PATHWAYS TO STEM OCCUPATIONS: ADVANCED CURRICULUM AND COLLEGE OUTREACH PROGRAMS DURING HIGH SCHOOL

by

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Abstract

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This quantitative study uses data from the Educational Longitudinal Study of 2002 to examine the influence of high school program participation on the pursuit of STEM-related pathways (major field of study, educational attainment, occupation). With Bourdieu's concepts of capital and habitus as the underlying theoretical framework, I examine whether various forms of capital instilled from family and gained through education through participation in advanced curriculum and college outreach programs in high school are related to individuals' post-secondary pathways resulting in STEM-related careers. Data analysis includes descriptive statistics and multivariate statistics to determine the likelihood of STEM-related outcomes (e.g., field of study, occupation) in relation to high school capital (i.e., programs) and socio-demographic characteristics.

Findings suggest participation in advanced curriculum programs during high school increases the chances of students to engage in and complete a STEM-related major field of study, as well as seek employment in a STEM occupation. Additionally, advanced curriculum furthers the level of educational attainment. While participation in college outreach programs tends to have a positive effect on post-secondary access, a minimal relationship is evident in the pursuit and completion of STEM-related degrees or finding employment in STEM occupations. Specific socio-demographic characteristics

(i.e. being White, male, having highly educated parents, and belonging to the highest SES quartile) are found to associate with STEM outcomes as well. In summary, this study demonstrates that the combined effect of high school programs and socio-demographic factors contribute to deepening the inequality in access and attainment in STEM academic fields and occupations.

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Chapter 1

Introduction

As far back as 1945, the concern for the nation's competitiveness and global authority has focused on improving education in science, technology, engineering, and mathematics (STEM) fields. Seventy years ago, in a letter to the President of the United States, Dr. Vannevar Bush, director of the Office of Science and Research said:

> Advances in science when put to practical use mean more jobs, higher wages, shorter hours, more abundant crops, more leisure for recreation, for study, for learning how to live without the deadening drudgery which has been the burden of the common man for ages past...But to achieve these objectives - to secure a high level of employment, to maintain a position of world leadership - the flow of new scientific knowledge must be both continuous and substantial…the future of science in this country will be determined by our basic educational policy (1945, para. 6).

In 1983, the U.S. Department of Education's National Commission on Excellence published the report, *A Nation at Risk*, which identified the need for school reform if the United States were to remain competitive and a leader in the global economy (Gardner). Citing increased illiteracy, decreased science and math scores on national assessments and lowered ranks in global comparisons of achievement, the National Commission of Excellence in Education challenged America's educational institutions to raise the performance level of their students particularly in reading, math, and science (Gardner, 1983).

More recently, President Obama (2009) launched the *Educate to Innovate* campaign to focus on improving math and science education programs such that the United States "reaffirm and strengthen its role as the world's engine of scientific discovery and technological innovation" (para. 8). Since the mid-20th century, advancing educational excellence in high schools and improving STEM education have been established as distinctive goals of the American education system. In order for the U.S. to compete globally, the American educational systems must produce a highly qualified STEM workforce.

Pursuing STEM careers appears to be a significant challenge for American youth. The phenomenon of decreasing numbers along STEM pathways has been referred to as a consistently narrowing pipeline (Cannady, Greenwald, & Harris, 2014). The STEM pipeline begins in early education and progressively narrows through the completion of post-secondary education (PSE), with significantly less students entering STEM careers than those who had opportunity or interest, suggesting a "leak" in the pipeline. Nearly 55% of students entering college as STEM majors either change to a non-STEM major field of study or leave without fulfilling credentialing requirements (Chen & Weko, 2009). These leaks have been attributed to subpar academic preparation for too many high school students and failure to diversify the talent pool (e.g., by gender and race) as to attract and retain more of those capable to succeed in these fields (Enberg & Wolniak, 2013).

Insufficient academic preparation has been of primary concern for student success along the STEM pipeline (Bonous-Hammarth, 2000; Museus, Palmer, Davis, & Maramba, 2011). Research has identified academic rigor as a primary factor contributing to post-secondary success (Adelman, 2006). Academic preparation, specifically the level of completion of advanced math and science courses, has been considered a principal contributor to success throughout the STEM pipeline (LeBeau et al., 2012). Participation and success in Advanced Placement (AP) high school classes can contribute to academic preparation as well as the selection of specific majors in college (Ackerman, Kanfer, & Calderwood, 2013). As such, the decision to participate in advanced curriculum during high school impacts the ability of students to enroll and succeed in specific areas of study, specifically STEM fields (Ackerman et al., 2013).

Another fact is that female, U.S.-born minority, and economically disadvantaged students are underrepresented in STEM fields and occupations (MacPhee, Farro, & Canetto, 2013). Females and underrepresented racial and ethnic minorities (URM's), specifically African Americans, Hispanics, and American Indians, are growing in participation and completion of post-secondary education and present an untapped human resource to fulfill the needs for a qualified U.S. STEM workforce (National Science Foundation [NSF], 2013). Although recently the number of foreign-born workers in science and technology has grown within the U.S. in an attempt to meet the demand for a qualified STEM workforce, this is definitely not a long-term solution for a sustainable knowledge economy (Lowell, 2010). In 2011, college-educated foreign-born workers accounted for 26% of the science and engineering workforce, up from 22% in 2000, which exceeded the overall foreign-born U.S. population (13%) (NSF, 2014). These statistics show that recruitment of foreign-born workers for STEM occupations has become a focus for post-secondary institutions and employers, and this trend has led to a disregard of the existing pool of underrepresented Americans in these fields (Collier, 2007).

The underrepresentation of certain groups in STEM has been extensively documented and is an issue of great concern for educators and policy makers. STEM occupations have been historically dominated by White and Asian men (Tyson, Lee, Borman, & Hanson, 2007). Currently, minorities account for nearly 40% of students through 12th grade, more than a quarter of the population, and make up a mere 18% of STEM bachelor degrees (Hrabowski, 2012). Although the minority population is growing, their representation in STEM fields has remained low (Daily & Eugene, 2013). Women have experienced a similar underrepresentation phenomenon, because their growing numbers in post-secondary education STEM fields is lacking equal representation in occupations (Blickenstaff, 2005). The percent of females entering STEM fields is more than half that of males entering these disciplines (Chen & Weko, 2009). However, females who do enter STEM careers make up only about a quarter of the science and engineering workforce although they represent over 50% of the population (Tyson et al., 2007). Increasing diversity by expanding entry and retention of minorities and women into the STEM fields may lead to an increase in the talent pool of STEM workers produced by the American educational institutions.

Engaging students in rigorous advanced academic coursework during high school in preparation for post-secondary education as well as expanding the talent pool by promoting STEM programs to underrepresented groups (i.e., through outreach programs) can provide the means to build a qualified STEM workforce based equally on the American-born population. While school districts and government entities are engaged in expanding college access through advanced curriculum and outreach programs, to my knowledge, the benefits of these programs in promoting post-secondary educational pathways leading to STEM occupations have not received adequate attention in the research literature.

Statement of the Problem

A significant amount of resources are provided by state and federal governments in developing advanced high school curriculum and college outreach programs (Bunnell, 2009; Domina, 2009). In addition, students who participate in both academically rigorous programs as well as outreach programs commit time, effort, and money in reaching the goal of enrolling in and graduating from a post-secondary institution (Domina, 2009;

Dyce, Albold, & Long, 2013; Foust, Hertberg-Davis, & Callahan, 2009). A legitimate question is whether this investment could also contribute to growing a strong STEM workforce.

Employment in STEM fields is expected to grow to over nine million by 2022 (Vilorio, 2014). STEM jobs provide higher earnings than the U.S. average and typically require post-secondary education (Cover, Jones, & Watson, 2011; Vilorio, 2014). However, STEM fields of Natural Sciences and Mathematics combined, as well as Computer Science and Engineering combined, each only conferred degrees to about 8% of graduates in 2011 (U.S. Bureau of Labor Statistics, 2014). It has long been the responsibility of education systems to foster and maintain an influx of students into these fields. However, this has not always occurred, supporting the metaphor of a “leaky” pipeline. With the predicted shortfall of a qualified STEM workforce, access and persistence of talented youth in STEM fields has become even more important.

Since the shortage of a qualified STEM workforce is often related to inadequate academic preparation in high school and lack of a diverse talent pool pursuing degrees in these fields (Enberg & Wolniak, 2013), more research is needed to understand the role of various high school programs in addressing these issues. Participation in advanced curriculum and college outreach programs may prove to be the avenue for sustaining and diversifying the flow of students into the STEM pipeline. The preparation and skills acquired from these high school programs may also provide the means for persistence in the post-secondary STEM pipeline. Understanding the factors that impact successful trajectories through the STEM pipeline is critical for promoting a growing and sustainable STEM workforce.

Researcher's Viewpoint

Growing up, I was fortunate to have parents that found value in education. With neither of my parents completing college, the goal was set by them that each one of their children would accomplish what they had not – earn a bachelor's degree. My parents understood that in order for work and life to be a little simpler and more rewarding, education beyond a high school diploma was necessary. As I am nearing the completion of my doctoral degree, my accomplishments have far exceeded the goal set by my parents.

While attending high school I was identified to participate in specific Advanced Placement courses – mathematics and economics. While my exposure to advanced curriculum was limited, it was the belief of my teachers in my ability to be successful – or my simply annoying behavior in class because the grade-level curriculum moved too slowly, that I was moved out of the regular curriculum classes. Regardless of the reason, I had a proponent for my placement in advanced classes. Without these teachers on my side, promoting me for enrollment in these courses, the likelihood of my participation would have been minimal – as my siblings had not participated in advanced curriculum nor did my parents have knowledge of these courses. Therefore, my own experience made me realize the importance of having teachers, parents, or friends who guide the student toward taking more challenging classes during high school as well as the essential role more demanding curriculum would have on academic preparation. My own experience contributed to the interest in understanding whether advanced curriculum is indeed the passport to higher learning for other high school students.

Looking back, I am grateful for the opportunity to have participated in these classes. However, I would not say my experience was always satisfactory. Most of my teachers were male, not that this was a bad thing, but as one of the few females in the class, I sometimes felt as if I was being overlooked. Male students were more often called upon to answer questions. They also had a tendency to congregate together in class and converse more with the teacher. The impression I had was math was dominated by males. However this experience may have shaped my future, I am unsure, but I do believe it instilled in me the belief in my own ability and the ability to take my own path.

As I entered college, I felt academically prepared for the demands of college classes. However, I did not feel as socially prepared for the vast college community before me. Fortunately, I have two older siblings who attended college and could be my sounding board as I traversed the challenges of enrolling in courses, declaring a major, and accessing the college environment as a whole. Had it not been for my academic preparation and the fact I had exposure to the college-going process from my siblings, I think I may have felt lost in my pursuit of higher education.

I believe this is the gap college outreach programs fill for many high school students. Unfamiliar with these programs during my high school career, my public school work experience exposed me to the concept of college outreach programs. As I saw students engage in conversations about going to college, selecting a major, and their careers thereafter, I began to wonder how these programs impact the paths chosen by these students. Do these programs that exist in many high schools provide the readiness necessary to access and persist in college, especially for first generation college students. For many students who are apart of these programs, being the first to attend college, they face the challenge of the unknown. I think these types of programs begin to make the unknown associated with going to college more familiar.

It is my belief that both types of programs, advanced curriculum and college outreach program, meet the needs of students engaged in their continuing education, albeit in different ways. In my experience, the advanced courses I took in high school provided the foundation I needed to be able to work through the demanding college coursework and persevere, even when I found particular courses difficult. The atmosphere of the advanced courses seemed to cultivate a college-going culture among the students in the class. Meanwhile, college outreach programs provide students with a practical foundation necessary for success in college. As I observe students engaged in a college outreach program, I see that their participation helps in building the knowledge necessary to navigate the complexities of attending college. Outreach programs create a college-going culture among its participants by increasing exposure to college related activities. For instance, students take part in college visits starting as early as 7th or 8th grade. Students also receive information related to financial aid and the admission process. By providing mentoring and tutoring opportunities, these programs also support the academic development needed in college. It is my belief that both types of programs advance the skills needed to succeed in post-secondary education.

Educators have a tremendous duty to build and promote academic and social skills to students, to raise the bar of expectations. As a former math teacher, I understand the adversity that many students, especially females, have toward STEM fields. Mathematics has always been a passion for me. My former students would tell you I am simply weird because I thought math was fun. I would get excited teaching about parabolas. My goal as a teacher was to inspire my students, to open up mathematics to them. I felt it was my duty to provide my students not only with the content I was teaching but the possibility of what the future may hold for them if they seriously engage in learning math. My passion for math remains, and I feel, as part of the educational community, we need to promote STEM opportunities to our students.

Although I have left teaching math, I still interact with students in a way that may mold their future. Currently, as a junior high school counselor, I help students prepare and plan for their transition to high school as well as set goals beyond high school. When I meet with students, one thing we discuss is their academic strengths and weaknesses. In relation to academics, we also discuss what it is they think they want to do as a career when they grow up. Many students want to be a pro-athlete, but many others contemplate seriously what they might be doing 20 years from now. I have students who want to be doctors, engineers, and video game designers. However, once I explain some of the coursework associated with these careers, I witness hesitation on behalf of the student. Specifically, my female and underrepresented minority students stop and pause at the contemplation of the math and science courses needed for a specific STEM-related career. Although many of these students are currently successful in their mathematics and science coursework in junior high school, the consideration of more advanced coursework in high school and college causes uncertainty with their future plans. This hesitation causes me concern about the future of our STEM educated youth.

While many of my students are reluctant to engage in coursework associated with STEM careers, I also have many who are eager to pursue the challenge. Unfortunately, I have seen far too many students who excelled in STEM subjects and were excited by the subject during junior high school fall out in high school, and if they made it that far, fall out in college. I see students too easily give up, especially females when it comes to advanced mathematics and science courses. Although advanced curriculum prepares these students to succeed academically, there are still other factors associated with success in these subject areas. Whether it is the feeling of being overlooked, as I felt in my high school advanced math course, or some other contributing factor, females have traditionally a tendency to leak out of the STEM pathway. Do advanced curriculum or college outreach programs contribute enough to build and sustain the advancement of students into STEM disciplines beyond where they are today?

As I mentioned previously, I feel very fortunate that I had parents who felt education was a pathway to something better, and I had siblings who had forged that path before me. I also was fortunate that I had teachers who saw something in me, and provided me with an opportunity to excel academically. I believe advanced curriculum programs and college outreach programs have the potential to pave a path towards a better future for today's youth. Moreover, I believe they provide a stronger foundation to students who have potential to pursue STEM careers.

Purpose of the Study

The purpose of this study is to examine the impact of student participation in advanced coursework and college outreach programs on their potential pursuit of STEM-related pathways during post-secondary education and work. The sheer number of students involved in these high school programs warrants our attention if the attainment of education excellence and global competitiveness of the United States is to be enhanced and sustained, by growing a highly qualified workforce specifically in areas of science, technology, engineering, and mathematics. Therefore, this study intends to inform on the influences of high school advanced curriculum and college outreach programs on the STEM pipeline. The study will address the overarching question: Are STEM-related educational choices and occupational outcomes different for students who participate in AP/IB and/or college outreach programs? The study will employ the Educational Longitudinal Survey of 2002 that follows a nationally representative sample of 10th graders between 2002 and 2012 (age 26).

Research Questions

Specifically, this study will address the following research questions:

Question 1 What is the relationship between post-secondary pathways (i.e., described in relation to post-secondary education participation and initial choice of major field of study) and high-school program (i.e., enrollment in AP/IB courses or college outreach programs) when controlling for socio-demographic factors (i.e., gender, race, parental education, socio-economic status)?

Question 2 What is the relationship between level of educational attainment by age 26 and high-school program (i.e., enrollment in AP/IB courses or college outreach programs) when controlling for socio-demographic factors (i.e., gender, race, parental education, socio-economic status)?

Question 3 What is the relationship between credentialed field of study by age 26 (i.e., whether related or not to STEM) and high-school program (i.e., enrollment in AP/IB courses or college outreach programs) when controlling for socio-demographic factors (i.e., gender, race, parental education, socio-economic status)?

Question 4 What is the relationship between occupational choices by age 26 (i.e., whether related or not to STEM) and high-school program (i.e., enrollment in AP/IB courses or college outreach programs) when controlling for socio-demographic factors (i.e., gender, race, parental education, socio-economic status)?

Significance of the Study

With the anticipated shortage of a U.S.-qualified STEM workforce, it is imperative to develop the skills and interest of America's youth in STEM-related fields as well as promote persistence in these fields. Females and underrepresented minorities provide an untapped resource to fulfill the growing demand of a STEM-related workforce. How can the school system promote science and technology to high school students, enhance their math and science academic preparedness, and offer guidance toward enrollment and success in post-secondary institutions? This study proposes that specific high school programs may serve this goal.

This study will focus on two types of initiatives. Advanced curriculum provides students with the academic rigor and skills associated with success in STEM fields while college outreach programs supplement the need for guidance and college information that some students lack from family. Taking advanced mathematics and science classes has been attributed to be a factor of success through the STEM pipeline, although even those students who excelled in these subject areas have leaked out (Chen & Weko, 2009; LeBeau et al., 2012). Therefore, if educators of STEM programs (both secondary and post-secondary) understand the factors increasing entry into the STEM pipeline, further steps can be taken to boost recruitment and retention within these programs. Promoting the importance of STEM fields to females and underrepresented minorities early in their education and dispelling stereotyped career images may provide the opportunity to increase interest, enrollment, and perseverance through the STEM pipeline among these groups. Increased access to college planning, mentoring, and exposure to STEM-related occupations throughout schooling may also inhibit the persistency of gender-oriented occupation pathways (Joy, 2006; Museus, Palmer, Davis, & Maramba, 2011). Additionally, building the academic skills necessary for success in rigorous STEM programs is essential for encouraging student perseverance and completion of STEM programs. Moreover, these success factors may be of particular interest to institutions of higher education who wish to grow STEM focus. Therefore, study findings will be relevant to both secondary and post-secondary institutions.

Given the large number of American students participating in advanced academic and outreach programs, it is important to identify if participation has any effect on successful completion of STEM majors and entry into the STEM workforce. For instance, the Student Service Program in the U.S. Department of Education provides funding for Upward Bound, Talent Search, and GEAR UP. Without understanding the relationship (if any) between advanced academics and outreach programs on potential STEM pathways, it will be difficult for policy makers, educational institutions, or students and parents to comprehend the benefits of maintaining and promoting these programs. Similarly, school districts, many which have experienced budgetary cuts, need to understand if the benefits of advanced programs are aligned with the stated goals of American education. Advanced curriculum and outreach programs have been found to contribute to increased post-secondary access, although more research is needed to understand if they positively affect all students (Chajewski, Mattern, & Shaw, 2011; Pell institute, 2009; Walsh, 2011). The study will also help understanding whether the student and societal investment associated with these programs contribute to building the talent pool of students needed to help “reaffirm” America’s position as a leader in global science and technology.

