring the interrelationship of the variables was possible. The intention of this study was not to repeat previous studies that contend few women, students of color, and first-generation college students enter engineering programs but to examine the factors associated with university academic preparation, which would be beneficial for these specific student populations.

Results discussed in the beginning of Chapter IV build upon previous research studies adding claim to the concern of the discouraging numbers of women, students of color, and first-generation college students who enter four-year engineering degree

programs. Furthermore, the descriptive data supports the notion of the importance of completing rigorous high school math courses prior to enrollment in four-year degree programs. This study, however, focused on engineering degree programs and found that most students (86%) who entered this specific program completed a minimum of one year of calculus prior to enrollment, which is well beyond the minimum three years of high school math required by many states for high school graduation. This level of math is also well beyond the admission requirement for the College of Engineering, which is one-half year of trigonometry. This may have contributed to the high percentage of students who placed directly into Math 140, University calculus I (82%).

Previous research (Clewell et al., 1992) indicated that although women and students of color were admitted to the university equally academically prepared, it was questionable how "equally academically prepared" was defined. Furthermore, various studies have determined that high school curriculum completion is an important factor that contributes to bachelor's degree completion but limited research exists that focus on the type of high school math completed, calculus for example, and then compared this to university math preparation. By incorporating a university math placement exam as the dependent variable, this study was better able to examine the academic preparation of the admitted engineering students while simultaneously exploring how the highest level of high school math completed may be associated with successful enrollment in engineering bachelor's degree programs and university math preparation.

Past research has examined the influence of a number of variables associated with successful completion of bachelor's degree programs, yet limited research exists that tracked admitted students' high school transcripts, a tool useful for exploring the highest

level of high school math completed as compared to number of years of high school math (Carnegie Units). Furthermore, many studies focused on the education level of the parent (Useem, 1992; Warburton et al., 2001) but various student and high school background variables were missing, which may have skewed the results. By incorporating the percentage of students considered math proficient and economically disadvantaged, along with other relevant variables simultaneously, a better model of degree completion can be built for populations less likely to be found in engineering bachelor's degree programs, specifically women, students of color, and first-generation college students.

Many previous studies incorporated the Social Cognitive Career theory as the foundation of their theoretical analysis but this theory focuses on the self-efficacy of students in a particular high school subject, math for example. Although math self-efficacy may be an important contributor to the type of high school math students complete in high school, this study focused on examining the relationship of various variables to university math preparation. This study did not incorporate a survey that examined student math perceptions, ruling out the incorporation of theories related to self-efficacy. The Social Learning Approach to Career Decision Making (Mitchell & Krumboltz, 1990) emphasizes the interrelationship of the variables incorporated within this study, specifically the type of high school curriculum a student completes in comparison to the environmental and social conditions a student experiences. While this study did not focus on why students chose certain high school math classes over others, it does highlight the outcomes for those students who are on the engineering path and who still do not complete a high enough high school math class.

The primary null hypothesis posed for this study was that high school math courses do not relate to university math placement scores. The analysis conducted in this study emphasized the disadvantage of students who are considered first-generation college students, a population less likely to complete a rigorous high school math curriculum and then enter engineering bachelor's degree programs. Within this population are women and students of color, two groups typically incorporated into studies without also examining parent education level as a possible factor more highly associated with high school curriculum completion and university academic preparation. The next section summarizes the study and provides an interpretation of the results.

Summary of the Analysis

The population in this study included 515 public high school students who graduated in 2003 and who enrolled in The Pennsylvania State University, University Park College of Engineering Fall 2003. Not knowing any other information about the population included in this study, descriptive analysis was important in order to gather information pertaining to the variables incorporated within this study, including gender, ethnicity, parent education level, percentage of students considered math proficient and economically disadvantaged within each student's high schools, high school grade point averages, SAT math scores, and university math placement scores. Results of the descriptive analysis can be found in chapter 4. Regression analysis results are included after each variable to show the percent of variance of university math placement scores.

Interpretation of Results

Genetic Endowments

Previous research indicates that few women (Nauta et al., 1999) and students of color (Mau, 1995) enter engineering bachelor's degree programs. This study found similar results at one large research institution. Various research exists that examines possible reasons for the low numbers of women and students of color enrolled in engineering programs yet, after decades of examining the continued low percentage rates of these populations, women and students of color are still far behind the enrollment of White male students in engineering bachelor's degree programs. An assumption exists that the total number of Asian Americans found in engineering career fields surpasses that of Whites. What can be said is that Asian Americans outnumber other persons of color in engineering career fields and engineering bachelor's degree programs but Asian Americans still lag behind White males in engineering degree programs and later entrance to engineering career fields. Although African Americans show higher percentage rates of enrollment and graduation from bachelor's degree programs as compared to two decades ago, this student population is still less likely to enroll in engineering bachelor's degree programs (R^2=.050).

Environmental Conditions and Events

This study showed that, on average, most admitted students did not graduate from high schools with a large percentage of economically disadvantaged students but the percentage of students considered math proficient was slightly more than half of the students enrolled in the high school. This study highlights the disadvantage of attending a high school with a large enrollment of economically disadvantaged students. Students

have been found to be math proficient within the low-income high schools and proficient enough for the PSSA, yet the math curriculum within these schools may have not prepared students for Penn State's math placement exam. This study added to previous research by incorporating these two variables. Previous studies may have inflated results due to these variables missing from the research. The addition of environmental conditions and events were strong than genetic endowments alone (R^2=.109).

Learning Experiences

This study showed that although women tended to have higher high school grade point averages, women in this study had lower SAT math scores than their male counterparts. Women admitted to this engineering program tended to complete calculus in high school but they may not have completed a high enough math level prior to completing the SAT, which would lower SAT math scores. Furthermore, little research exists that examined whether women tend to complete the SAT exams earlier then their male counterparts. Although few African male students were enrolled in this engineering program this population of students was more likely to complete high school math levels lower than calculus. As previous researchers have indicated high school math curriculum completion relates to SAT math scores. Unless the high school curriculum structure changes for all students the select group of students with open access to algebra in the 8th grade will continue to have higher SAT math scores and complete calculus more often than those students denied access due to school tracking systems, specifically students of color and potential first-generation bachelor's degree seeking students. The results of this study showed that African American male students had lower high school grade point averages and SAT math scores and the effects of high school course taking were stronger

for this population. Two separate regression analysis were conducted, one without SAT math scores included (R^2=.303) and another with SAT math scores included (R^2=.527).

Task Approach Skills

Because first-generation status and ethnicity, as shown in this study and earlier studies, affects high school math curriculum completion and academic preparation for bachelor's degree programs more so than gender, results of the university math placement score compared the difference in math placement scores by first-generation status and ethnicity. Descriptive statistics showed that African Americans and Hispanic/Latino students had lower math placement scores than Asian Americans and White students. This study showed that first-generation students' math placement scores were lower than non-first-generation students but African American and Hispanic/Latino comparisons were more discouraging. A significant difference existed between the academic preparation of first-generation African American and Hispanic/Latino students as compared to other first-generation and non first-generation comparisons. White first-generation student scores were only one point lower than non-first-generation White students but 10 points or more higher than all African American and Hispanic/Latino students, including those of non-first-generation students, supporting other research (e.g., Bennet & Okinaka, 1990; Grandy, 1994; Hewitt & Seymour, 1991; National Research Council, 1991; National Science Board, 2000; and Yauch, 1999) that describes White students as continuing the lead in academic preparation for bachelor's degree programs, specifically engineering.

It is interesting to note that the university math placement exam did well with determining placement into lower math levels (math courses lower than Math 140),

however, this exam does not show strong ranges when looking at student placement into Math 140. This could be accounted for by the wide range of scores necessary for placement into Math 140. The range of 19-34 may be too wide for predictability in regards to success in Math 140. Future studies should look at the difference in Math 140 grades among all those students who placed within the allowable placement range. For example, students with placements between 19 and 25 may be more likely to do poorly in Math 140 or drop the course during the semester as compared to those students who were in the range of 26-34.