Definition of Terms

Advanced Curriculum: Advanced curriculum provides high school students access to college-level coursework while in high school. Two such programs are

Advanced Placement and International Baccalaureate. Programs promote college enrollment and college credit earning potential.

College Access Programs: Programs designed to promote college enrollment to economically and educationally disadvantaged students, primarily those who are first generation and minority students. The programs include Talent Search, Upward Bound, and GEAR UP and provide services such as tutoring and mentoring.

STEM Occupations: The U.S. Bureau of Labor Statistics (2012) reports STEM workgroups as two major domains that include two subgroups each. The first is the Science, Engineering, Mathematics, and Information Technology Domain with subgroups a) Life and physical science, engineering, mathematics, and information technology occupations, and b) Social science occupations. The Science and Engineering-related Domain includes a) Architecture occupations and b) Health occupations.

Underrepresented/Overrepresented: Terminology used to describe marginal percentages in relation to the sample. For instance, females are overrepresented in selecting an initial non-STEM field of study given the marginal percent of 62% compared to the sample of 53%.

Overview of Chapters

This dissertation consists of five chapters. Chapter 1 introduced empirical evidence that emphasizes the importance of STEM education and occupations and the main research objectives built on the assumption that high school programs could play a role in students choosing STEM-related pathways. Chapter 2 provides a review of literature focused on the influence of participation in high-school programs (i.e., AP/IB and/or college outreach) on post-secondary and occupational choices. Background information related to AP, IB, and outreach programs is provided. It also introduces the proposed theoretical framework that guides the choice of influencing factors and will be used to interpret and discuss the study findings. After the literature review, chapter 3 presents the methodology of this study including data sources and research design. Chapter 4 details the findings of the study for each research questions, and provides a summary of main findings. Finally, chapter 5 discusses selected findings of the study in relation to research literature, as well as the study limitations, significance, and implications for practice and policy. Recommendations for further research to expand the current study are likewise presented.

Chapter 2

Literature Review

High school academic preparation and achievement influence the transition to college, the college experience and success, and ultimately the transition to the workforce (Crisp, Nora, & Taggart, 2009). Advanced curriculum programs promote and develop academic skills that contribute to higher achievement of students while college outreach programs build social capital (e.g., resources, networks) that prepare, guide and support students transition to college. As a result, possession of academic and social capital affect how students make educational (e.g., PSE participation and educational attainment, field of study) and occupational choices.

Presented in this chapter is a brief history of advanced curriculum and college outreach programs. Furthermore, it includes literature related to post-secondary pathways including choice of STEM-related field of study and educational attainment, as well as STEM-related occupations. I give particular attention to the role played by socio-demographic factors in high school program participation and in engaging in STEM-related pathways.

High School Capital

Advanced Curriculum Programs

Over the past 10 years, student participation in AP courses has doubled in size, with more significant increases for minority students (College Board, 2014a). Similar to AP participation, the International Baccalaureate Diploma Programme (IBDP) has undergone considerable growth in the U.S. with over 68,000 students completing the required IB coursework in 2013 (International Baccalaureate Organization [IBO], 2014a). Students who participate in advanced academic programs have been linked to higher rates of college access (i.e., enrollment) and retention, as well as elevated levels of social and academic capital (Gonzalez, Stoner, & Jovel, 2003; Mattern, Marini, & Shaw, 2014; Shaw, Marini, & Mattern, 2012). Furthermore, Sparfeldt (2007) found that compared to other students, academically advanced students show more interest in investigative fields, such as science and technology, signifying the potential of AP/IB coursework leading toward interest in STEM fields and occupations.

Advanced Placement and the IBDP provide students the opportunity to take college-level coursework, as well as earn college credits while attending high school. AP courses allow students to select specific subject areas in which to pursue rigorous curriculum, whether it be English, Economics, or Biology (College Board, 2014a). Unlike AP courses, the IB diploma is a comprehensive two-year program encompassing several areas of advancement from arts to sciences (IBO, 2014a).

Involvement in both programs, AP and IB, do not come without costs, for the district, school, and student. Fees related to course offerings and examinations can increase school funding appropriated for courses designated as AP or IB. Thirty-four AP courses are available through the College Board with start-up costs up to $11,000 in order for schools to incorporate these classes into their course offerings (College Board, 2014b). Schools offering the IBDP maintain a financial commitment as well; fees assessed by the IBO range from an initial investment of $4000 to recurring annual fees over $10,000. The establishment of AP and IB courses in high schools also requires expenses associated with teachers' professional development in addition to materials and equipment. Furthermore, student participation entails financial responsibilities on their own behalf; students incur registration fees for IB, and assessment fees for each AP or IB examination taken, although a reduction in AP fees is provided for those students identified as low-income (College Board, 2014b; IBO, 2014b).

The College Board (2014b) reports more than 90% of colleges and universities in the U.S. offer college credit for qualifying scores on AP exams, as well as advancement to higher-level course work, or both. In 2011, 3,300 universities and colleges received AP scores from over 940,000 students for consideration in admission, placement, and/or credit (College Board, 2014a). IB diploma recipients may also be awarded college credits, however, no standard for doing so has been established among post-secondary institutions (IBO, 2014a). Some states, such as Texas, have set legislation for state universities in the awarding of a minimum of 24 hours of college credit for the completion of the IBDP with minimum scores of 4 on examinations (Texas Higher Education Coordinating Board, 2014).

"By providing necessary knowledge and skills, AP courses have helped to raise students' levels of awareness and preparation for the future challenges of higher education, thus improving access and success at the post-secondary level" (Martinez & Klopott, 2005, p.14). This academic preparation from rigorous high school curriculum is a primary predictor in the completion of college degrees (Adelman, 2006). Additionally, advanced high school curriculum promotes the enrollment of students in four-year post-secondary institutions and graduation within six years of entrance (Chajewski, Mattern, & Shaw, 2011; McCauley, 2007).

A quantitative study of first-year college students at one North Carolina university, conducted by Kretchmar and Farmer (2013), found students, who were enrolled in any advanced curriculum coursework in high school (AP, IB, and dual credit), had higher grade point averages (GPA) in college compared to students who did not take advanced coursework. However, results also suggested that taking a large number of advanced courses during high school was not strongly associated with first year GPA, but enrollment in a maximum of five advanced courses throughout high school was sufficient for academic success. Kretchmar and Farmer stated “some rigor is better than none” (p. 32), providing evidence from their study that any participation in advanced curriculum bears positive association with post-secondary success regardless of the field of study pursued by students. Although academic returns from additional advanced coursework were minimal with respect to first year GPA, the findings clearly show a benefit for taking such courses in high school.

Advanced Curriculum and Equity Issues

The preliminary review of advanced curriculum fees shows that school districts and families incur substantial costs associated with the implementation of and participation in advanced curriculum programs. Research suggests that the financial obligations of advanced curriculum may inhibit participation in such programs for underrepresented students (Walker & Pearsall, 2012). On the other hand, the college enrollment and completion rates of underrepresented students are higher for those participating in advanced courses, indicating these programs are indeed highly beneficial for these students and provide the necessary academic rigor required for college success (Martinez & Klopott, 2005; McCauley, 2009).

Klugman (2012) suggested advanced curriculum programs promote social reproduction of class advantage due to existing resource inequities in schools. Klugman analyzed high school resources from 710 schools across the United States by using ELS: 2002 national data. School programmatic resources, such as AP and IB course offerings, were found to be more abundant in schools enrolling students with higher socio-economic status (SES). Additionally, not only were course offering associated with higher SES, but so was student participation. Hence, higher SES students have advantage over low SES students in receiving better academic preparation and access to college level curriculum.

Walker and Pearsall (2012) conducted a qualitative study of Latino students' access and participation in AP courses in one high school in the Western United States. All the students in the study met the academic requirements for participation in AP courses, however findings suggested program cost for participating in AP was a primary factor that inhibited student participation. Additionally, the lack of understanding the connection between AP and college finances was also a contributor for not participating in AP. Indeed, students and parents did not associate the participation in AP courses and earning a qualifying score on the AP exams with decreased college tuition and time required for graduation. On the other hand, some students who did participate attributed their participation in AP classes and college aspirations to teacher support and access to college outreach programs, suggesting previous academic achievement is not the only factor influencing advanced curriculum participation.

Research clearly shows that URM's and females remain underrepresented in advanced curriculum (MacPhee, Farro, & Canetto, 2013). While the benefits of advanced curriculum have been tied to college enrollment and retention, costs and academic requirements associated with these programs can inhibit the participation of select students, specifically minorities and low socio-economic students. As reported by Klugman, (2012), those students with higher socio-economic status have advantage to expand their opportunities of advanced curriculum compared to those less economically advantaged. Therefore, other programs must bridge the gap between academic preparation and college access.

College Outreach Programs

College outreach programs provide underrepresented students with the social capital necessary for college enrollment and retention, which cannot be obtained through participation in advanced curriculum programs by all students. As opposed to focusing on advanced curriculum, college outreach programs seek to build social capital consisting of resources and guidance for a diverse student population (Dyce, Albold, & Long, 2013; Swail & Perna, 2002). From the very design of these programs (i.e., targeting specific student populations), participants are mostly coming from the low socio-economic and minority student groups. Access to college, not advanced academic preparation, is the main goal of programs such as Talent Search, Upward Bound, and Gaining Early Awareness and Readiness for Undergraduate Programs (GEAR UP). Nearly one million students participate in any one of these programs each year. The Pell Institute (2009), found students involved with Talent Search and Upward Bound persisted in college longer or completed their degrees, earned more credits, and had higher grade point averages than similar students not involved in an outreach program.

College outreach programs were initiated in the United States when President Johnson declared his “war on poverty” with the passage of the Economic Opportunity Act of 1964 giving birth to the Upward Bound program. The next several years bore the Talent Search program and Student Support Services. These three programs designed to promote educational opportunities for the less advantaged became known as the TRIO programs (Cowan-Pitre & Pitre, 2009).

According to the U.S. Department of Education (ED), approximately 60,000 students participated in the regular Upward Bound program during 2013 with an average cost of $4,170 per participant (ED, 2014a). The purpose of Upward Bound as a college outreach program is to generate social capital (i.e., guidance, access to resources, social networks) among lower income, first generational students with the intent of increasing enrollment and retention in post-secondary education programs. Upward Bound program benefits involve also tutoring, mentoring, college tours, and information on financial aid programs. The most recent data from ED reports an expected post-secondary enrollment rate for Upward Bound participant of 82% for 2009 high school graduates (ED, 2014a).

Talent Search also provides assistance to disadvantaged youth in the pursuit of post-secondary education opportunities (ED, 2014b). Funding for Talent Search is $428 per participant with nearly 300,000 students participating in the program (ED, 2014b). Nearly 79% of “college ready” high school graduates in 2008 who participated in a Talent Search enrolled in post-secondary education (ED, 2014b).

In 2013, GEAR UP awarded $286,434,520 to schools for program participation of nearly 617,000 students (ED, 2014c). Differing from Talent Search and Upward Bound, GEAR UP uses a cohort design that integrates an early intervention component where participants are identified no later than 7th grade. Similarly, GEAR UP aims at increasing college enrollment of low-income students (ED, 2014c). The cohort model is a whole-grade concept, providing services to all students within a selected grade level instead of select students meeting eligibility requirements. In addition to mentoring and outreach supports, GEAR UP also uses funds to provide college scholarships.

Using ELS: 1988 data, Walsh (2011) examined the effectiveness of participation in Upward Bound and Talent Search programs on college student’s attendance rates. The national representative sample of 358 students was analyzed for post-secondary enrollment in any type of institution. Results suggested participation in Upward Bound and Talent Search programs increased attendance rates among low SES African American and Hispanic students compared to program non-participants. Furthermore, their college attendance rates were brought to a comparable level with White students of average socio-economic status. When not controlling for SES, program participation still increased the likelihood of attending college, although, White students exceeded enrollment compared to African American and Hispanic students.

GEAR UP has also been found to effectively influence college going among less advantaged students. Bausmith and France (2012) conducted a study of 173 schools participating in GEAR UP using matched cohort data from the National Center for Educational Statistics over a seven year span. The results support Walsh's (2011) findings that intervention programs promote college readiness and access among low-income students. GEAR UP schools, compared to non-GEAR UP schools showed significant increases in sophomore PSAT participation, junior PSAT participation and SAT scores for critical reading and mathematics. Overall, the GEAR UP participants indicated positive returns on several college readiness measures.

Cabrera et al. (2006) also studied student preparedness for college in relation to school participation in GEAR UP over a three year period. Comparing performance on standardized reading and mathematics tests between GEAR UP participants and non-participants, the researchers found minimal impact of program participation on the college readiness measure of reading achievement. While GEAR UP participation did not meaningfully impact the reading achievement during this timeframe, math achievement, on the other hand, significantly increased compared to non-GEAR UP schools.

Participation in advanced curriculum and outreach programs both influence students' college-going activities. For instance, participation in advanced curriculum is associated with higher college GPA, persistence, and graduation; whereas outreach program participation has provided benefit to students resulting in improved academic achievement and college enrollment.

Post-Secondary Pathways

Post-secondary Participation

While the focus of this study is not whether students attend college, or what specific types of college they choose, the literature suggests that certain characteristics and factors that influence the college-going decision-making process are ultimately related to the choice of major field of study and occupation. It is important to note that most STEM-related occupations require a bachelor's degree or higher (Cover, Jones, & Watson, 2011). Student characteristics including socio-economic status and academic preparation influence the decision whether to attend college and pursue areas of studies leading to STEM-related occupations.

The U.S Bureau of Labor Statistics reported on average, Hispanic and African American households spent significantly less on higher education than White Americans by 57% and 69%, respectively. Additionally, Asians spent approximately 57% more on tuition than Whites for the years between 2008 and 2010 (Luo & Holden, 2014). Although not reported, these differences could be attributed, in part, to the choice parents make for the post-secondary education of their children. For example, Hispanic students have higher initial enrollment rates at 2-year institutions, whose tuition rates are significantly lower than 4-year institutions (Gonzalez, 2012). Recently, the U.S. Bureau of Labor Statistics (2014) reported college enrollment rates for the 2013 high school graduates: nearly 66% of high school graduates had enrolled in college or university, slightly down from the previous year, with 68% enrollment for females and 64% males. Approximately 40% of students enrolled in post-secondary education attended 2-year institutions whereas roughly 60% attended a 4-year institution. Whether or not students attend 2-year or 4-year institutions may influence the pursuit of STEM-related pathways, as many STEM opportunities are related to higher levels of educational attainment. These decisions may also be highly impactful on the racial diversity noticeable within STEM-related fields of study and occupations.

Although the decisions whether to attend college or not may be economically motivated, college-going behaviors are determined by individual and institutional factors. .

Chapman (1981) proposed a college-going model that incorporated student characteristics and external influencing factors. Student characteristics were comprised of academic achievement, aptitude, SES, and educational aspirations. External influencing factors consist of college attributes (e.g., cost, location) and influential relationships that affected college-going decisions. Chapman suggested that information gained during high school and the influence of significant people, particularly parents, were prominent factors of attending college. Costs, location, and college type were attributes tied to SES that impeded student decisions to attend college. He also stated SES was a backdrop that affected attitudes, aspirations, and behaviors related to college-going. While he suggested students who have higher aspirations typically experienced greater levels of academic success and encouragement for future education, information gained during high school can strengthen student aspirations as well as mediate for SES effects.

In relation to Chapman's model, adding to student characteristics, participation in advanced academic programs could be an element conducive to the decision-making process for college participation and choice. The curriculum of AP courses and the AP examinations are more rigorous than regular curriculum and tests, and instill in students a higher level of academic achievement and proficiency. However, students who gained knowledge of college-going activities, perhaps through outreach programs, also increased their likelihood of enrollment due to higher level of information about the college going processes.

More recently, Chajewski, Mattern and Shaw (2011) examined the college-going behavior of students who took AP exams during high school. Through analysis of national data for a cohort consisting of 2007 seniors, the researchers found that the number of AP exams taken was associated with an increased likelihood of enrollment in a post-secondary institution. For instance, students who participated in AP exams were almost twice as likely to attend a post-secondary institution compared to students who did not take AP exams, while students who took a minimum of two AP exams had an even greater chance. Overall, 83% of students participating in AP exams compared to nearly 46% of those who did not, enrolled in a post-secondary institution. Moreover, students who engaged in AP coursework and exams had higher Preliminary Scholastic Aptitude Test (PSAT) scores than those who did not, suggesting higher levels of overall academic performance. Importantly, the findings additionally suggested that gender and ethnicity did not play a significant role in the likelihood to enroll in post-secondary institutions.

Participation in advanced curriculum can be linked to the school resources and the socio-economic composition of the school. Klugman's (2012) study not only examined the relationship between course offerings and SES but the relationship between school resources and PSE participation. His study reviewed 710 high schools on the basis of programmatic resources (advanced courses), social resources (social relations), and pedagogical resources (teacher training). Klugman's research suggested the higher socio-economic status and the more diverse program offering of the school, the more likely students are to enroll in post-secondary education compared to non-participation.

Participation in college outreach programs could also influence PSE participation. Outreach programs provide social capital in the forms of resources and guidance to post-secondary enrollment among underrepresented groups (Swail & Perna, 2002). Constantine, Seftor, Martin, Silva, and Myers (2006) explored post-secondary participation of Talent Search participants in Florida, Texas and Indiana. Overall, Talent Search participants were more likely to enroll in a post-secondary institution and were more likely to be enrolled full-time compared to students not in the program.

A U.S. Department of Education's (2008) report found that Upward Bound participation did not affect significantly on student enrollment in post-secondary institutions, however, Upward Bound participation was found to be statistically significant in the PSE enrollment of Hispanic students (Myers, Olsen, Seftor, Young, & Tuttle 2004). On the other hand, the U.S. Department of Education (2008) has reported success of its GEAR UP program, suggesting three factors of college-going (i.e., increased parental expectations, increased parent and student exposure to college information) were significantly impacted by student participation in that program.

Glennie, Dalton, and Knapp (2014) researched the post-secondary enrollment and success of participants in GEAR UP, Upward Bound, and Talent Search using ELS: 2002 data. Participants in the programs took part in college transition activities at a higher rate than non-participants. By their 12th grade year, more participants than non-participants had sought college entrance information, applied for financial aid, and applied to college. These results demonstrated the role of college outreach programs to build social capital, by providing information related to the steps involved in accessing college.

School resources and high school program offerings, in particular, have been identified as primary elements that affect post-secondary pathways leading towards college enrollment. While these elements are integral to the continuation of post-secondary education, they are also vital in the pursuit of STEM-related pathways, starting with the choice of major field of study.

Initial Field of Study

The enrollment in post-secondary education is followed by the requirement to select a major field of study. This decision may well be influenced by high school experiences related to previous academic success and/or high school program participation, as well as student characteristics. Most research conducted on choice of STEM majors has been related to math and science achievement in high school. Gender differences have often been identified in student participation in rigorous math and science high school courses as well as the pursuit of STEM majors. Taking high school Physics was found to positively influence the choice of a STEM majors in male students, whereas female participation in advanced math courses, particularly Calculus, was positively associated with the declaration of a STEM major (Trusty, 2002). Overall, students who participated in several advanced math and science courses in high school were found to complete STEM majors at a higher rate (Maltese, 2008). Limited research has focused on the connection between advance curriculum programs or outreach programs and choice of STEM fields.

Early research examined the relationship between ACT scores and choice of college major for academically talented students. Kerr and Colangelo (1988) conducted a study of 76,951 high school students who participated in the 1985-86 school year administration of the ACT exam. Levels of academic ability were derived from ACT scores in the 80th (high average), 95th (moderately talented), and 99th (highly talented) percentile ranges. Noticeable relationships between academic ability and choice of college major were found within STEM areas, specifically engineering, biological sciences, and physical sciences. Nearly 40% of moderately and highly talented students intended a major in engineering, whereas high average students chose business at nearly the same rate. Significant gender differences also marked choice of STEM majors. Of highly talented students who chose engineering as a major, one-third were males whereas less than 10% were females. On the other hand, females chose biological sciences at a rate three times greater than males.

Ackerman, Kanfer, and Calderwood (2013) conducted a study of Georgia Institute of Technology first-year students (N = 26,693) from 1999 to 2009. The researchers found high school AP coursework was associated with the pursuit of STEM majors. The number of students who intended to major in a STEM field took more AP exams than those whose major was in a non-STEM field. Of STEM majors, females overall took an equal number of AP exams as males, but most of them were in non-STEM areas with the exception of the AP Biology exam.

Research has shown differences in major field of study for non-citizen and citizen students. Using data from two Texas public universities, Nores (2010) compared choice of major by citizenship status. Nearly 58% of international students were found to enroll in STEM majors, and 45% of resident alien, primarily composed of Asian and Hispanic students, declared STEM majors. The percent of STEM majors among citizens was significantly lower at 26% with Whites accounting for the lowest share at 23% and Asians the highest share at 41% followed by Hispanics (31%). Nores attributed some of these differences to expected labor market outcomes and the value of STEM education among immigrant students. Additionally, Nores found differences within citizenship groups by gender, with the American-born group experiencing the largest gender gap with respect to participation in STEM majors.

Morgan, Gelbgiser, and Weeden, (2012) conducted a study using ELS: 2002 data to analyze gender differences in college major choice and intended occupation. This study categorized STEM only majors as fields associated with engineering, computers, mathematics, and some sciences (e.g., physics, chemistry). Omitted from STEM was the category of biological sciences, which was grouped separately with health and clinical sciences and included such majors as nursing and pharmacy. Findings showed gender differences for specific majors: 21% of males chose a STEM only major (e.g., physics/chemistry or engineering) compared to 5% of females, while nearly 16% of females selected biological-related sciences in comparison to 5% of males. For the same sample, when high school academic achievement was compared across genders, standardized math and reading scores were nearly equal which suggests that academic preparedness is not always a determinant of major field selection. Additionally, their findings indicated females who showed interest in STEM during high school abandoned these majors in college in favor of biological, health, or clinical sciences majors. Overall, the results were contradictory to previous research suggesting that gendered differences in STEM majors and intended occupations were weakly related to academic preparation in high school or work and family goals but strongly related to occupational plans.

Factors Affecting Post-secondary Education Persistence and Success

Multiple factors such as socio-demographic characteristics and high school programs impact young people's decision to pursue post-secondary education and, if they do, to choose specific fields of study that are likely to lead to a STEM-related career. As previously mentioned, taking advanced math and science courses in high school, citizenship, and gender have been identified as contributing factors in the pursuit of STEM studies. With over half the students who enter STEM-related fields leaving before fulfilling credentialing requirements, factors associated with 'leaking out' the STEM pipeline are of critical importance (Chen & Weko, 2009). Similarities exist between the effects of high school experiences on PSE participation and choice of major, and persistence in these fields. Both high school and college factors influence the persistence of students especially as they traverse the STEM college pipeline.

Overall, college persistence leads to higher educational attainment as well as pursuit of more challenging degrees (e.g., STEM-related). Reason (2009) defined persistence as an individual objective as opposed to an institutional goal, and considers persistence as progress towards a goal, in many cases, graduation from college. He presented persistence in relation to precollege student characteristics including socio-demographic factors, academic experiences and academic dispositions. While persistence has been considered an individual endeavor, Reason also indicated institutional characteristics influencing student interactions, campus climate, and classroom experiences also impact persistence.

In addition to findings related to the declaration of a STEM major, Ackerman et al. (2013) researched pre-college academic attributes associated with student persistence in STEM majors. The findings suggested that simply participating in AP courses was not a significant predictor of post-secondary academic success but earning high scores on the AP exams was associated with increased chances to graduate from college. Somewhat surprisingly, the number of college credits that high school students were awarded from AP exams in non-STEM subject areas was connected to higher graduation rates in STEM majors, suggesting the academic rigor associated with AP coursework, regardless of subject area, can lead to higher rates of college persistence, even in STEM-related college majors.

Niu and Tienda (2013) studied college persistence in relation to the economic composition of Texas high schools. Using Texas Education Agency data, the researchers classified schools into income poverty quartiles based on shares of economically disadvantaged students. Schools with the lowest share of students who had ever been on free or reduced lunch were categorized as affluent, the highest share designated as poor, and those schools with an average share of students on free/reduced lunch were classified as average high schools. Although the study did not specify AP/IB courses and exam taking patterns, inferences can be drawn with regards to the relationship between the economic composition of the school and advanced curriculum. Niu and Tienda indicated that poorer schools have fewer AP course offerings, which is a finding also supported by Klugman (2012). The results also indicated students from poor school were half as likely to graduate or remain enrolled in college four years after high school graduation compared to students from average high schools, whereas affluent students graduated five times more often than average high school students. Academic preparation associated with more advanced course offerings found in affluent high schools was identified as a main factor related to the higher college graduation rate. Additionally, the results showed no disparity in college persistence by different racial groups from high schools with the same economic composition, but findings showed females were twice as likely to graduate within four years or still be enrolled compared to males. The main conclusion of the study is that the economic make-up of the high school attended is affecting both advanced curriculum offerings and college persistence.

Using transcript data from the National Educational Longitudinal Study (NELS) 88-00, Ma (2011a) examined STEM persistence among males and females by focusing on high school achievement, course taking, and future aspirations. Contrary to the previous study (Niu and Tienda, 2013), her findings suggested males and females have similar rates of college persistence. Males and females were nearly equal in attaining a bachelor's degree in a STEM-related field when an expected STEM major was identified in high school, although females' intentions to enter STEM majors were significantly lower than males. Once in college, females were slightly more likely to graduate with a STEM degree than males, as well as graduate with a non-STEM degree. Furthermore, females selected STEM majors at a later date, while in college, whereas males' intentions were identified during high school. High school science and math course-taking and self-assessed ability were strong indicators of persistence in the STEM pipeline.

Conversely, Shaw and Barbuti (2010) found females to switch STEM majors at a higher rate than their male counterparts. In the study, the researchers found students majoring in STEM fields to act differently than the rest of the sample in that they were less likely to leave their STEM major. However, group differences existed; females, first generation college students, and URM's were more likely to switch from a STEM major within three years of entering college. Not surprisingly, the researchers found students who exhibited strong math and science skills in high school, as well as students who took AP exams, were less likely to change their STEM major. Additionally, being enrolled in certain STEM fields, in conjunction with earning a terminal degree (e.g., doctorate), increased the persistence of students in STEM majors.

While the research may differ on the persistence rate between males and females, one fact is clear – not enough students are persisting through the STEM pipeline. Although academic success in high school may lead to greater levels of persistence, it is persistence itself that is integral factor in the attainment of academic credentials leading to a STEM-related career.

Educational Attainment

While many studies focus on the decision to attend college, choice of initial major field of study, and persistence throughout college, others focus on the ultimate goal of all these stages -- the completion of a college degree and attainment of higher levels of education. Educational attainment, as defined by the National Center of Education (2014), is the highest level of education completed by the individual. Although educational attainment levels have increased in the population, gender and racial differences still exist. In recent years, females have closed the gender gap in the attainment of bachelor's or master's degrees, whereas the attainment gap between Whites and Black or Hispanics has widened (NCES, 2014).

Hargrove, Godin, and Dodd (2008) examined how high school student participation in AP courses and exams associates with college graduation rates within 4 years of high school graduation. Their findings indicated that participation in AP courses notably increased the four year graduation rate when comparing AP course participants (36%) and non-participants (14%). Additionally, as the mean number of AP exams taken and mean scores increased, so did the graduation rates. Over 50% of students who took a minimum of 4 AP exams and earned scores of 4 or 5 on these exams graduated college within 4 years of high school. Furthermore, successful completion of the AP course and exam yielded higher 4-year college graduation rates when evaluated against students who only participated in either the AP course or AP exam. While Hargrove, Godin, and Dodd's study does not identify levels of educational attainment beyond a bachelor's degree, the findings are suggestive of increased levels of attainment for students who participate in advanced curriculum during high school.

Bachelor's degree attainment was examined to assess the influence of Texas high school students' participation in the Advanced Placement Incentive Program (APIP) (Jackson, 2014). The programs provide incentive funds to teachers based on the number of students taking AP exams with qualifying scores as well as funds to students to forgo costs associated with AP exams with the intent of improving the quality of AP education provided by teachers and increasing AP participation of students. Important to note is the socio-demographic make-up of APIP schools compared to non APIP schools; APIP schools were located in urban areas with higher representation of minority students compared to rural and predominately white non APIP schools; both groups had similar percentages of low socio-economic students. APIP participation increased not only the number of AP exams taken but also immediate enrollment in college. Furthermore, the results found positive trends on attainment of a bachelor's degree, specifically for

Hispanic and Black APIP participants. Similar to Hargrove et al., AP exam taking is associated with increased rates of bachelor degree attainment.

In relation to race and educational attainment, Arbona and Nora (2007) examined factors believed to influence Hispanic students' perseverance through post-secondary education and degree attainment. Similar to previous research (Adelman, 2006), their findings suggested college preparedness and academic rigor were integral factors associated with Hispanic students attending college. Additionally, specific pre-college factors were found to influence degree attainment for students who began their PSE at either a community college or a 4-year institution. High educational aspirations and academic rigor were influential in degree attainment of students who began at community college, whereas parental education and peers who intended to attend a 4-year institution were significantly linked to the attainment of a bachelor's degree for those who began at a 4-year institution. These findings indicate pre-college characteristics as highly influential in the attainment of an undergraduate degree among Hispanic students.

Ou and Reynolds (2012) identified early determinants of college degree attainment for low socio-economic youth in an urban setting using data from a 20 year longitudinal study conducted in Chicago. The researchers examined early educational factors in order to identify which were associated with positive outcomes of college attendance and degree attainment. Findings indicated that academic performance, parental involvement and expectations, student expectations, and social adjustment as early as elementary school were important factors contributing to the attainment of a bachelor's degree. Related to previous research, Ou and Reynolds surmised socio-demographic factors including race, SES, and parents' education level were not significant factors in the completion of a bachelor's degree. However, these socio-demographic factors were found important in affecting whether or not a student attends college.

In summary, most STEM-related occupations require a bachelor's degree or higher. Academic preparation during high school is not only affecting college enrollment but student chances to earn a bachelor's degree. Research also demonstrates that student aspirations and parental involvement were contributing factors in the attainment of a college degree.

STEM-related careers

Credentialed STEM Field of Study

As students persist through college, the goal is to earn a credential in one's major field of study. Similar to pursuing PSE and declaring a major, high school academic preparation plays a part in credential earning. College experience factors also contribute to obtaining a credential. In regards to completed majors in STEM fields, LeBeau et al. (2012) conducted a study examining high school and college transcripts data and school characteristics of students who completed STEM degrees at one Midwestern university. Their findings indicated that the type of mathematics curriculum program at the high school level, specifically National Science Foundation funded, commercially developed, or the University of Chicago School Mathematics Project was not associated with the completion of a STEM-related degree. More so, this evidence suggested that no particular math curriculum evaluated in the study was more efficient in preparing students for the rigorous coursework associated with completing a STEM degree. Additionally, findings revealed that school specific characteristics such as location or course offerings were not impactful on earning a college degree in STEM. However, several factors were found significant in the credentialing of STEM majors, specifically, high school mathematics GPA and performance on the mathematics portion of the ACT. Similar to previous studies, gender and race were also influential in the completion of a STEM major.

Tyson, Lee, Borman, and Hanson (2007) examined high school mathematics and science courses taking of students who completed STEM degrees at Florida universities. Somewhat contradictory to the findings of LeBeau et al. (2012), these researchers found student enrollment in specific high school math and science courses conducive to the completion of STEM-related degrees. Calculus and Physics courses were principal factors contributing to STEM degree completion. Further analysis including socio-demographic factors revealed surprising results in regards to the racial disparity among STEM baccalaureate degree recipients. Minority students who engaged in the highest level of math and science courses during high school were at least as likely as their White counterparts to obtain a STEM degree.

Expanding the analysis of factors contributing to the attainment of a STEM bachelor’s degree, Maltese and Tai (2011) examined the education experiences of students from middle school through the completion of college using NELS: 88 data. The study examined multiple predictors related to high school interests and course taking as well as college-related factors such as credits attempted, choice of major, and career intention. Interestingly, the models in this study indicated socio-demographic data, specifically race, gender, and SES did not have significant associations with the completion of a STEM degree. However, self-assessment of math or science ability and number of science courses taken were linked to persistence in and earning of a STEM bachelor’s degree. While interest in math and science courses during high school was a high predictor of STEM degree completion, once in college, students who changed their major or failed courses were less likely to complete degrees in STEM fields. Overall, interest in STEM fields early in the pipeline was a good predictor of whether students who persevered through the pipeline would complete a STEM-related bachelor's degree as opposed to completing a non-STEM degree.

In summary, while specific math curriculum during high school may not impact the completion of a STEM degree, it is apparent that specific coursework during high school may be influential in post-secondary participation as well as the persistence necessary to obtain a STEM credential.

STEM Occupations

Post-secondary pathways chosen by students extend far beyond choosing to participate in PSE and selecting a major field of study. Occupational opportunities are directly related to college-going activities, specifically in STEM-related fields that typically require at least a bachelor's degree. Much of the research focusing on STEM occupations revolves around the effects of gender and college major on occupational attainment and outcomes.

Joy (2006) analyzed gender differences in college major and subsequent occupational attainment using data from the National Center for Education Statistics' Baccalaureate and Beyond Longitudinal Study 1993/1994. Although noticeable gender differences existed in specific male-dominated fields such as engineering and computer sciences, the researcher suggested gender occupational segregation into first-jobs out of college was only partially due to gender differences in college major. Joy found that gender inequity persisted in occupations mainly if the college major and occupation were weakly associated. Pursuit of a high paying occupation, favorable work environment, and gender-norm conformity (i.e., feminine or masculine identified fields) may be factors that influence first-job choices. However, the research suggested that the strong relationship between gender and occupation is the result of gender disparities in the selection of college major as seen in specialized fields such as nursing and engineering. Not surprisingly, Joy found science majors more likely to be males and more likely to enter male-dominated occupations, whereas, majors in education or social sciences were predominately females and likely to enter female-dominated occupations. Additionally, factors related to high future earnings and free time increased the likelihood of entering gender-neutral occupations compared to male or female-dominated professions.

Ma's (2011b) research had similarities to Joy's study, suggesting the stratification of college majors influenced the occupational stratification, whereby college majors work as a sorting mechanism to future occupations. Examining the 1990 census and NELS: 1988-1994 data, Ma proposed one's choice of college major was influenced by gender and racial identification within occupational fields, especially science and engineering. This personal identification significantly impacted students' decision to pursue these careers. For instance, of students with the same pre-college attributes (i.e., SES, course-taking patterns), those whose gender-race group was predominant in a technical field, were more likely to select a technical major. Persistent patterns found in female-dominated fields and technical fields support the saying "birds of a feather flock together" (Ma, 2011b, p.115). As a result, policies intended to attract underrepresented groups into science and engineering fields are at odds with the socio-demographic occupational structure; increasing the diversity of students in science and engineering can increase their demographic share in the labor force, because those currently in the STEM labor force significantly influence the ones entering science and engineering.

Melguizo and Wolniak (2011) examined the connection between major field of study and career earnings among minority students. Using data from the Gates Millennium Scholarship (GMS) program, the researchers found higher earnings among GMS graduates with clear congruence of field of study and occupation, and with substantially higher earning premiums for STEM graduates. STEM majors with non-congruent careers (i.e., college major not matched to occupation) still exceeded earning premiums of non-STEM majors with related occupations. Earning differences among minority groups existed within specific majors; African American students who majored in STEM earned less than their Latino or Asian/Pacific Islander counterparts. Interestingly, the specific fields of Biology and Life Sciences yielded higher earnings among African Americans. Not surprisingly, non-STEM major earnings were substantially less than STEM major earnings.

Career outcomes of STEM and non-STEM graduates were examined for 10 years after graduation using data from the Baccalaureate and Beyond Longitudinal Study (Xu, 2013). Xu assessed the influences of economic cost and benefits, and cultural and social capital with college graduates' chosen career path as it related to major field of study. Findings suggested students with higher college GPA in their major field of study and females who graduated at an older age were more likely to pursue careers related to their undergraduate majors. Male STEM graduates had a significantly higher likelihood of maintaining a career related to their college major 10 years after graduation than did females. Furthermore, findings suggested economic benefit of congruent career choices; STEM graduates with congruent careers experienced higher paying jobs than non-STEM graduates or those with non-congruent careers. Academic performance and clear occupational trajectories (e.g. science or engineering compared to sociology) improve employment in major-related occupations.

Orr, Lord, Layton, and Ohland (2014) focused on the career outcomes of Mechanical Engineering (ME) students within the U.S. Although a gender gap existed in ME field of study, females were more likely to persist and graduate with a ME degree than males. Nearly 50% of students who graduated with ME degrees did not declare ME as an initial major. Those who initially declared a ME major were equally likely to graduate or not; and those that left ME were more likely to choose a non-engineering field to complete. Additionally, the researchers found the highest matriculation rates for Asian students and the lowest for Hispanics among the ME students.

Finally, Robst (2007) examined the congruence between credentialed field of study and occupation using the National Survey of College Graduates. Robst identified higher areas of mismatch between education credential and work in the fields of social sciences and liberal arts, suggesting the general skills acquired from these degrees are more universally used in varied occupations. The researcher suggested professions requiring a specific occupational skill set have lower degrees of mismatch. Surprisingly, high prevalence of mismatch was found in Biological sciences and mathematics, specifically for males. However, engineering majors experienced low levels of mismatch finding jobs related to their fields of study. Interestingly, females had low mismatch in engineering and mathematics professions, possibly suggesting females who do persist in the completion of a degree in these fields also persist in finding jobs in the corresponding occupation.