When discussing academic preparation, this study did show that admitted students were not equally academically prepared. African American and Hispanic/Latino students scored much lower on the university math placement exam than Asian American and White students, which could signify that this population is more likely to drop out of engineering bachelor's degree programs. If students must begin an engineering program three math levels lower than their counterparts, for example, these students would tend to take longer to graduate or struggle mathematically as compared to other student populations. By adding university math placement scores as the dependent variable, this study added to the breadth of research comparing the academic preparation of students entering engineering degree programs. According to this study, although most students complete calculus in high school, not all students are academically prepared to begin calculus I (Math 140) at Penn State.

Implications of the Results

The findings of this study have implications for theory in regards to incorporating additional variables within a model for bachelor's degree completion as well as

considering which variables more statistically relate to other independent variables. When drawing a model of university math preparation, genetic endowments, environmental conditions and events, and learning experiences may directly relate to task approach skills, which would then have a direct relation to the dependent variable of task skills. If university math placement scores were an independent variable and engineering bachelor's degree completion was the dependent variable, both SAT math scores and university math placement scores may have direct relationships to the dependent variable. Additional research is needed that examines this possible model.

The practical implications of the results relate to the structure of the high school math curriculum. If all students were required to complete Algebra I in the 8th grade and geometry and Algebra II by the end of the 10th grade, more students would have higher SAT math scores, including women and students of color, populations less likely to complete Algebra I in the 8th grade. Furthermore, if high schools followed a more constrained curriculum by requiring completion of trigonometry and a minimum of a half a year of pre-calculus, more students may be granted access to the engineering pipeline. Students would be more likely completing appropriate math courses that would better prepare them for engineering bachelor's degree programs, however the quality of each student's high school math course in comparison to other high school math questions remain in question. During the 11th grade students would again redefine their future goals with the aid of their school counselor and if engineering were identified as an interest, it would be important for school counselors to strongly encourage students to complete calculus during the students' senior year.

Chaney (1995) found that math courses taken beyond the minimum high school

math requirements related to a stronger relationship with achievement in mathematics, as did this study. The Pennsylvania Department of Education must understand that even college students change their career track after admission to the university and by not structuring the high school curriculum in a manner that allows students the opportunity to change their mind about math interest many students are shut out of advanced high school math courses prior to SAT completion.

It is hard for this researcher to fathom a math curriculum so varied for a population of 8th grade students who mostly do not understand the ramifications of their curriculum decisions in relation to future career goals. Many young students relate career interests to television shows and careers in science and engineering may seem appealing to those less knowledgeable about the curriculum requirements of the intended field. Students may simultaneous say “yes” to engineering but “no” to intensive math, meet the requirements for admission to engineering degree programs and then have to drop out of the program due to being ill prepared for the content of the curriculum. A varied middle school and high school math curriculum could block these students out of math intensive careers later in life. An intensive math curriculum allows students’ potential career lists to be longer. If students change their minds about pursuing a math intensive bachelor’s degree program later in life at least it would be due to a lack of interest and not due to a lack of academic preparation.

The high school curriculum is also impacted by current national debate. The No Child Left Behind Act does not take into account the quality of the math curriculum in each high school or the lack of certified teachers within some urban high schools. Removing students from high schools by the use of a voucher does begin to fix a

continuing problem, which is that low income school districts have less opportunity to offer advanced math courses and students wishing to, or as a part of necessity, stay in high schools located in their own neighborhoods will continue to be less prepared for engineering bachelor's degree programs. How magnet, vocational, and charter high schools compare in relation to university math preparation is also an important area of research.

The National Commission on Excellence in Education (Finn et al., 2001) recommended that high school graduation requirements include three years of math for all high school students yet, as this study showed, most students who entered this engineering bachelor's degree program completed a minimum of one year of calculus. A small number of students completed more than one year of calculus. The number of years of high school math will not set students on the path for calculus completion. Only by requiring Algebra I in 8^{th} grade for all students will the likelihood of increased SAT math scores and calculus completion for all students heading to engineering bachelor's degree programs come to fruition. Schmidt et al. (1996) and Lee et al. (1997) suggested that the United States does not offer an intensive high school curriculum as compared to other countries. If the U.S. wishes to increase the pool of U.S. citizens in math intensive career fields, a more constrained and intensive high school math curriculum for all students would be necessary, not just for those students attending private high schools.