Theoretical Framework

An appropriate theoretical framework for this study is based on Bourdieu's notions of capital (1986) and habitus (1990). Bourdieu suggests that various forms of capital (e.g., economic, cultural, and social) provide the means to access social status and to succeed in the "games of society" (p. 241). All forms of capital are intertwined and individuals who possess more capital increase their opportunities for success in the social world. Academic and social outcomes can be bolstered or hindered based on the amount of capital possessed by an individual that gives one the ability to traverse educational systems (Gaddis, 2013). Accumulation of capital comes from available resources such as family, social status, and material objects. Hence, the educational trajectories taken by those of the dominant culture and the dominated culture are inherently “transmitted from generation to generation legitimizing the circular reproduction of educational hierarchies” (Bourdieu & Passeron, 1990, p.208).

Social capital consists of “the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance and recognition” (Bourdieu, 1986, p. 249). Although social capital is seen as being inherited from family, it also can be obtained through group membership and network connections (Bourdieu, 1986) over one’s life course. Group membership and networks provide access to resources that otherwise may not be accessible, increasing cultural capital (Portes, 1998). Simply stated, social capital is the resource available to individuals as it relates to their position within the social structure (Adler & Kwon, 2002, p. 18); for students, the social structure is the school environment while the resources are the particular courses and activities and networks of which students are participants.

Cultural capital is the possession of knowledge, competencies, or dispositions relative to society’s values placed on social and cultural cues that are passed down by family and are dependent on social status (Dumais, 2002). Bourdieu (1984) posits that cultural capital is the possession of a code allowing individuals the ability to decipher and appreciate the relations and artifacts represented in the dominant culture. As a result of the relationship between cultural capital and social status, Gaddis (2013) suggests that individual’s lack of cultural capital “serves as barrier to upward mobility,” specifically for youth from low SES backgrounds, because the behaviors and characteristics associated with the dominant culture are rewarded in the education system which “translates into higher levels of educational achievement and attainment” (i.e., academic capital) (p. 2). However, the acquisition of cultural capital from exposure to and experience with characteristics of the dominant culture can increase the accumulation of academic capital. “Academic capital is in fact the guaranteed product of the combined effects of cultural transmission by the family and cultural transmission by the school (which depends on the amount of cultural capital directly inherited by the family)” (Bourdieu, 1984, p. 23). Thus, successful accumulation of cultural capital through schooling can directly impact the academic achievement of students by learning the behaviors, standards, and skills of the dominant culture necessary to negotiate their educational experience (Lamont & Lareau, 1988).

In particular, embodied cultural capital is important in education because it is directly related to habitus which is “a system of lasting, transposable dispositions, which, integrating past experiences and actions, functions at every moment as a matrix of perceptions, appreciations and action” (Bourdieu, 1977, p. 82). Since habitus is the “basis of perception and appreciation of all subsequent experiences” (Bourdieu, 1990, p. 54), is thereby linked to one’s ability to increase the level of capital. In Bourdieu’s view habitus is also “a system of internalized structures, schemes of perception, conception, and action common to all members of the same group or class and constituting the precondition for all objectification and apperception” (Bourdieu, 1977, p. 86). As a result, “habitus acquired in the family underlies the structuring of school experiences” and hence the structuring of subsequent experiences (p. 87). Thereby, habitus is the basis to one’s perception of academic ability and how one engages in and acts within the educational system. One’s place in the social structure tends to diversify dispositions associated with learning, academic achievement and investment in education and are related to the amount of cultural capital possessed. Habitus, also entrenched in family and social structure, influences attitudes, aspirations, and motivations of what is or is not possible, permeating one’s sense of value and ability (Gaddis, 2013).

The concepts of social and academic capital, as well as habitus, are appropriate to examine college transition and occupational outcomes of students whose institutional membership includes participation in advanced academics and outreach programs. In simple terms, capital represents the resources available to an individual while habitus embodies one's inclination to utilize those resources. Individuals who belong to the dominant culture have more access to and are more able to accumulate capital because they share common understandings of the world (e.g., dispositions, values and beliefs about education) and embrace similar ways to strategize their actions (e.g., attaining higher levels of education). Students in advanced curriculum programs have higher levels of academic (i.e., knowledge, skills, abilities) and social capital (i.e., family guidance, access to information) and exhibit dispositions toward learning based on belief in one's general academic ability and success. Students in outreach programs are likely to develop cultural (academic) and social capital through schooling needed to negotiate their pathways throughout the education system. Their dispositions may include meeting the expectations associated with their social class such as remaining in their 'place' versus increasing motivation and confidence from acquiring capital to overcome barriers related to their social position. Consequently, this acquisition and enhancement of capital can improve educational outcomes for individuals from the non-dominant culture thus promoting academic achievement and upward mobility (Tramonte & Willms, 2009).

The premise of this study is that in addition to capital acquired within family (e.g., cultural and social capital), school institutions can supply capital through their investment in students by promoting academic achievement and higher educational attainment, for example through attending and graduating from college (Dufur, Parcel, & Troutman, 2013). Students participating in AP and IB come with some level of cultural and social capital, as these students already possess the behaviors and characteristics (habitus) conducive to academic achievement, but continue to acquire capital through teacher and peer interactions and by taking college level coursework. Students participating in outreach programs, such as Upward Bound, Talent Search, and GEAR UP, are acquiring and enhancing existing capital (cultural, social, and academic); the benefits of membership provide knowledge of college and college-going activities through mentoring and college tours. Ultimately, social resources within the school setting are augmented from student's shared personal knowledge that enhance the collective social capital, aiding in the cumulative development of higher academic aspiration and achievement among the group (Caldas, Bankston, & Cain, 2007). The growth of academic and social capital thereby allows students to better maneuver their pathways into post-secondary education and successful completion of programs, and their choice of fields of study and occupations.

Summary

In summary, a review of extant literature related to post-secondary pathways, attainment and occupations focus around three primary points of concern: academic preparation, gender, and race as main individual factors affecting the outcomes. More specifically, STEM-related outcomes appear to rely heavily on the rigor of high school mathematics and science courses. While researchers such as Adelman (2006) posit the importance of academic rigor on post-secondary success, other researchers identify academic rigor as a source of social reproduction (Klugman, 2012), limiting the accessibility of post-secondary success to those of the dominant culture. Post-secondary participation is highly advantaged for those with previous academic success and access to school resources (e.g., advanced coursework) conducive to the transition to PSE. The pursuit of STEM-related outcomes (credentialed FOS and occupation) have been found to be greatly influenced not only by the access to higher level mathematics and science courses in high school but also higher levels of self-assessed ability in those subjects. More so, entrance into STEM fields is reinforced by gender and racial identification with professionals already employed in STEM occupations and experiencing congruence between field of study and occupation.

Although considerable research has been conducted on factors impacting the college-going decision making of students, gaps still remain in the literature, specifically in relation to how college outreach programs and overall advanced curriculum are associated with the successful negotiation of careers along the STEM pipeline. This study extends the current research on post-secondary research and STEM-related outcomes by examining the predictive factor of capital gained from high school program participation at each step of the STEM pipeline from high school graduation to employment 12 years later. In doing so, this study aims to describe how academic and social capital factors operate to affect student success throughout the STEM pipeline.

Chapter 3

Research Method

The purpose of this study is to explore the effect of participation in advanced curriculum and college access programs during high school on post-secondary outcomes (i.e., PSE participation, choice of STEM-related major field of study, attainment) and the likelihood of pursuing STEM-related occupations. The overarching research question is *Does participation in advanced curriculum and college outreach programs encourage high school students to pursue STEM-related career pathways?*

Specifically, this study addresses the following research questions:

a.) What is the relationship between post-secondary pathways (i.e., described in relation to post-secondary education participation and initial choice of major field of study) and high-school program (i.e., enrollment in AP/IB courses or college outreach programs) when controlling for socio-demographic factors (i.e., gender, race, parental education, socio-economic status)?

b.) What is the relationship between level of educational attainment by age 26 and high-school program (i.e., enrollment in AP/IB courses or college outreach programs) when controlling for socio-demographic factors (i.e., gender, race, parental education, socio-economic status)?

c.) What is the relationship between credentialed field of study by age 26 (i.e., whether related or not to STEM) and high-school program (i.e., enrollment in AP/IB courses or college outreach programs) when controlling for socio-demographic factors (i.e., gender, race, parental education, socio-economic status)?

d.) What is the relationship between occupational choices by age 26 (i.e., whether related or not to STEM) and high-school program (i.e., enrollment in AP/IB courses or college outreach programs) when controlling for socio-demographic factors (i.e., gender, race, parental education, socio-economic status)?

Data

ELS: 2002 Data

This quantitative study utilizes data from the Education Longitudinal Study (ELS): 2002, 2004, 2006, and 2012. High school sophomores were surveyed during the base year (2002), and surveys were also administered to their parents, teachers, and school administrators. Sampling consisted of 750 schools and over 16,000 students, producing a nationally representative sample embodying the diversity of the American population by spanning socioeconomic status, region, and race/ethnicity. Survey sampling strategy ensures that ELS: 2002 provides data for a nationally representative sample (see more details in Appendix A).

The first follow-up occurred in 2004, where students were expected to be seniors in high school. The second follow-up survey was administered in 2006 to all base-year and first follow-up participants. In 2006, students may either be in college or part of the workforce. The third follow-up was conducted in 2012, eight years after expected high school graduation. This survey provides data regarding college completion and employment. Additionally, information on marital and family status, community participation, and college transcript history was collected. The ELS database includes information collected from more than 16,000 students, of whom about 11,000 have been surveyed at all 4 times.

Public and Restricted-use Data

NCES provides access to data collected from ELS: 2002 through public-use and restricted-use files. Several variables are suppressed in the public-use files. The restricted-use database also includes additional files that provide detailed information on enrollments, credentials, fields of study, occupations, and transcripts. Some of this information is included in the public file although in a summarized form. Therefore, in order to conduct analysis for this study, the use of restricted data is necessary. Specifically, variables related to educational attainment (i.e., credentialed field of study) and detailed data on occupation (i.e., 6-digit ONET[1] codes) are found only in the restricted-use files. Permission to use ELS: 2002 restricted-use data was granted from the National Center of Educational Statistics in April 2014. In accordance with University research protocol, IRB approval was approved specifically for this dissertation from the University of Texas at Arlington in November 2014 (see Appendix B).

Sample

This current study employs data from the base year, the 2004, 2006, and 2012 follow-ups resulting in the longitudinal research sample with complete information on relevant variables for all times to consist of about N=11,000 respondents. However, since the final focus is to examine occupational attainment in relation to STEM choices, the research sample includes only respondents who reported their occupation in 2012 and who have valid data for all other variables. The selection criterion leads to a sample of N=9921. To preserve the sample size for all analyses, categories of some outcome variables are defined accordingly (e.g., to include PSE non-participants or PSE non-completers).

Research Design

Student Questionnaires

This study is mainly based on the student questionnaires that were administered in the base year (2002) and on each subsequent follow-up surveys (2004, 2006, 2012).

[1] O*NET Occupations are categorized based on the 23 job families included in the Occupational Information Network (O*NET) taxonomy. Additional information available at www.onetonline.org.

The base year questionnaire was divided into seven sections: identification information, experiences in school, future plans, usage of other languages, finances and work, family, and self-beliefs. The school experience section included specific questions related to participation in advanced curriculum coursework and college access programs. The first follow-up more specifically addressed student participation in Talent Search, Upward Bound, or Gear UP programs. While the base year and first follow-up surveys focused on experiences in secondary school, the subsequent surveys focused on post-secondary pathways. The second follow-up survey (2006) extended the focus of the student survey to include post-secondary transitions including college access, choice, and initial major field of study. The third follow-up furthered the extension of post-secondary pathways addressing college graduation, employment, and labor market outcomes.

In addition, this study employed information from the ELS: 2002 restricted-use data file collected during the third follow-up. The credentialed field of study information was obtained from the Institutional Attendance file that includes data on all post-secondary institutions and programs attended by students by 2012. The detailed information on occupations was acquired from the Current Activities and Education restricted data file. The information on field of study and occupation was used to derive single variables assigned to each survey participants that could be linked to the other variables employed in the study through unique student identifiers.

Conceptual Model

ELS: 2002 data allows for the examination of educational and occupational outcomes in relation to high school academic capital. The conceptual model for this study is based on the assumption that high school capital relates to post-secondary pathways (i.e., participation and choice of initial field of study), educational attainment (i.e., degree(s) obtained by 2012), credentialed field of study, and occupational outcomes while controlling for socio-demographic factors (Table 3.1). Since the study is focused on STEM-related educational and occupational outcomes, the categories for field of study and occupation are derived accordingly (e.g., STEM or non-STEM). Although the four type of outcomes (i.e., initial and completed FOS, educational attainment, occupation) are examined separately, I hypothesize they are all shaped by a specific type of academic capital acquired in high school through engagement in advanced curriculum and/or in college outreach programs. And consistent with Bourdieu's assumptions of capital creation within family, the models take into account the effect of student background and demographic characteristics.

Table 3-1 Conceptual Model of Educational and Occupational Outcomes

<table>
<tr><th>Individual Characteristics</th><th>High School Capital</th><th colspan="2">Outcomes</th></tr>
<tr><td>Gender
Race/ethnicity
SES</td><td rowspan="3">High school program
• AP/IB
• College Outreach
• Non-participation</td><td>PSE participation & major FOS (2006)
• Non PSE participation
• PSE participation, no major
• STEM
• Non-STEM</td><td rowspan="3">Occupation by 2012:
• STEM
• Non-STEM</td></tr>
<tr><td rowspan="2">Parental education</td><td>Educational attainment (2012)
• No PSE attendance
• Some PSE
• UNG[1] certificate/diploma/ Associate
• Bachelor or Post-baccalaureate
• Graduate degree</td></tr>
<tr><td>Credentialed field of study (highest degree by 2012)
• Non PSE participation
• No PSE completion/major Unknown
• STEM
• Non-STEM</td></tr>
</table>

[1] Undergraduate certificate/diploma provides students with a focused area of study with less credit requirements than an undergraduate degree.

The design variable of the study, high school capital -- measured by participation in specific high school curriculum and/or outreach programs, is an indicator of academic and social capital acquired by a student. The main assumption of the study is that this specific indicator of high school academic capital is crucial in orientating the student toward pursuing post-secondary education, choosing a major field of study, reaching different levels of educational attainment, and selecting STEM-related occupations. Acquisition and development of capital are factors impacting the college experience and perseverance though the STEM pipeline (Gonzalez, 2012; Shaw & Barbuti, 2010). Socio-demographic factors are included in the model to moderate the association between high school program enrollment and educational and occupational outcomes that represent the dependent variables. Individual characteristics describe the socio-demographic background and include gender, race/ethnicity, SES, and parental education.

Variables

The main dependent or outcome variables for this study are post-school pathway/initial field of study by 2006, educational attainment by 2012, credentialed field of study by 2012, and occupation by 2012. Each dependent variable is categorical and further details are presented below and in Table 3.2.

PSE Pathways and Major Field of Study (2006/2012). In the second follow-up survey (2006) students reported whether they ever attended a post-secondary institution and, if they attended, what was their first major field of study (2006). Field of study is recorded in the data using the six-digit Classification of Instructional Programs (CIP) codes used by colleges and universities. I derived a 4-category variable describing students' initial participation in post-secondary education (i.e., no PSE participation, PSE participation no major FOS) and choice of field of study (i.e., non-STEM or STEM). Major field of study categories provided in the ELS data are aggregated to align with STEM categories identified for occupation. STEM-related FOS includes biological sciences, mathematics/computer/ physical sciences, and engineering. Non-STEM field of study

Table 3-2 Variables and Constructs

Variable/Construct Name	Type	Categories
Socio-demographic characteristics		
Gender (F1SEX)	Categorical 2-category variable	1 = Male 2 = Female
Race/Ethnicity (F1RACE)	Categorical 5-category variable	1 = White 2 = Black/African American 3 = Hispanic 4 = Asian/Hawaii/Pac. Islander 5 = Multiracial, non-Hispanic
SES[1] (F1SES1QU)	Categorical 4-category variable	1 = First quartile (lowest) 2 = Second quartile 3 = Third quartile 4 = Fourth quartile (highest)
Parental education (F1PARED)	Categorical 4-category variable	1= High school/less 2= 2-yr college attend/ complete 3= 4-yr college attend/ complete 4= Graduate degree
High School Academic Capital		
High School Program (BYS33A, BYS33B, BYS33L, F1S24A, F1S24B, F1S24C)	Categorical 3-category variable	1 = AP or IB 2 = Talent Search or Upward Bound or GEAR UP 3 = Non-participant
Outcomes		
Post-secondary pathways /Initial major field of study in 2006 (F2MJR2_P)	Categorical 4-category variable	1 = Never attended PSE 2 = PSE, no major 3= Non-STEM majors 4= STEM majors
Educational attainment in 2012 (F3ATTAINMENT)	Categorical 5-category variable	1 = No PSE attendance 2 = Some PSE, no credential 3 = UNG certified/diploma or Associate degree 4 = Bachelor or Post-baccalaureate 5 = Graduate degree
Credentialed field-of-study in 2012 (F3ICREDFIELD_1)	Categorical 4-category variable	1=Non PSE participant 2=No PSE completion/Unknown 3=STEM 4=Non-STEM
Occupation in 2012 (F3ONET6CURR, 6-digit ONET codes)	Categorical 2-category variable	1 = Non-STEM occupation 2= STEM occupation

[1]SES is a composite variable of family income, mother/father highest education, mother/father occupation.

aggregates all other categories (i.e., social sciences/psychology/legal, health, business/management, education, humanities, other).

Credentialed field of study by 2012 constitutes a 4- category variable in which STEM and non-STEM fields were also created by aggregating corresponding categories using the STEM classifications provided by the 2014 Science and Engineering Indicators (NSF, 2014). Specifically, STEM field of study includes biological, agricultural, and environmental life sciences; computer and mathematical sciences, physical sciences, and engineering. Excluded from this definition are health sciences and other medical-related majors, which are included into the non-STEM category to align with the NSF's (2014) report. In addition, I created categories for those who attended PSE but did not complete college by age 26 or provided missing/unknown information, as well as students who did not attend PSE by age 26.

Educational Attainment. During the third follow-up survey, respondents were asked to report the highest level of degree completed by 2012. Respondent selection of attainment level was recorded as one of the following 10 categories: No HS credential, no PS attendance; HS credential, no PS attendance; Some PS attendance, no PS credential; Undergraduate certificate; Associate degree; Bachelor's degree; Post-Baccalaureate certificate; Master's degree/Post-Master's certificate; Doctoral degree. I derived survey responses into a 5-category variable: No PSE attendance; Some PSE, no credential; UNG certified/diploma or Associate degree; Bachelor's or Post-baccalaureate; Graduate degree.

Occupation. The third follow-up survey includes information on current or most recent job and corresponding occupation using the Occupational Information Network (O*NET) 6-digit classification codes. Categories were aggregated into a 2-category variable (i.e., STEM and non-STEM occupations) as described in Appendix C. For the purpose of the study the STEM occupations are classified to align with the STEM disciplines indicated by O*NET: chemistry, computer science, engineering, environmental science, geosciences, life sciences, mathematics, and physics/astronomy (www.onetonline.com).

Main Independent Variable. Several variables in the data provide information on high school pre-college participation in AP, IB, Talent Search, Upward Bound, or GEAR UP. Participants were asked during the base-year survey "have you ever been in any of the following kinds of programs in high school? Advanced placement, International Baccalaureate, or special programs to help students plan or prepare for college?" College access program enrollment were further investigated using the first follow-up survey: "Talent Search, Upward Bound, and GEAR UP are programs that help economically disadvantaged high school students prepare for entering and succeeding in college. At any time during high school, have you participated in these programs or a similar program? Please mark the school year during which you participated in Talent Search, Upward Bound, or Other [including GEAR UP]?"

First, participation in advanced curriculum or college access programs are coded 1 for participation and 0 for non-participation. Then, I created a unique 3-category variable that describes whether students never participated in any of the advanced or outreach programs, whether they participated in any outreach program, and whether they participated in any advanced curriculum program. If students participated in both outreach and advanced program, they are placed in the advanced program category.

It is important to note that the data contains enough information to derive a more detailed 6-category variable that provides specifics about each program described above, but there is too much program overlap that would complicate unnecessarily the analysis and is outside the scope of this study. Therefore, using a 3-category variable seems to be the best choice.

Control Variables. The conceptual model is based on the assumption that other student characteristics affect the relationship between high school programs and STEM-related educational and occupational outcomes. Therefore, I consider several control variables such as gender, race/ethnicity, socio-economic status and parental education that describe the socio-demographic characteristics of the student. Gender is a 2-category variable (male/female). Race/ethnicity is a 5-category variable: White; Black/African American; Hispanic; Asians/Hawaii/Pacific Islander; Multiracial. The parental education variable is based on the highest level of education attained by at least one parent. For the purpose of this study, I aggregated it as a 4-category variable (high school or less, 2-year college attended/completed, 4-year college attended/completed, graduate degree). Socio-economic status is created in the ELS file as a composite score based on parental education, parental occupation and family income and is reported as quartile date (4-categories from lowest to highest).

Data Analysis

Statistical Package for the Social Sciences software (SPSS Statistics 22) was used to analyze the data.[2] Both descriptive and multivariate analyses are used to address the research questions. Descriptive statistics are performed to describe and classify the data in order to provide an overview of the research sample and explore further associations among variables. For instance, cross-tabulations are employed to assess the bivariate associations between outcome variables and high school program

[2] All analyses are conducted with normalized weights that are computed from the survey weights provided in the ELS data. Normalized weights preserve the counts in the sample but reproduce the proportions in the population.

for all students and within each socio-demographic group. Multivariate statistics (e.g., logistic regressions) are then employed to examine the relative contribution of several variables on outcomes.

Specifically, cross-tabulations and chi-square tests are utilized for this study to assess the significance of association between categorical variables such as outcome variables (e.g., field of study, occupation, educational attainment) and independent variables (e.g., high school program, socio-demographic characteristics) (Gall, Gall, & Borg, 2007). Cross-tabulations present the distribution of data for two categorical variables. The chi-square test of independence allows the researcher to assess differences between the observed values and expected values within each category of the variables. If no differences exist, the two variables are considered independent (no association) which leads to a small chi-square test. On the other hand, when differences do exist between the observed and expected values in the two-way table, the chi-square test is large, and the variables are considered related. A statistically significant relationship between the variables will be considered if the *p* value of the chi-square test is less than .05.

Binary logistic regression allows the researcher to model the likelihood of a dichotomous dependent variable outcomes (e.g., STEM or non-STEM occupation) based on the variables input into the model. “Logistic regression allows for the investigation of the amount of variance in a dichotomous dependent variable that is explained by independent variables while controlling for all other variables in the equation” (Sokatch, 2006, p.133). The results provide estimation of the predictability of the outcome occurring by calculating changes is the log odds of the dependent variable (Menard, 2002). Log odds are presented as odds ratios, and provide information as to how much or less likely an outcome is to occur when each category of an independent variable is compared to its reference category (Tabachnick & Fidell, 2007). In this study, odds ratios will help assess the effect of each independent variable on the occupational outcome (i.e., 2-category variable). For instance, since the reference occupational category is ‘non-STEM occupation’ an odds ratio above one that occurs for a certain category of an independent variable indicates it is more likely for that group to be in a STEM occupation when compared to the corresponding reference category of same independent variable. Multinomial logistic regression, which produces similar results as binary logistic regression, is used when the dependent variable has multiple categories. Table 3.3 presents the research plan for the study and indicates variables and statistical procedures used to answer the four research questions.

Table 3-3 Research Plan

Research Question	Variables	Procedure
RQ1: DV: PSE participation and Major field of study in 2006	<u>Initial Major field of study</u> High School Program Gender Race/Ethnicity SES Parental education	Cross-tabulations & chi-square tests Multinomial logistic regression
RQ2: DV: Educational Attainment in 2012	<u>Educational Attainment</u> High School Program Gender Race/Ethnicity SES Parental education	Cross-tabulations & chi-square tests Multinomial logistic regression
RQ3: DV: Major field of study 2012 credential	<u>Credentialed FOS</u> High School Program Gender Race/Ethnicity SES Parental education	Cross-tabulations & chi-square tests Multinomial logistic regression
RQ4: DV: Occupation in 2012	<u>Occupation</u> High School Program Gender Race/Ethnicity SES Parental education	Cross-tabulations & chi-square tests Binary logistic regression

In order to answer the first three research questions, multinomial logistic regression is used to evaluate the relationship between initial field of study, educational attainment, and credentialed field of study with high school programs when controlling for socio-demographic factors. Multinomial logistic regression is an appropriate analysis to be used with categorical dependent variables with more than two categories. In this case, the variables have 4, 5, and 4 categories, respectively.

To conduct the multivariate analysis for research question four, binary logistic regression is used to assess the relationship between the dependent variable (occupation) and the independent variables of high school advanced academic or college access programs, and all socio-demographic variables. Binary logistic regression is appropriate for this research question because the dependent variable of occupation is dichotomous.

Chapter 4

Findings

This chapter presents the findings of the study. Results were obtained through SPSS data analysis addressing each research question. For each research question that examines relationships between categorical variables, bivariate statistics (i.e., cross-tabulations and chi-square tests) are first used to provide some description of the data and simple tests of associations. Then, multinomial logistic regressions are employed to predict the likelihood of various post-secondary pathways and choice of first field of study, levels of educational attainment, and credentialed field of study by the set of predictors proposed for these models. Finally, binary logistic regression is conducted to determine the likelihood of STEM-related occupations using the same set of predictors. Each regression model is built on the same set of predictors that include high school program and socio-demographic factors such as gender, race/ethnicity, parental education and socio-economic status. Before presenting these specific results, I will provide descriptive statistics of the research sample.

Socio-Demographic Profile of Participants

Utilizing SPSS, a nationally representative sample (N=9,921) was classified into three categories, based on their participation in advanced curriculum (AP/IB) and in college outreach programs. A third category includes students who did not participate in any of these programs during high school. Information on programs is based on both 2002 and 2004 student questionnaires (Appendix D). Table 4.1 presents the counts and percentages of socio-demographic categories within each high school program that can be compared to the marginal percentages for all students in the sample. In the first column, next to the variable name, I also indicate the significance of the chi-square test of association between high school program and each of the socio-demographic factors.

Table 4-1 High School Program by Socio-Demographic Factors (Counts / column %)[a]

Variables	High School Program: Advanced Curriculum	College Outreach	Non-Participant	ALL (%)
Gender (ns)[b]				
Male	910 (46%)	790 (45%)	2980 (48%)	47%
Female	1060 (54%)	950 (55%)	3240 (52%)	53%
Race/Ethnicity (***)[b]				
Asian/Hawaii/Pac. Islander	100 (5%)	80 (5%)	210 (3%)	4%
Black/African American	240 (12%)	380 (22%)	690 (11%)	13%
Hispanic	270 (14%)	260 (15%)	900 (14%)	14%
Multiracial, non-Hispanic	80 (4%)	90 (5%)	250 (4%)	4%
White	1290 (65%)	920 (53%)	4170 (67%)	64%
SES (***)[b]				
First Quartile (lowest)	340 (17%)	440 (25%)	1490 (24%)	23%
Second Quartile	380 (20%)	440 (26%)	1610 (26%)	25%
Third Quartile	530 (27%)	450 (26%)	1570 (25%)	26%
Fourth Quartile (highest)	720 (37%)	400 (23%)	1540 (25%)	27%
Parental Education (***)[b]				
High school or less	370 (19%)	420 (24%)	1740 (28%)	26%
2 yr. coll attended/completed	410 (21%)	450 (26%)	1440 (23%)	23%
4 yr. coll attended/completed	730 (37%)	620 (36%)	2080 (33%)	35%
Graduate degree	460 (24%)	250 (15%)	960 (15%)	17%
ALL	**1,970 (20%)**	**1,730 (17%)**	**6,220 (63%)**	**9,920**

[a] Counts are rounded to the nearest ten. Percentage totals may not equal 100% due to rounding.
[b] Significance of chi-square tests of association between high school program and each socio-demographic factor is presented *p<.05 **p<.01 ***p<.001

High School Program and Gender

The data reveals nearly proportional representation of males and females in both advanced curriculum and college outreach programs with slight overrepresentation by females in both programs (e.g., 54% in advance curriculum and 55% in outreach program as compared to 53% of female students in the sample). Differences are not statistically significant as indicated by the chi-square test of association between gender and high school program participation.

High School Program and Race/Ethnicity

White students constitute almost two thirds of students in the sample and they are mostly program non-participants or enrolled in advanced courses, clearly underrepresented (53%) in the college outreach programs. While participation in advanced curriculum is almost matching the overall racial distribution in the sample, discrepancies are visible in the racial distribution within college outreach program in which Black/African American students are overrepresented as compared to White students. The Hispanic student representation within each category is nearly equal and mimics the ratio of Hispanics within the sample. Overall, there is a statistically significant association between race/ethnicity and high school program participation.

High School Program and Socio-economic Status

As anticipated, student participation in advanced curriculum is overwhelmingly dominated by the highest economic quartile. Meanwhile, the first and second quartile students are visibly underrepresented within the advanced curriculum high school program. As previously mentioned, academic capital is linked to economic status and students involved in advanced curriculum programs already possess capital instilled from family and acquired due to higher social status.

Somewhat surprising is the even representation of students from different socio-economic groups in the college outreach programs and among non-participants, although it is slightly less likely for students in the highest quartile to be among college outreach program participants or among non-participants. It is important to note that contradictory to the design of outreach programs to aid low-income and disadvantaged youth, this student population is nearly equally distributed in this program among the lowest two (51%) and highest two (49%) socio-economic quartiles. Overall, there is a statistically significant association between socio-economic status and high school program participation.

High School Program and Parental Education

While distributions among non-participants and college outreach program participants match quite closely the distribution of parental education categories in the sample, clear discrepancies are noticeable for the advanced curriculum program. Not surprising is the overrepresentation of students from an environment with higher levels of parental education attainment. Only 40% of the students enrolled in advanced curriculum programs during high school have parents with education levels below 4-year post-secondary institutions, whereas they represent 49% in the sample. Meanwhile, about 50% of these students are involved in outreach programs, and 53% are program non-participants. On the contrary, students whose parents have graduate degrees represent 24% of those enrolled in the advanced curriculum program and only 15% among college outreach program and program non-participants. Overall, there is a significant association between parental education and high school program participation.

Research Question 1

> What is the relationship between post-secondary pathways (i.e., described in relation to post-secondary education participation and initial choice of major field of study) and high-school program (i.e., enrollment in AP/IB courses or college outreach programs) when controlling for socio-demographic factors (i.e., gender, race, parental education, socio-economic status)?

Post-Secondary Pathways/Major Field of Study (2006): Bivariate Analysis

Presented in this section are the results from the bivariate analysis to examine whether choices students make after high school in terms of post-secondary participation and selection of initial major field of study (FOS) associates with high school program and socio-demographic factors. For those who pursue post-secondary education, fields of study are formally classified as STEM and non-STEM. In addition, some post-secondary participants did not report any field of study and others did not attend post-secondary education by 2006 (age 20).

Table 4.2 presents the results of this analysis. First, I note that 23% of the sample did not attend post-secondary education by 2006 and 30% attended, but did not report a major field of study because they were either not enrolled anymore or just started or did not know their majors. Additionally, STEM fields of study account for only 8% of the sample with non-STEM FOS accounting for the largest portion of the sample (39%).

High School Program: Important to mention is that 63% of the students did not participate in any high school program, while I notice a nearly equal representation between those who participated in advanced curriculum (20%) and college outreach programs (18%). With the presumption that social and academic capital enhanced through high school program participation would lead to increased PSE participation and choice of STEM fields of study (FOS), one would have expected that these students would be overrepresented in both STEM and non-STEM FOS groups; however only advanced curriculum students are overrepresented in both categories.

In fact, as indicated in Table 4.2, advanced curriculum students account for one-third of the students selecting a STEM field of study even if they represent only 20% of the sample. Conversely, the advanced academic students are distinctly underrepresented among the ‘no PSE’ -- group of those not pursuing post-secondary education.

Table 4-2 Post-secondary Pathway/Initial Field of Study (2006) by High School Program and Socio-demographic Factors (Counts / column %)[a]

	PS Pathway/Initial FOS				ALL (%)
Variables	No PSE	Some PSE, no FOS	Non-STEM	STEM	
High School Capital (***)[b]					
Advanced Curriculum	280 (12%)	570 (19%)	840 (22%)	280 (33%)	20%
Outreach	380 (17%)	530 (18%)	680 (18%)	150 (18%)	18%
Non-participant	1640 (71%)	1850 (63%)	2320 (60%)	410 (49%)	63%
Gender (***)[b]					
Male	1260 (55%)	1430 (48%)	1440 (38%)	550 (66%)	47%
Female	1040 (45%)	1530 (52%)	2400 (62%)	280 (34%)	53%
Race/Ethnicity (***)[b]					
Asian/Hawaii/Pac. Islander	40 (2%)	130(4%)	155 (4%)	60 (7%)	4%
Black/African American	360 (16%)	420(14%)	410 (11%)	120 (15%)	13%
Hispanic	500 (22%)	450(15%)	420 (11%)	70 (9%)	14%
Multiracial, non-Hispanic	150 (6%)	120(4%)	120 (3%)	30 (4%)	4%
White	1250 (54%)	1850(63%)	2730 (71%)	550 (66%)	64%
SES (***)[b]					
First Quartile (lowest)	950(41%)	660(22%)	570 (15%)	90 (11%)	23%
Second Quartile	720(31%)	780(27%)	780 (20%)	160 (19%)	25%
Third Quartile	450(20%)	810(27%)	1100 (29%)	190 (23%)	26%
Fourth Quartile (highest)	190(8%)	710(24%)	1380 (36%)	390 (47%)	27%
Parental Education (***)[b]					
High School or Less	980(43%)	730(25%)	700 (18%)	120 (14%)	26%
2 yr. college attended/completed	600(26%)	760(26%)	800 (21%)	140 (16%)	23%
4 yr. college attended/completed	550(24%)	1060(36%)	1500 (39%)	320 (38%)	35%
Graduate degree	160(7%)	410(14%)	840 (22%)	270 (32%)	17%
ALL	**2300 (23%)**	**2960 (30%)**	**3840 (39%)**	**840 (8%)**	**9920**

[a] Counts are rounded to the nearest ten. Percentage totals may not equal 100% due to rounding

[b] Significance of chi-square tests of association between high school program and each socio-demographic factor is presented *p<.05 **p<.01 ***p<.001

The data reveals that high school outreach program participants are evenly represented among all post-secondary pathway groups. With the intent of outreach programs to increase college access, it is surprising that this group of students is only slightly underrepresented in the ‘no PSE’ group.

Students not participating in any high school program are overrepresented in the ‘no PSE’ category making up close to three-fourths of this group. They are substantially underrepresented among those who selected STEM as their initial field of study (49% compared to 63% in the sample). Overall, there is a significant association between high school program participation and post-secondary pathway/initial FOS.

Gender: Females and males are comparably represented in ‘some PSE, no FOS’, while males are overrepresented and females underrepresented in the ‘no PSE’ group. However, clear differences are evident in the categories of STEM and non-STEM initial field of study. As anticipated is the underrepresentation of females in STEM-related fields of study (34%) compared to male students (66%) relative to the sample of 47% and 53%, respectively. Conversely, findings indicate males are underrepresented in non-STEM FOS. Overall there is a statistically a statistically significant association between gender and post-secondary pathway/initial FOS.

Race/Ethnicity: Multiracial students have nearly equal representation in all PSE participation categories with a slight overrepresentation in the ‘no PSE’ participation group; however, differences are apparent for the other racial groups, specifically in the ‘no PSE’ participation, non-STEM FOS, and STEM FOS categories. Somewhat surprising is the slight overrepresentation of White students (66%) and Black/African American students (15%) within the STEM FOS group compared to the population of 64% and 13%, respectively. Asian students, as anticipated, are highly represented in STEM fields of study, 7% compared to 4% in the sample. On the other hand, underrepresented are

Hispanic students in both STEM and non-STEM fields of study and Black/African American students in non-STEM FOS. While Asian and White students are underrepresented in the ‘no PSE participation’ category, the other racial groups are overrepresented, accounting for nearly half of students who do not participate in PSE. Interestingly, the only group overrepresented in initial non-STEM field of study consists of White students. Overall, there is a statistically significant association between race and post-secondary pathway/initial FOS.

Socio-economic Status: While each socio-economic quartile is nearly equally represented within the sample, noticeable disparities are found in the categories of ‘no PSE’ participation, non-STEM FOS, and STEM FOS. Not surprising is the overrepresentation of students from the highest quartile among those who opted for an initial STEM field of study, accounting for nearly 50% of students compared to only 27% in the sample. Furthermore, students in the first and second SES quartile are largely underrepresented among those choosing an initial STEM field of study, making up together only around 30% of initial STEM majors. While students from the lowest quartile are slightly underrepresented in the category of ‘some PSE no FOS’, they are overwhelmingly overrepresented among the ‘no PSE’ participation group. Important to note, the highest two quartiles are overrepresented in both non-STEM and STEM FOS categories compared to the sample. These results provide confirmation of the connection between SES and post-secondary pathways. Overall, there is a significant association between SES and post-secondary pathway/initial FOS.

Parental Education: As expected, students coming from families with the lowest level of parental education are overrepresented in the ‘no PSE’ participation group and underrepresented among those who declared majors. Nearly 70% of PSE non-participants have parents whose education levels were 2-year college or below, whereas

70% of those choosing STEM majors have parents whose education levels were bachelor's or above, compared to 49% and 52% of the sample, respectively. Furthermore, students with higher educated parents (i.e., 4-year college attended/completed or graduate education) are also overrepresented among the non-STEM field of study group. Although the lowest representation within the sample consists of those students whose parents completed graduate education, these students are overrepresented in STEM-related majors. Meanwhile, the underrepresentation of students with highly educated parents in the 'no PSE' participation group supports the notion that the cultural capital instilled from family may contribute to college pursuit. Overall, there is a statistically significant association between parents' level of education and post-secondary pathway/initial FOS.