Other implications relate to the importance of school personnel in their role of encouraging students to complete advanced math courses in high school. The American School Counselor Association's National Model (2003) emphasizes the importance of how students will be different because of the aid of school counselors, yet in the model

course registration is seen as a misuse of school counselors' time. Potential first-generation college students rely on the encouragement of their teachers and school counselors in helping these students select an appropriate math curriculum, yet these populations are more likely to complete vocational high school courses. The Social Learning Approach to Career Decision Making is a theory well suited for exploration of the various factors associated with high school curriculum completion and school counselors can use this model to examine the affects of social and environmental learning conditions on students' likelihood of completing advanced high school math courses.

School counselors should consider the registration program as the opportunity to engage students in discussions of their academic schedule in relation to future post-secondary plans. School counselors should encourage all students to complete a rigorous high school math curriculum but even these school personnel are limited by the availability of Algebra I in the 8th grade as well as the number of students allowed to enroll in Algebra I in the 8th grade, if it is offered at all. This study was unable to examine the population of students within each student's high school math classes nor compare the percentage of students that completed Algebra I in the 8th grade, but if students rely on their peers for information pertaining to the type of classes the students will schedule in high school, first-generation students, students of color, and women may tend to schedule courses with their friends.

Suggested Future Research

Although this study highlighted variables excluded from previous studies in relation to academic preparation for university math courses, more research is needed that focuses on the use of similar variables found within this study. The incorporated variables

accounted for 53% of the variance, however, more research should be conducted at public institutions located in urban areas, as well as at historically Black colleges and universities (HBCUs). This would increase the numbers of students of color found in engineering bachelor's degree programs.

Future research is also recommended that exams the interrelationship of percentage of math proficiency and economically disadvantaged. If a higher percentage of economically disadvantaged students in a high school leads to a lower percentage of math proficient students within a high school, further research is needed that incorporates factors that relate to this. Also, the relationship of high school math completion and SAT math scores is important in determining the highest level of high school math completed by students prior to completion of the SAT. Previous research has shown that a rigorous high school curriculum relates to higher SAT scores, but little research exists that incorporates the specific type of high school math completed, as shown on students high school transcripts.

Other research important to this study includes the examination of public high schools with a more constrained high school math curriculum as compared to public high schools with various math options. Consequently, many high schools have different math sequencing that requires students to complete Algebra I and geometry prior to Algebra II as compared to high schools that require students to complete Algebra I and II prior to geometry. Does one sequence better prepare students for the SAT math exam as well as preparation for trigonometry and pre-calculus as compared to the other? Why high schools incorporated such different requirements across states, within the same state, and especially within the same county is unknown. More research that highlights how these

decisions are made and why would add to this research. Incorporating the use of hierarchical linear modeling techniques to show how students do academically in high school math through university math courses continues to be important.

It is important that school counselors and teachers provide women and students of color the information necessary to appropriately select a high school math curriculum that leaves various future careers open. It is also crucial to provide these student populations with academic opportunities in elementary and middle school that will introduce women and students of color to the various math and science career fields, especially for student populations less likely to receive this information in their home environments due to parents' lack of knowledge regarding these opportunities. Without this crucial knowledge, women and students of color will continue to be less likely to have interests in engineering career fields, especially first-generation college students.

Limitations of the Research Study

Limitations must be addressed when considering the interpretation of the results. Despite the significance found for most variables, the percentage of variance for some of the variables as well as the descriptive statistics reported for each variable indicates further analysis is needed to uncover information pertaining to the results found. Further research might examine the use of variables, the correlation among the variables, as well as the use of hierarchical regression analysis as compared to hierarchical linear modeling.