Multinomial Regression Results: Post-Secondary Pathway/Major Field of Study Model

The multinomial logistic regression analysis presents the likelihood of pursuing post-secondary education and selecting an initial major field of study (STEM or non-STEM) as compared to being a PSE non-participant in a model that includes high school program participation and a set of socio-demographic variables as predictive factors. Results are shown in terms of odds ratios independently for each variable and are presented in Table 4.3. The odds ratios are calculated for each predictor against specific reference categories such as advanced curriculum program participant, male, White, highest SES, having parents with graduate degrees; characteristics that describe the most advantageous position. The Nagelkerke's R^2 coefficient indicates that 19% of the variance in the outcome is explained by the overall model. Likelihood ratio tests indicate that all variables contribute significantly to the model. The specific effect of each predictor is further discussed.

Table 4-3 Multinomial Logistic Regression Model for PSE Participation/Major Field of Study (no PSE=ref.)

	Odds Ratios		
Variable/categories	PSE, No FOS	Non-STEM	STEM
High school program (Adv curriculum = ref)			
Outreach	.78*	.75**	.51***
Non-participant	.62***	.55***	.31***
Gender (Male=ref)			
Female	1.42***	2.30***	.72***
Race (White=ref)			
Asian/Hawaii/Pac.Isl.	2.47***	2.16***	3.78***
Black/African	.96	.72***	1.16
Hispanic	.87	.66***	.65**
Multiracial, non-Hisp	.57***	.42***	.58**
SES (4th quart=ref)			
3rd Quartile	.46***	.37***	.28***
2nd Quartile	.30***	.18***	.18***
1st Quartile (lowest)	.21***	.11***	.09***
Par educ (Grad=ref)			
4-yr coll compl/attend	1.26	1.04	.76
2-yr coll compl/attend	1.19	.88	.54**
High school or less	.94	.73*	.48***

$^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

High School Program: The most important variable for this study is the high school program participation assumed to build academic and social capital through the enhancement of academic preparedness and college readiness. Compared to advanced curriculum students, both outreach program participants and non-participants in any high school program are at decreased odds of selecting any field of study by 2006, particularly a STEM-related field. While the odds ratios are higher for outreach program participants compared to non-participants, suggesting capital acquired from participation provides a positive contribution in terms of post-secondary participation and choice, distinct differences exist between advanced curriculum and outreach program participants. For instance, participants in outreach programs are about half as likely to select a STEM field of study when compared to the advanced curriculum participants. However, students in outreach programs do have slightly more chances of participating in PSE without selecting a field of study or choosing a non-STEM major. The difference between the odds ratios for outreach and non-participant groups are minimal for the ‘some PSE, no FOS’ category, suggesting capital gained from participation in outreach programs has only little although positive contribution on PSE participation. Selecting a STEM major is definitely related to participation in advanced curriculum during high school regardless of the type of AP courses taken.

Gender: Females, as compared to males, are significantly more likely to enter college with either a non-STEM field of study or no field of study. For instance, females are more than twice as likely as males to select an initial major in a non-STEM field rather than be a PSE non-participant. On the contrary, females are significantly less likely to select a STEM-related major. Overall, females are more likely than males to select a field of study not related to STEM rather than be a PSE non-participant.

Race/Ethnicity: Compared to White students, Asian students are not only more likely to participate in PSE, but these students are also significantly more likely to select either a non-STEM or STEM-related major. As indicated in Table 4.3, Asian students are approximately four times as likely to select an initial STEM-related field of study as opposed to be a PSE non-participant. Compared to White students, Black/African American students are insignificantly more likely to pursue a STEM-related FOS. Hispanic students, on the other hand, are about one-third less likely to major in either a non-STEM or STEM-related field as they are to be PSE non-participants, while Multiracial students are nearly half as likely to select a non-STEM or STEM-related major. Nonetheless, racial differences are less pronounced in the model for Black/African American and Hispanic students in the category of ‘some PSE, no FOS’. Overall, being either a White or Asian student increases the likelihood of pursuing post-secondary education and selecting either a STEM-related or non-STEM field of study.

Socio-economic status: Compared to the highest economic quartile, students in the lower three quartiles are significantly less likely to major in either a STEM or non-STEM field of study. For the lowest SES quartiles, odds ratios are decreasing gradually when comparing ‘some PSE, no FOS’, non-STEM and STEM-related fields of study to ‘no PSE’ participation. For instance, students in the third SES quartile are about half as likely to participate in ‘some PSE with no FOS’ versus being non-participants as compared to students in the highest SES quartile, and are even less likely to select a STEM or non-STEM field of study. Students with the lowest SES backgrounds have odds ratios revealing a significantly diminished likelihood of selecting a STEM or non-STEM field of study when compared with students from the highest SES level. Overall, socio-economic status differences are highly pronounced and being from the highest SES level has significant advantages in not only attending PSE but declaring a major field of study, particularly in a STEM discipline.

Parental Education: While the effects of parent education on PSE participation and choice of major field of study is less pronounced in the model as indicated by odds ratios that are not statistically significant, level of parental education is significant in the decreased likelihood of pursuing a STEM major by those whose parent attended a 2-year college or less. Compared to students whose parents attended graduate school, students whose parents’ education is below the graduate school level have a decreased likelihood of pursuing a STEM-related major field of study. However, students whose parents attended a 4-year college have comparable odds of pursuing PSE without declaring a major as they do for declaring a non-STEM field of study. When compared to PSE non-participants, students whose parents attended at least a 2-year college have a higher likelihood of PSE participation, but do not to choose an initial STEM-related major. Overall, selecting a STEM major field of study is associated with students whose parents attained the highest levels of education.

Research Question 1: Summary of Findings

In summary, the results of these analyses indicate a relationship between high school program participation and post-secondary pathway/initial field of study. While outreach program participants are advantaged over high school program non-participants with respect to PSE participation, and choice of non-STEM FOS and STEM-related FOS, the advantage obtained from participating in an outreach program is negligible compared to the advanced academic students, specifically in pursuing an initial STEM-related field of study. Advanced academic students have a significantly increased likelihood of PSE participation and of selecting a STEM-related field of study compared to other high school program groups.

The analysis also shows a relationship between socio-demographic factors and PSE participation/initial major field of study. Specifically, the data shows that students who are male, Asian, from the highest economic quartile, and have parents with a graduate degree are overrepresented in PSE, particularly in a STEM-related field of study. On the contrary, students underrepresented in a STEM-related field of study are more likely to be females, Hispanic students, those from the lowest SES, and those whose parents had lower levels of education. These findings are also supported by the multinomial logistic model.

Research Question 2

What is the relationship between level of educational attainment by age 26 and high-school program (i.e., enrollment in AP/IB courses or college outreach programs) when controlling for socio-demographic factors (i.e., gender, race, parental education, socio-economic status)?

PSE Attainment: Bivariate Analysis

Presented in this section are the results from the bivariate analysis to investigate whether post-secondary educational attainment by year 2012 associates with high school program and socio-demographic factors. The cross-tabulations are presented in Table 4.4. PSE participation and educational attainment by year 2012 includes five categories organized by degree level (i.e., associate, bachelors, graduate). Additionally, some respondents did not attend PSE while others attended but failed to earn any credential (by 2012).

High School Program: Based on the main assumption of this study that possession of social and academic capital associates with post-secondary education access and higher levels of educational attainment, it is expected to see advanced curriculum participants overrepresented in the college attainment categories (i.e., bachelor and graduate degrees). In fact, as indicated in table 4.4, advanced curriculum participants account only for 20% of the sample but are overwhelmingly represented among the bachelor's (26%) and graduate (34%) degree completion groups. On the contrary, the advanced curriculum students are underrepresented in the 'no PSE' participation (12%), 'PSE/no credential' completed by 2012 (17%), or Associate degree level (15%) groups. Non-participants in any of the high school programs, on the other hand, are overrepresented in each of these categories making up nearly two-thirds or more of each attainment group of 'no PSE' participation, no credential completed, and Associate degree level.

Table 4-4 Level of PSE Attainment by Socio-Demographic and Group Participation (Counts / column %)[a]

	PSE Attainment					ALL (%)
Variables	No PSE	Some PS, no credential	UNG cert./dipl. & Assoc. deg.	Bachelor & Post-bacc	Graduate degree	
High School Capital (***)[b]						
Advanced Curriculum	150 (12%)	510 (17%)	290 (15%)	760 (26%)	260 (34%)	20%
Outreach	160 (13%)	560 (18%)	380 (20%)	520 (17%)	110 (15%)	18%
Non-participant	900 (75%)	2020 (65%)	1230 (65%)	1690 (57%)	390 (51%)	63%
Gender (***)[b]						
Male	730 (60%)	1530 (50%)	790 (40%)	1360 (46%)	270 (36%)	47%
Female	480 (40%)	1560 (50%)	1100 (58%)	1620 (54%)	490 (64%)	53%
Race/Ethnicity (***)[b]						
Asian/Hawaii/Pac. Islander	20 (2%)	100 (3%)	60 (3%)	160 (5%)	50 (6%)	4%
Black/African American	180 (15%)	520 (17%)	300 (16%)	250 (8%)	60 (7%)	13%
Hispanic	250 (20%)	540 (18%)	330 (17%)	270 (9%)	50 (7%)	14%
Multiracial, non-Hispanic	70 (6%)	140 (5%)	80 (4%)	100 (3%)	30 (4%)	4%
White	680 (57%)	1790 (58%)	1130 (59%)	2200 (74%)	580 (76%)	64%
SES (***)[b]						
First Quartile (lowest)	550 (46%)	820 (27%)	520 (28%)	320 (11%)	60 (8%)	23%
Second Quartile	390 (33%)	860 (28%)	550 (29%)	530 (18%)	110 (14%)	25%
Third Quartile	190 (16%)	820 (26%)	520 (28%)	840 (28%)	180 (24%)	26%
Fourth Quartile (highest)	70 (6%)	600 (19%)	310 (16%)	1280 (43%)	420 (55%)	27%
Parental Education (***)[b]						
High school or less	580 (49%)	850 (27%)	600 (32%)	420 (14%)	80 (11%)	26%
2 yr. coll attended/completed	310 (26%)	790 (26%)	520 (28%)	550 (19%)	120 (15%)	23%
4 yr. coll attended/completed	240 (20%)	1100 (36%)	580 (30%)	1220 (41%)	290 (38%)	35%
Graduate degree	70 (6%)	360 (12%)	200 (10%)	780 (26%)	270 (36%)	17%
ALL	**1200 (12%)**	**3090 (31%)**	**1890 (19%)**	**2970 (30%)**	**760 (8%)**	**9920**

[a] Counts are rounded to the nearest ten. Percentage totals may not equal 100% due to rounding.

[b] Significance of chi-square tests of association between high school program and each socio-demographic factor is presented *p<.05 **p<.01 ***p<.001

The data reveals nearly equal representation of the high school outreach program participants within each educational attainment group, comparable also with their representation in the sample. It is important to notice that among PSE non-participants, only 25% of them are comprised of students who reported participation in either advanced curriculum or outreach programs during high school. Although increased post-secondary access appears to be a positive outcome of high school programs participation, there are apparent differences between the two programs in relation to levels of educational attainment. Overall, there is a significant association between high school program and PSE attainment.

Gender: Females and males are quite proportionally represented in ‘some PSE/no credential’, Associate degree and bachelor degree groups, with a negligible overrepresentation of females at both levels of completed degrees. Somewhat surprising is the overrepresentation of females (64%) with graduate degrees compared to male students (36%) relative to the distribution in the population of 53% and 47%, respectively. Not unexpected is the finding of males being overrepresented in the ‘no PSE’ participation group. Overall, there is a significant association between gender and PSE attainment.

Race/Ethnicity: While multiracial students match the overall racial distribution in the sample for each attainment level with slight overrepresentation in the ‘no PSE’ participation and ‘PSE/no credential’ categories, discrepancies among the other non-White groups are apparent. Black/African American and Hispanic students account for more than one-quarter of the sample, they are overrepresented among the PSE non-participants, ‘PSE/no credential’, or recipients of an Associate level degree, and are overly underrepresented in the bachelor and graduate degree attainment groups. On the contrary, White students constitute nearly two-thirds of the sample and mostly make up degree attainment at the bachelor and graduate level while they are underrepresented in the ‘no PSE,’ ‘PSE/no credential,’ and Associate groups. Asian students mirror representation in each category to that of White students, with higher overrepresentation among bachelor and graduate degree recipients. Overall, there is a significant association between race and PSE attainment.

Socio-economic Status: As expected, higher levels of degree attainment are exceedingly overrepresented by students belonging to the highest economic quartile. Moreover, students in the first and second quartile are pointedly underrepresented in the bachelor or graduate degree groups. These results provide evidence to the link between SES and higher levels of educational attainment, which in the long term leads to the acquisition of various forms of capital (i.e., academic, human, social, economic capital). Somewhat surprising is the nearly equal representation of third quartile students in the attainment of ‘PSE/no credential, associate and bachelor’s degree. Overall, there is a significant association between SES and PSE attainment.

Parental Education: The distributions of levels of parental education closely match the distribution in the sample for two educational attainment categories: ‘PSE/no credential’ and Associate level degree. However, considerable differences are apparent at the attainment levels of ‘no PSE’ participation, bachelor, and graduate degrees. Nearly 75% of PSE non-participants have parents whose education levels were at 2-year college or below, whereas these students represent only 49% of the sample. Furthermore, the two highest levels of parental education (i.e., 4-year college attended/completed and graduate education) represent 52% of the sample, but they comprise 67% of students’ bachelor degree attainment and 74% of graduate degrees. Overall, there is a significant association between parents’ education and their children’s PSE attainment.

Multinomial Regression Results: Post-Secondary Education Attainment Model

The multinomial logistic regression analysis provides the likelihood of attaining different levels of post-secondary education attainment as compared to being a PSE non-participant in a model that includes high school program participation and a set of socio-demographic variables as predictive factors. Results are presented in Table 4.5 in terms of odds ratios independently for each variable. The odds ratio are calculated for each predictor against reference categories, specifically, advanced curriculum, male, White, highest SES, and graduate level of parental education. The Nagelkerke's R^2 coefficient shows that 22% of the variance in the outcome is explained by the overall model. The effect of each variable is further presented.

Table 4-5 Multinomial Logistic Regression Model for PSE Level of Attainment (no PSE=ref.)

	Odds Ratios			
Variables/categories	Some PSE, No credential	UNG cert./dipl. /Assoc. deg	Bachelor & Post-bacc. deg	Graduate degree
High school program (Adv curriculum=ref)				
Outreach	1.09	1.27	81	.57**
Non-participant	.72**	.76*	.43***	.30***
Gender (Male=ref)				
Female	1.72***	2.33***	2.26***	3.56***
Race (White=ref)				
Asian/Hawaii/Pac.Isl	2.21***	2.26**	3.32***	3.81***
Black/African	1.26*	1.16	.60***	.58**
Hispanic	.1.22*	1.15	.68***	.55**
Multiracial, non-Hisp	.78	.67*	.49***	.55*
SES (4th quart=ref)		.		
3rd Quartile	.43***	49***	.25***	.18***
2nd Quartile	.24***	.25***	.09***	.06***
1st Quartile (lowest)	.18***	.16***	.05***	.03***
Par educ (Grad=ref)				
4-yr coll compl/attend	1.55*	1.41	1.13	.90
2-yr coll compl/attend	1.24	1.44	.84	.69
High school or less	.90	1.18	.62*	.50**
*p < 0.05; **p < 0.01; ***p < 0.001.				

High School Program: Compared to advanced curriculum participants, outreach program participants and especially non-participants in any high school program are at decreased odds in attainment of a bachelor or graduate degree. With outreach programs intended to increase college access and success, the fact the odds ratios for this group are higher compared to non-participants suggests that participation in the program does provide some positive PSE outcomes. However, clear differences exist between advanced curriculum and outreach program participants. Specifically, participants in outreach programs are only about half as likely to earn a graduate degree when compared to the advanced curriculum group. Students in outreach programs do have an increased likelihood to participate in PSE without earning a credential or earn a credential at the Associate degree level, although these odds ratios are not statistically significant. Meanwhile, non-participants in any high school program are at clear disadvantage at attending and especially completing post-secondary education degrees.

Gender: Females, compared to males, are significantly more likely to attend a post-secondary institution and earn some form of credentials. Specifically, females are nearly three and a half times more likely to complete a graduate degree, over twice as likely to earn a bachelor's degree or Associate level credential as opposed to being a PSE non-participant. While females were found to be less likely to pursue STEM-related majors (as indicated in Table 4.3), they were found to be significantly more likely to earn higher levels of PSE attainment. Overall, females were more likely than males to attend a post-secondary institution regardless of level of attainment rather than be a non-participant.

Race/Ethnicity: Not only are Asian students more likely to pursue majors in STEM-related fields (as indicated in Table 4.3), but this group of students is also significantly more likely to obtain higher degrees compared to White students. For instance, as compared to White students, Asian students are nearly four times more likely to earn a graduate degree rather than not participate in post-secondary education. On the contrary, compared to White students, Black/African American, Hispanic, and Multiracial students are nearly half as likely to earn a graduate degree as they are to be PSE non-participants. Overall, minority students are overrepresented in lower levels of PSE attainment: ‘some PSE, no credential’ or Associate level degree.

Socio-Economic Status: Similar to the findings on post-secondary participation and initial major field of study, students from the lowest economic quartiles are significantly less likely to earn any educational credential or even participate in PSE compared to students from the highest economic quartile. As indicated by the odds ratios in Table 4.5, when compared to PSE non-participants, being in the second highest economic quartile already decreases the likelihood of obtaining any PSE degree. In fact, students from the third quartile were less than 75% as likely to earn a bachelor or graduate degree. The lowest SES students have odds ratios that indicate a much reduced likelihood of earning a bachelor’s or graduate degree when compared to the highest SES students. Earning a post-secondary credential is certainly related to socio-economic status.

Parental Education: The effect of parental education is less prominent in the model as many of the odds ratios are not statistically significant. However, students whose parents attended at least 2 years of college have comparable odds of attending post-secondary school or earning a certificate, diploma, or associate’s degree, and even 4-year college degrees. Parental education effect was significant only in the low likelihood of earning bachelor’s and graduate degrees for students whose parents had a high school diploma or less. The effect of parental education on student educational attainment by 2012 is not as explicit as the effects of other predictors.

Research Question 2: Summary of Findings

In summary, as evident by these analyses, levels of PSE attainment and high school program participation are related. Outreach program participants do not nearly gain advantage for increased levels of attainment similar to the advanced curriculum students, specifically in obtaining graduate degrees, however, outreach program students do have increased chances of participating and earning post-secondary credentials compared to those who did not participate in any specific high school program. The latter group shows quite low likelihood to attain 4-year college level degrees.

Analysis also shows relationships between socio-demographic factors and educational attainment. For instance, the data reveals that students of minority status (except Asians), those with the lowest socio-economic status, and having parents with the lowest levels of education are overrepresented (and more likely) to belong to the 'no PSE' participation, 'PSE/no credential,' and Associate degree attainment categories. Conversely, students overrepresented in the highest levels of attainment (i.e., bachelor's, graduate) are females, White or Asian, from the highest SES quartiles, and have parents with graduate degrees.

Research Question 3

> What is the relationship between credentialed field of study by age 26 (i.e., whether related or not to STEM) and high school program (i.e., enrollment in AP/IB courses or college outreach programs) when controlling for socio-demographic factors (i.e., gender, race, parental education, socio-economic status)?

Credentialed Field of Study (2012): Bivariate Analysis

I present in this section bivariate analysis results that show whether credentialed field of study by year 2012 relates to high school program and socio-demographic factors. The cross-tabulations are presented in Table 4.6. PSE participation and credentialed field of study by year 2012 includes four categories. Credentialed field of study is aggregated into STEM and non-STEM degrees. Furthermore, some students were not post-secondary participants (by 2012) or did not complete PSE or report a credentialed field of study.

High School Program: The assumption of this study was that the possession of academic and social capital (through participation in specific high school programs) promotes not only higher post-secondary education attainment but also completion of STEM-related degrees. Therefore, I expect that advanced curriculum participants will be overrepresented in non-STEM and especially in STEM-related credentialed field of studies.

As indicated in Table 4.6, advanced curriculum participants are overrepresented among those who obtained STEM degrees (32%) while only accounting for 20% of the sample. Conversely, advanced curriculum students are underrepresented among PSE non-participants and those who did not complete PSE or did not report a field of study. Students who did not participate in any high school program are overrepresented in each of these categories, making up three-quarters of these two groups. Furthermore, non-participants in any of the high schools programs are underrepresented among those who completed PSE degrees in either a STEM or non-STEM field of study. The data reveals almost equal representation of outreach program participants in all PSE credential categories, similar to their representation within the sample.

Noteworthy, only 12% of advanced curriculum students and 13% of outreach program participants did not participate in post-secondary, whereas 75% of non-participants in high school programs did not attend PSE by the year 2012. These results suggest the enhanced academic and social capital acquired through high school program

Table 4-6 Credentialed Field of Study by Socio-Demographic and HS Program Participation (Counts / column %)[a]

	Credentialed FOS				ALL (%)
Variables	No PSE	No PSE completion/ Unknown FOS	Non-STEM Degree	STEM Degree	
High School Capital (***)[b]					
Advanced Curriculum	150 (12%)	530 (17%)	1080 (22%)	220 (32%)	20%
Outreach	160 (13%)	580 (18%)	880 (18%)	110 (17%)	18%
Non-participant	900 (75%)	2100 (65%)	2880 (60%)	340 (51%)	63%
Gender (***)[b]					
Male	730 (60%)	1600 (50%)	1880 (39%)	470 (69%)	47%
Female	480 (40%)	1610 (50%)	2950 (61%)	210 (31%)	53%
Race/Ethnicity (***)[b]					
Asian/Hawaii/Pac. Islander	20 (2%)	100 (3%)	210 (4%)	50 (7%)	4%
Black/African American	180 (15%)	530 (17%)	530 (11%)	60 (9%)	13%
Hispanic	250 (20%)	560 (18%)	570 (12%)	60 (9%)	14%
Multiracial, non-Hispanic	70 (6%)	140 (5%)	170 (4%)	20 (3%)	4%
White	680 (57%)	1870 (58%)	3350 (69%)	480 (72%)	64%
SES (***)[b]					
First Quartile (lowest)	550 (46%)	860 (27%)	790 (16%)	70 (11%)	23%
Second Quartile	390 (33%)	900 (28%)	1030 (22%)	120 (18%)	25%
Third Quartile	190 (16%)	840 (26%)	1340 (28%)	170 (26%)	26%
Fourth Quartile (highest)	70 (6%)	610 (19%)	1670 (35%)	310 (46%)	27%
Parental Education (***)[b]					
High school or less	580 (49%)	890 (28%)	970 (20%)	90 (14%)	26%
2 yr. coll attended/completed	310 (26%)	830 (26%)	1030 (21%)	120 (18%)	23%
4 yr. coll attended/completed	240 (20%)	1130 (35%)	1800 (37%)	250 (38%)	35%
Graduate degree	70 (6%)	360 (11%)	1040 (22%)	200 (30%)	17%
ALL	**1200 (12%)**	**3210 (32%)**	**4830 (49%)**	**670 (7%)**	**9,920**

[a] Counts are rounded to the nearest ten. Percentage totals may not equal 100% due to rounding.
[b] Significance of chi-square tests of association between high school program and each socio-demographic factor is presented *p<.05 **p<.01 ***p<.001

participation may, in fact, provide the means necessary to access and persist through PSE to earn a post-secondary credential. Academic and social capital, whether existing or acquired through high school program participation, leads to increased degree completion compared to program non-participants, although there are substantial differences between the two programs in relation to earning a STEM-related credential. Overall, there is a significant association between high school program and credentialed FOS by 2012.

Gender: Not surprisingly, female and male students are inversely represented with respect to the completion of STEM or non-STEM degrees. Males are overwhelmingly represented in STEM (69%) and underrepresented in non-STEM fields of study (39%); whereas, females are underrepresented in STEM (31%) and overrepresented in non-STEM fields of study (61%). In addition, females are less likely to be PSE non-participants while males are more likely to be PSE non-participants. Overall, there is a significant association between gender and credentialed FOS.

Race/Ethnicity: While all racial groups closely match the distribution in the sample with respect to obtaining a non-STEM credential, differences exist within all other groups. Black/African American, Hispanic, and Multiracial students are each underrepresented in the completion of STEM degrees and are overrepresented in the ‘no PSE’ and ‘no PSE completion/Unknown FOS’ categories. While Asian students only comprise 4% of the sample, they are clearly overrepresented in STEM degree completion category (7%), With White students consisting of about two-thirds of the sample, it is not surprising that this group also makes up most of the earned credentials, accounting for nearly three-quarters of those who obtained credentialed STEM degrees and just over two-thirds of non-STEM recipients. Overall there is significant association between race and credentialed FOS.

Socio-economic Status: While the overall economic distribution of the sample is relatively equal for all four quartiles, it is not surprising that students belonging to the lowest two economic quartiles are overly underrepresented in the completion of non-STEM and STEM-related degrees, but are overrepresented among the PSE non-participants. Although students from the third economic quartile are nearly equally represented for each credentialed field of study, not surprisingly, students from the highest quartile are overrepresented in both STEM and non-STEM fields of study compared to all other economic groups. In fact, as indicated in Table 4.6, students belonging to the highest economic quartile account for almost 50% of those who obtained credentialed STEM degrees. These results provide further evidence of the association between SES and post-secondary success in the form of a college degree, particularly in STEM fields.

Parental Education: As expected, students whose parents completed their education at the minimum level (high school or less) are less likely to complete PSE and obtain a STEM-related degree. Furthermore, students with parents whose education levels were at 2-year colleges are also underrepresented among those with STEM degrees. Meanwhile, students whose parents attended or completed 4-year college are equally represented among those who attended or completed PSE regardless of their major FOS. The only noticeable result in terms of achievement of STEM-related degrees is for students whose parents have graduate education who are overwhelmingly represented in this category (30%) compared to their representation in the sample (17%). Overall there is a significant association between parental education and credentialed field of study.

Multinomial Regression Results: Credentialed Field of Study (2012) Model

The multinomial logistic regression analysis presents the likelihood of earning a credential in a specified field of study (i.e., non-STEM, STEM) as compared to being a PSE non-participant in a model that includes high school program and a set of socio-demographic variables as predictive factors. The results are presented in Table 4.7 in terms of odds ratios. The odds ratios are calculated for each predictor against a specific reference category. The Nagelkerke R^2 of .18 indicates that 18% of the variability in the outcome is explained by the overall model. Likelihood ratio tests indicate that all variables contribute significantly to this model.

Table 4-7 Multinomial Logistic Regression Model for Credentialed Field of Study, 2012 (no PSE=ref.)

	Odds Ratios		
Variables/categories	No PSE completion/ Unknown FOS	Non-STEM degree	STEM degree
High school program (Adv curriculum=ref)			
Outreach	1.10	.98	.66*
Non-participant	.74**	.54***	.33***
Gender (Male=ref)			
Female	1.68***	2.79***	.81*
Race (White=ref)			
Asian/Hawaii/Pac.Isl	2.21**	2.70***	4.31***
Black/African	1.27*	.83	.70*
Hispanic	1.23*	.87	.73
Multiracial, non-Hisp	.78	.56***	.54*
SES (4th quart=ref)			
3rd Quartile	.42***	.28***	.23***
2nd Quartile	.24***	.12***	.10***
1st Quartile (lowest)	.17***	.07***	.05***
Par educ (Grad=ref)			
4-yr coll compl/attend	1.59**	1.17	.99
2-yr coll compl/attend	1.30	.99	.80
High school or less	.84	.78	.62*
$*p < 0.05$; $**p < 0.01$; $***p < 0.001$.			

High School Program: As indicated by the odds ratios in Table 4.7, outreach program participants and non-participants are at decreased odds of earning a credential in a STEM-related field of study. For instance, advanced curriculum participants are nearly 3 times more likely than non-participants and 1.5 times more likely than outreach program participants to complete a degree in a STEM-related field of study. These results provide evidence that academic capital associated with rigorous high school coursework is related to an increased likelihood of completing education in a STEM field of study. In addition, the increased odds of outreach participants when compared to non-participants in the completion of a STEM-related degree suggests some academic benefit is associated with outreach program participation during high school. Meanwhile, outreach program participants are as likely as advanced curriculum participants to complete a non-STEM degree or to attend some PSE.

Overall, student participation in any high school program increases the likelihood of completing a STEM or non-STEM degree, or at least obtaining some post-secondary education by 2012 when compared to non-participation in high school programs. However, it is apparent that participation in advanced curriculum is more strongly related to the completion of STEM-related degrees than participation in outreach programs.

Gender: Females, compared to males, are significantly more likely to earn a credential in a non-STEM field of study or even be non-completer rather than being non-participant in PSE. As the odds ratios indicate in Table 4.7, females are nearly three times more likely as males to complete a non-STEM credential but are about 1.25 times less likely to earn a STEM-related credential. While females were found to reach higher levels of PSE attainment compared to males, they are less likely to declare an initial STEM-related field of study and subsequently, less likely to earn a STEM credential. Gender is a distinct factor affecting the pursuit and completion of STEM degrees.

Race/Ethnicity: Similar to previous findings related to initial field of study, Asian students have a significantly higher likelihood of earning a credential in a STEM-related field of study. Specifically, as compared to White students, Asian students are over four times more likely to complete a STEM-related degree than be a PSE non-participant and at least twice as likely to earn a credential in a non-STEM major or be a PSE non-con-completer/Unknown field of study. Furthermore, compared to White students, Black/African American and Hispanic students are at decreased odds of earning either a STEM-related or non-STEM credential. For instance, these two groups of students are nearly 1.5 times less likely to complete a STEM-related degree. Multiracial students are nearly half as likely as White students to complete either a STEM-related or non-STEM degree, as opposed to be a PSE non-participant. Black/African American and Hispanic students are less likely to obtain STEM-related degrees and more likely to be PSE non-completers by 2012.

Socio-economic Status: As with each previous model in this study, SES is found to be a highly significant predictor of educational outcomes. Similar to the findings on post-secondary education participation and choice of initial field of study, students from the highest economic quartile are significantly more likely to earn a STEM-related credential. As indicated by the odds ratios in Table 4.7, when compared to PSE non-participants, even being in the second highest quartile already significantly lessens the likelihood of earning any credential. Specifically students in the third quartile are less than 70% as likely to earn a non-STEM or STEM-related credential. Compared with students from the highest quartile, students in the lowest quartile are at much reduced odds to earn a credential in either a non-STEM or STEM-related field of study, or even to be a PSE non-completer as compared to being PSE non-participants. As the model suggests, socio-economic status is a significant predictor of credentialed fields of study.

Parental Education: The effect of parents' education is less pronounced in this model predicting the likelihood of earning PSE credentials, as most of the odds ratios are not statistically significant. While students whose parents attended a 4-year or 2-year college could be more likely than those whose parents have graduate education to be PSE non-completer or have unknown FOS, there is no significant difference in the likelihood to obtain a STEM-related or non-STEM degree among these three groups. Students whose parental education is high school or less are nearly half as likely to complete a STEM-related degree. I can conclude that parental education is not highly relevant to credentialed field of study.

Research Question 3: Summary of Findings

In summary, the results of this section demonstrate a relationship between credentialed field of study and high school program. Students who participated in advanced curriculum are more likely to complete a STEM-related degree and in general, they are more likely to complete degrees in any field of study. While outreach program participants may not experience any visible advantage in earning a STEM degree, they are still at some advantage compared to high school program non-participants.

In addition, the analysis also indicates a relationship between socio-demographic factors and credentialed field of study. Specifically, the data suggests a socio-demographic profile of a credentialed STEM recipients as being male, White or Asian, belonging to the highest SES, and having parents with graduate level education. Whereas, non-STEM degree recipients are more likely to be female, White, from the top two economic quartiles, and having parents who attended either a 4-year college or graduate school.

Research Question 4

What is the relationship between occupational choices by age 26 (i.e., whether related or not to STEM) and high-school program (i.e., enrollment in AP/IB courses or college outreach programs) when controlling for socio-demographic factors (i.e., gender, race, parental education, socio-economic status)?

Occupational Outcomes (2012): Bivariate Analysis

This section presents the results from the bivariate analysis that investigates whether occupational outcomes by year 2012 associate with high school program and socio-demographic factors. Occupational outcomes of students who reported employment information in 2012 were classified into two categories: STEM- related and non-STEM occupations, as detailed in Appendix C. I will further discuss the cross-tabulations results presented in Table 4.8.

High School Program: First, I notice that advanced curriculum students who only account for one-fifth of the sample, make up close to one-third of those employed in a STEM occupation. While outreach program participants are narrowly underrepresented in STEM-related occupations, both advanced curriculum and outreach program participants are closely represented in non-STEM occupations. The data also reveals that non-participants in high school programs are underrepresented in STEM-related occupations. These findings are not surprising when related to the previous models of initial and credentialed field of study that show that advanced curriculum students are clearly overrepresented in the STEM-related fields. Outreach program participants, on the other hand, are slightly underrepresented in the STEM initial field of study, STEM credential, and STEM-related occupations, although proportions are matching the representation in the sample. Therefore, it appears that advanced curriculum and outreach program participants persevere more than non-participants throughout the STEM pipeline. Overall, there is a significant association between high school program participation and occupational outcome.

Table 4-8 Socio-Demographic Data by Occupation (Counts / column %)[a]

	Occupation		ALL (%)
Variables	Non-STEM	STEM	
High School Capital (***)[b]			
Advanced Curriculum	1820 (19%)	160 (29%)	20%
Outreach	1650 (18%)	80 (16%)	18%
Non-participant	5920 (63%)	290 (55%)	63%
Gender (***)[b]			
Male	4280 (46%)	400 (75%)	47%
Female	5110 (54%)	140 (25%)	53%
Race/Ethnicity (***)[b]			
Asian/Hawaii/Pac. Islander	350 (4%)	30 (6%)	4%
Black/African American	1270 (14%)	40 (7%)	13%
Hispanic	1390 (15%)	40 (8%)	14%
Multiracial, non-Hispanic	400 (4%)	20 (4%)	4%
White	5980 (64%)	400 (75%)	64%
SES (***)[b]			
First Quartile (lowest)	2210 (24%)	60 (12%)	23%
Second Quartile	2360 (25%)	90 (16%)	25%
Third Quartile	2400 (26%)	150 (28%)	26%
Fourth Quartile (highest)	2430 (26%)	230 (44%)	27%
Parental Education (***)[b]			
High school or less	2450 (26%)	80 (15%)	26%
2 yr. coll attended/completed	2190 (23%)	100 (19%)	23%
4 yr. coll attended/completed	3220 (34%)	200 (38%)	35%
Graduate degree	1520 (16%)	150 (28%)	17%
ALL	**9390 (95%)**	**530 (5%)**	**9,920**

[a] Counts are rounded to the nearest ten. Percentage totals may not equal 100% due to rounding.
[b] Significance of chi-square tests of association between high school program and each socio-demographic factor is presented *p<.05 **p<.01 ***p<.001

Gender: Female and male students are nearly proportionally represented in non-STEM occupations, but clearly disproportionally represented in STEM occupations. Expected is the underrepresentation of females (25%) in STEM occupations compared to males (75%) relative to the sample distribution of 53% and 47% respectively. These results align with previous research indicating male students who complete STEM degrees enter related fields of employment more so than females (Xu, 2013). As indicated in Table 4.6, the distribution of credentialed STEM majors is overtly male dominated supporting the resultant higher distribution of males in STEM-related occupations. In addition, the proportion of females who completed a STEM major (as shown in Table 4.6), is greater than their proportion in STEM occupations, suggesting females may not seek employment in their credentialed field of study, specifically if it is a STEM-related field. Overall, there is a significant association between gender and occupations.

Race/Ethnicity: While the racial group distribution of the sample closely matches the overall distribution within non-STEM occupations, discrepancies are found within STEM-related occupations. Not unexpected, Black/African American and Hispanic students, who were underrepresented in credentialed STEM field of study, are also underrepresented in STEM occupations. As anticipated, White students, who account for about two-thirds of the sample, are overrepresented in STEM occupations, comprising three-fourths of this occupational category. Additionally, Asian students account for 6% of STEM occupations group while representing only 4% of the sample. An interesting note, multiracial students are represented equally in STEM-related occupations with the sample, but were previously found slightly underrepresented in credentialed STEM FOS. Overall, there is a significant association between race/ethnicity and occupational outcomes.

Socio-economic Status: The distribution of each economic group for non-STEM occupations closely mirrors the sample distribution. Distinct differences are evident in STEM-related occupations, where the highest quartile is strongly overrepresented (44%) and the lowest quartile undeniably underrepresented with 12%. Although students from the second quartile are underrepresented in STEM occupations, students from the third quartile are nearly proportionality represented. Overall, there is a significant association between SES and occupational outcomes.

Parental Education: The distribution of levels of parental education for non-STEM occupations nearly matches the distribution in the sample. However, substantial differences exist within STEM occupations. Nearly two-thirds of students employed in a STEM occupation have parents whose education levels were 4-year college or above, whereas these students only represent 52% of the sample. Furthermore, the two lowest levels of parental education (i.e., high school or less and 2-year college attended/completed) represent 49% of the sample as compared to 34% within STEM occupations category. These findings indicate not only do students with more educated parents complete STEM degrees (as indicated in Table 4.6) but also enter the workforce in a STEM-related occupation. Overall, there is a significant association between parental education and occupational outcomes.