Use of Variables

This study focused on the students who were already admitted to this engineering bachelor's degree program. Because of the University's location in a predominantly White community and the low numbers of women and first-generation college students

typically enrolled in engineering programs, the low numbers of these student populations make it difficult to generalize findings to similar populations. Just because few students of color enrolled in this program does not support the notion of students of color being less academically prepared. This institution is predominantly White and predominantly White institutions (PWIs), as the name suggests, have fewer students of color enrolled. Students of color, specifically African American students, may enroll in historically Black colleges and university (HBCUs) engineering bachelor's degree programs more than at predominantly White institutions. Furthermore, students of color may be more likely to enroll in college and university settings in urban areas. The few numbers of students of color and women enrolled in this program may have impacted the percentage of variance of math placement scores.

Correlation Among Variables

This study did not compare the level of high school math completed in relation to other independent variables. By making SAT math scores a dependent variable, other independent variables including high school math completed and high school grade point average would possibly relate to SAT math scores. Furthermore, the variables of first-generation status and the percentage of students considered economically disadvantaged may relate to the variable of high school math completion, however, the low numbers of those variables would contribute to insignificant results. A similar study at an institution with larger populations of first-generation students and students of color, specifically a large public institution located in an urban area, may find more significant results. Some correlation existed among these independent variables but it was not significant enough to remove variables.

Use of Hierarchical Regression as Compared to Hierarchical Linear Modeling

Previous studies have used hierarchical linear modeling in comparing how students have done in math across time. Although math preparation was the main concern of this study, this study did not incorporate hierarchical linear modeling as part of the analysis. This study focused on preparation for Math 140 as suggested by the ability of students to place into Math 140. A follow up study using HLM in assessing how students did in high school math as compared to the grades in university math as well as a longitudinal study following students from admission through graduation from the engineering degree program would add to this area of research.

Conclusions

The Social Learning Approach to Career Decision Making provides an excellent means to explore the various factors associated with academic preparation for university math placement exams. This study did not focus on why students chose certain high school math classes but emphasized the factors associated with outcomes related to their choice. This theory examines the interrelationship of various variables and their connections to students' task approach skills, or as used in this study, university math placement scores. The theoretical and practical implications were highlighted as well as suggestions for changes in current bachelor's degree completion models.

This study added to the research that previously showed first-generation students tend to have lower high school grade point averages than non first-generation students as well as supporting the research that showed women tended to have higher grade point averages than men. Overall all, first-generation college students are less likely to enroll in engineering bachelor's degree programs (Horn & Nunez, 2000; Terenzini et al., 1996)

and this study corroborated the findings of previous studies. This study also showed that first-generation students tend to have lower high school grade point averages, lower SAT math scores, and when admitted to engineering bachelor's degree programs, enter the program less academically prepared than their non-first-generation counterparts. This study compared the highest high school math completed by gender, ethnicity, and first-generation status but found that students admitted to this engineering bachelor's degree program completed calculus more often than lower high school math courses, despite gender and first-generation status. The low numbers of first-generation students in this sample may have contributed to this finding.

Unknown is the descriptive statistic of high school students denied admission to this engineering program. It is possible more first-generation students were denied admission due to very low high school grade point averages and SAT scores as compared to non first-generation students. This study extended earlier research by comparing the relationship of all of these variables in relation to preparation for university calculus I, Math 140. Most significant was the ability of this researcher to use high school transcripts to compare the highest level of high school math completion as compared to the number of years of high school math.

The practical implications for school counselors relate to the importance of career guidance and academic encouragement of all students, especially during the course registration process. Furthermore, if more school counselors would study the affects of the current math structures within their own high schools, information could be shared with principals and superintendents about the importance of a more constrained math curriculum for the students. Also, programming for parents of the enrolled students that

focus on the importance of a rigorous high school curriculum related to the future career goals of the students would help family members become more informed aiding the families to become a stronger support system for their own students. Future first-generation college students and students of color would have the most benefit. Until all U.S. high school students have equal opportunity for an intensive high school curriculum, future first-generation students, students of color, and women will continue to be locked out of engineering bachelor's degree programs in the end.

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