Multinomial Regression Results: Occupational Outcomes Model

The binary logistic regression analysis provides the likelihood of engaging in a STEM-related occupation as compared to a non-STEM occupation in a model that includes high school program and a set of socio-demographic predictive factors. The results are presented as odds ratios for each variable in Table 4.9. The odds ratios are calculated for each predictor against the reference categories. Likelihood ratio tests indicate that all variables except parental education contribute significantly to this model. The Nagelkerke R^2 coefficient indicates that only 9% of the variability in the outcome is explained by the overall model. I will further discuss the effect of each predictor.

High School Program: Capital acquired from family and enhanced through the education system is an important factor related to educational and occupation outcomes.

Table 4-9 Logistic Regression Results of Occupational Outcomes (non-STEM=ref.)

	Odds Ratios
Variables/categories	STEM
High school program (Adv curriculum=ref)	
Outreach	.71*
Non-participant	.64***
Gender (Male=ref)	
Female	.29***
Race (White=ref)	
Asian/Hawaii/Pac.Isl	1.48*
Black/African	.52***
Hispanic	.62**
Multiracial, non-Hisp	.44
SES (4th quart=ref)	
3rd Quartile	.78
2nd Quartile	.50***
1st Quartile (lowest)	.47***
Par educ (Grad=ref)	
4-yr coll compl/attend	.82
2-yr coll compl/attend	.80
High school or less	.77
Constant	.24***
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.	

Odds ratios show that it is less likely for outreach programs participants and for non-participants to work in a STEM occupation as compared to advanced curriculum participants. While the difference between outreach program participants and non-participants is minimal for occupational outcomes, there appears to be a slight positive contribution of outreach program participation towards entrance into a STEM occupation.

Gender: Females, compared to males, are significantly less likely to engage in a STEM-related occupation. Specifically, females are around 3.5 times less likely to select a STEM occupation as compared to a non-STEM occupation.

Race/Ethnicity: When considering occupational outcomes, Asian students are significantly more likely to enter a STEM-related occupation compared to White students. Specifically, as indicated by the odds ratios in Table 4.9, Asian students are nearly 1.5

times more likely to enter a STEM occupation rather than a non-STEM occupation. On the contrary, Black/African American and Hispanic students are nearly half as likely to enter a STEM-related occupation rather than a non-STEM occupation when compared to White students. The odds ratio for multiracial students in comparison to White students is not statistically significant but there is decreased likelihood for multiracial students of being employed in a STEM occupation. Racial differences are highly apparent for Asian and White students in relation to finding jobs in STEM occupations.

Socio-economic Status: The effect of SES is only significant in the decreased likelihood of students from the two lowest quartiles being employed in a STEM-related occupation as opposed to a non-STEM occupation. Specifically, students from the highest economic level are nearly twice as likely to enter a STEM-related occupation compared to students in the first and second quartiles.

Parental Education: Students whose parents did not attend graduate school have a decreased likelihood of being employed in a STEM-related occupation as compared to a non-STEM occupation. For instance, compared to the highest parental education, students whose parents' education levels were at 4-year college or below were about 20% less likely to work in a STEM-related occupation. However, the effect of parental education is not as pronounced in this model, as all the odds ratios are not statistically significant.

Research Question 4: Summary of Findings

As evident by these analyses, occupational outcomes are related with high school program participation. Outreach program participants do not enter STEM occupations nearly as much as students who participated in advanced curriculum. However, outreach students do exhibit a marginal advantage in entering STEM occupations over non-participants in any high school program. While outreach program participants are equally represented in both non-STEM and STEM occupations, participants in advanced curriculum are overrepresented in STEM-related occupations.

Also, the analysis reveals an interesting relationship between socio-demographic factors and occupational outcomes. Consistent with the field of study analyses (initial and credentialed), the data reveals that being a female, minority (excluding Asian), from the lowest socio-economic status, and having parents with the lowest education level decreases the likelihood of STEM-related occupational outcomes. In opposition, students overrepresented in STEM occupations are males, either White or Asian, from the highest economic quartile, and who have the most educated parents.

Chapter Summary

Overall, being a participant in either an advanced curriculum or outreach program during high school provides advantages in educational and occupation outcomes compared to students who did not participate in any high school program. As the results indicate, participation in advanced curriculum, regardless of the courses taken, provides a greater likelihood for persistence and success in the STEM pipeline. Additionally, although students who participate in outreach programs may not exhibit the same benefit as advanced curriculum participants, this group of students does show increased participation in the STEM pipeline compared to students who did not participate in any high school program.

Socio-demographic factors also appear to be influential in post-secondary pathways and occupational outcomes, particularly for STEM fields of study, high levels of educational attainment, and STEM occupations. The students who exhibit characteristics often associated with the dominant culture (e.g. White, male, highly educated, wealthy family) are more likely to enroll in college, persist, and enter a STEM-related occupation. On the other hand, females, minority students (except Asian), students from families with less educated parents and lower socio-economic status have more difficulty in pursuing post-secondary pathways especially in STEM fields.

The following chapter will discuss in more detail the study findings (i.e., impact of high school program participation and socio-demographic factors on STEM-related outcomes) in relation to research literature. Specifically, I will focus on High school program and PSE pathways, High school program and Educational Attainment/Persistence, High school program and STEM-related credential, High school program and STEM occupations, Race and STEM outcomes, and SES and STEM outcomes.

Chapter 5

Discussion

This chapter includes a summary and discussion of the key findings of the study followed by implications for policy, practice, and future research. Additionally, strengths and limitations of this study are discussed, as well as the significance of this study in emphasizing the need for development of academic and social capital during high school that impacts post-secondary education pathways and long-term occupational outcomes.

High School Program and PSE Pathways

Many studies conducted on post-secondary education access and success suggest factors such as parental involvement, school resources, and peer aspirations as being influential in the decision to attend college. Research also proposes that academic preparation gained through rigorous high school coursework is a critical element in the matriculation of students into higher education (Adelman, 2006; Chajewski, Mattern, & Shaw, 2011; Klugman, 2012; Martinez & Klopott, 2005; McCauley, 2009; Perna, 2005, Sokatch, 2006). Specifically, student participation in advanced mathematics and science coursework as well as receiving high scores on AP exams have been associated with the pursuit of STEM majors (Ackerman et al., 2013; Tyson, Lee, Borman, & Hanson, 2007). These studies support the premise of my dissertation that academic capital reinforced through the participation in high school advanced curriculum programs should promote student enrollment in post-secondary education and favor the pursuit of STEM-related fields of study.

Similar to the literature, this present study has also indicated increased PSE enrollment among students who partook in academic rigorous coursework during high school in the form of advanced AP/IB curriculum. My study shows only 14% of the students engaged in an advanced curriculum program during high school did not enroll in post-secondary education. Additionally, 33% of all students who initially majored in a STEM-related field of study were composed of advanced curriculum students although they represented only one-fifth of the sample. Given that these students are involved in college-level coursework during high school, it is not surprising that they would pursue post-secondary education at a higher rate than their colleagues. Being well prepared academically and having developed learning ‘habits,’ they may also select STEM-related fields of study, typically considered more academically challenging than non-STEM fields. In reference to Bourdieu’s (1977) concept of habitus, dispositions toward learning stimulated by high-level coursework create the foundation for long-term academic behaviors and belief in one’s ability and success that influence one’s decisions to pursue post-secondary education in demanding but highly rewarded fields of study. More so, my study confirms this assumption that indicates academic capital acquired through advanced curriculum participation during high school appears to contribute to the pursuit of STEM post-secondary education. Persistently, students who engage in this type of academic preparation for college have higher perceptions of academic self-ability and higher educational aspirations (Bong, 1999; Cooney, McKillip, & Smith, 2013; Foust, Hertberg-Davis, & Callahan, 2009; Moakler & Kim, 2013).

This current study also explored the impact of participation in college outreach programs on post-secondary pathways. With the underrepresentation of certain groups of students (e.g., low SES, some racial groups) in advanced courses, outreach programs provide an avenue for these students in the pursuit of post-secondary education. Outreach programs aid students in accessing higher education through mentoring, advising, and college campus visits intended to increase post-secondary enrollment. Social and cultural capital acquired through outreach program participation may be as critical in attending college as academic preparation (Cates & Schaefle, 2011). While social capital supports the individual in gaining access to resources, embodied cultural capital is closely related to one's habitus (Bourdieu, 1986). If students did not have the chance to acquire specific forms of capital within family, school programs (e.g., college outreach programs) could produce a compensatory effect.

Similar to previous research, the findings of this study did indicate an increase of post-secondary access for outreach program participants as compared to non-participants. Specifically, only 22% of students who participated in an outreach program during high school did not initially participate in post-secondary education whereas 26% of the students who did not participate in any high school programs were still PSE non-participants in 2006. While the apparent increase in social and cultural capital resulted from outreach program participation improved post-secondary educational access for the group, it had a limited effect on STEM participation. Somehow, the possession of academic capital associated with advanced curriculum seemingly exceeds the benefits provided by outreach programs in college access and choice of field of study. With the implication of STEM-related majors being reliant on previous advanced coursework (Wai, Lubinski, Benbow, & Steiger, 2010), it is not surprising that outreach program participants do not pursue these fields in higher numbers, as the focus of outreach programs is primarily on post-secondary access. Only 18% of students engaged in STEM-related fields of study in 2006 were accounted for as outreach program participants.

As literature has suggested, selecting a college major can be informed by knowledge of labor market stratification (Ma, 2011) whereby students select a field of study that is representative of their own gender, race, or ethnicity. Although socio-demographic differences are not the main scope of this study, I would suggest that the higher representation of minorities and females in outreach programs may inhibit the pursuit of a STEM-related fields of study, as traditionally minorities and females are underrepresented in STEM occupations. While college outreach programs do show a benefit in post-secondary education access, the benefit related to STEM outcomes is less distinct.

High School Program and Educational Attainment/Persistence

This study further investigated the impact of high school program participation on educational attainment. Educational persistence and attainment have been connected to socio-demographic factors of gender, race, and socio-economic status, as well as academic preparation. Previous research has indicated that the advanced math and science courses as well as the number of advanced courses taken during high school improves a student's likelihood of persisting through college and obtaining a degree, specifically in a STEM-related field (Ackerman, Kanfer, & Calderwood, 2013; Tyson, Lee, Borman, & Hanson, 2007). The findings of this study agree with the existing literature. Over 50% of advanced curriculum students persist through college and earn either a bachelor's or a graduate degree. With a higher percent of advanced curriculum students pursuing STEM-related fields, and with many STEM fields requiring at least a bachelor's degree, it is not surprising this group of students also attain higher levels of education. The academic capital acquired through participation in advanced curriculum during high school allows these students to persist through the difficult STEM coursework in college. Although this study considers overall advanced curriculum rather than specific advanced math or science coursework, the fact that advanced curriculum students are more likely than others to pursue STEM-related fields, demonstrates that any challenging high school coursework stimulates students' academic behaviors. I argue that internalized dispositions created in these students, as related to their overall ability to be academically successful and reach higher levels of educational achievement, are effective in increasing college persistence. Although academic capital that consists in the knowledge and skills accumulated in specific subject matters would be more directly helpful to students engaged in STEM areas, the study findings suggest that any advanced curriculum, and not just advanced math and science courses are influencing factors in the pursuit of STEM-related studies and attainment of higher levels of education.

On the other hand, only 36% of outreach program participants attain an education level corresponding to bachelor's or graduate degrees. Social capital obtained from outreach program participation may have positively impacted student entrance into PSE but does not appear to be as influential in their college persistence and degree completion. In fact, 78% of outreach program participants entered college in 2006, but by 2012, only half attained at minimum a bachelor's degree. Many students involved in outreach programs are first-generation students, minorities, or come from low-economic households. Several explanations can be provided regarding the lower persistence of outreach participants compared to advanced curriculum students. It is possible that outreach students are just not as academically prepared to succeed in college as advanced curriculum students are. If this is the case, students who must then enroll in remedial college courses not only incur additional debt related to going to college but also may experience delays in graduation, resulting in an early exit from post-secondary education. It could also be that students from different ethnic backgrounds do not feel a cultural connection with an institution of higher learning or the support needed to persist. Furthermore, financial aid and loans may not cover the costs associated with college and students feel it was necessary to cut their losses sooner rather than incur additional debt. The capital acquired during high school outreach participation appears to be effective in increasing access but may not provide the necessary preparation to persist and succeed in the higher education environment, either academically or economically. However, in the defense of outreach programs providing benefit towards college persistence and attainment, this group of students did outperform high school program non-participants in the attainment of a bachelor's or graduate degree by 2012.

High School Program and STEM-related Credential

With recent reliance on foreign-born students to maintain the influx of workers in STEM-related fields in the United States, a concern over the growth of U.S.-born students completing STEM degrees is understandable. Expectedly, students who pursue more rigorous high school curriculum are more likely to fulfill the requirements to be credentialed in a STEM-related field of study. In agreement with previous research, findings from this study show that students involved in a high school advanced-curriculum program earn a STEM-related credential twice as much as the outreach program participants or high school program non-participants. Outreach program participation, while providing positive benefit in the initial declaration of a STEM-related major, does not appear to greatly impact the earning of a STEM credential.

Previous research has also demonstrated the need of academic preparation for success in STEM fields of study. Although results from this study show that advanced curriculum students successfully satisfy the requirements for a STEM credential at a higher rate compared to other high school students, there is also evidence of a leaking pipeline even for this group from initially declaring a STEM major in 2006 to actually earning a credential in 2012. This leak in the pipeline has created concern to governmental agencies, educational institutions, and business organizations. The results of this study suggest that although academic and social capital gained through high school program participation may increase initial choice of a STEM-related major, there could be are other factors in play that interrupt the completion of a STEM degree. For instance, previous research indicates a chilly environment as a reason why females do not persist through the STEM pipeline. Additionally, a lack of role models in STEM fields for underrepresented minorities has been identified as contributing to their non-completion of STEM degrees. However, none of these reasons should explain the exiting from the pipeline of students who are academically prepared to do the demanding coursework associated with these degrees (Blickenstaff, 2005; Cole & Espinoza, 2008). Although minimal, the decrease in representation of advanced curriculum participants from initial STEM majors (280 students) to STEM degrees (220 students) implies those students who are capable and have STEM interests when entering post-secondary institutions face barriers in the attainment of a STEM credential as well, which is an aspect that requires further research.

High School Program and STEM Occupations

It appears from this study a decrease occurs in the proportion of students who enter a STEM occupation by 2012, even if they had earned a STEM credential. As many highly regarded STEM occupations require advanced degrees, it is possible that some students continue onto higher levels of education instead of entering the workforce at this time. In agreement with previous research (Maltese & Tai,2011; Tyson, Lee, Borman, & Hanson,2007), the current study shows that students who participated in advanced curriculum experience higher success throughout the STEM pipeline and are more likely to end up in STEM occupations. Apparently, academic capital is a necessary element required to persist in STEM-related fields.

Less influential appears to be the social capital gained through outreach program participation. The study findings reveal that outreach participants fair slightly better than high school program non-participants in traversing the STEM pipeline, although differences are negligible. With outreach programs being dominated by females and inclusive of a large minority population and many first generation college students, it is not surprising that this group of students does not enter and/or persist in STEM occupations. For instance, females have been found to exit STEM occupations early after entry (Glass, Sassler, Levitte, & Michelmore, 2013); therefore, by 2012, it is possible that some outreach program students have actually exited a STEM occupation. Additionally, concerns related to cultural sensitivities in the workplace and racial stereotyping in the profession have been attributed to departures from STEM occupations. While social capital gained during high school may improve overall educational outcomes for these students, it is not significant in favoring STEM educational and occupational outcomes.

Race and STEM Outcomes

In agreement with previous research, this present study identifies White and Asian students overwhelmingly declaring a STEM major when entering post-secondary education, earning a STEM credential, and entering a STEM-related occupation. Cultural capital associated with being part of the dominant culture as well as increased academic capital from their participation in advanced curriculum programs can contribute to the successful journey of White students through the STEM pipeline. Similarly, Asian students possess higher levels of cultural and academic capital helping them in the pursuit of STEM fields. Asian parents push their children to achieve academically and pursue careers associated with upward social mobility and higher economic returns (Min & Jang, 2014). Furthermore, cultural representation within the STEM pipeline creates a ‘dominant culture’ environment, familiar to White students (Bourdieu & Passeron, 1990). Both White and Asian students benefit from having higher academic achievement that is rewarded within ‘elite’ (higher earning and status potential) occupations (Goyette & Mullen, 2006).

The underrepresentation of non-Asian minorities in STEM fields demonstrated by study findings is consistent with previous research. Study findings indicate a higher representation of Black/African American students initially declaring a STEM major but subsequently departing from the pipeline by not earning a STEM credential or entering a STEM occupation by 2012. Hispanic students remain underrepresented throughout the STEM pipeline. While Asian students experience a ‘cultural concentration’ within STEM fields that favor their presence in these fields, non-Asian minority students lack such a cultural environment. Research has suggested STEM fields as opportunities for social and cultural reproduction (Ma, 2011). With the importance of role-models and supportive cultural environments implicit in the success of minority students (Cole & Espinoza, 2008)), it is not surprising that Black/African American and Hispanic students do not pursue STEM fields at a higher rate.

The STEM leaking pipeline for non-Asian minorities can be the result of an early understanding of the higher economic returns related to STEM occupations driving the pursuit of an initial STEM major. However, thereafter, the lack of academic preparation and/or non-supportive institution climate have been cited as causing the departure of Black/African American students from STEM fields (Brown, Morning, & Watkins, 2005; Goyette & Mullen, 2006). Study findings show that Hispanic students, on the other hand, show less interest in STEM fields from the onset of post-secondary education. Literature suggests subpar academic preparation as a factor contributing to limited participation by Hispanic students in STEM fields, as well as the fact a majority of Hispanic students enroll in 2-year colleges decreasing their likelihood of selecting a STEM major (Crisp & Nora, 2012).

Overall, the lower number of minority students in the STEM pipeline has been attributed to cultural stereotyping, marginalization, and the individualistic and competitive nature of STEM programs (Museus, Palmer, Davis, & Maramba, 2011). Conversely, while this study did not examine the type of institution attended, research has suggested that Historically Black College and Universities (HBCU) and Hispanic Serving Institutions

(HIS) may provide positive environments for minority students, not only resulting in increased graduation but higher levels of attainment, specifically in STEM-related fields (Dowd, Malcolm & Macias, 2010).

SES and STEM Outcomes

Previous research has suggested the students from higher-income families and those who attend full-time and do not work have increased likelihood of completing college (Anderson & Kim, 2006). In accordance with other research, this study found students from families of the highest SES more likely to pursue post-secondary education, as well as select a major and earn a credential in a STEM-related field and enter the STEM workforce. Conversely, students from lower socio-economic statuses are less likely to pursue post-secondary education or earn a credential, let alone in a STEM-related field. Given that minority students are more likely to belong to a lower socio-economic group compared to White students, the ability to pay for college has been identified as a contributing factor to the attrition of minority students from STEM fields of study (Museus, Palmer, Davis, & Maramba, 2011). Socio-economic status was found to be a strong factor associated with post-secondary pathways and STEM outcomes.

Students have multiple pathways after high school: enter the workforce, enter some forms of post-secondary education either part-time or become a full-time student. Lower-income students may need to rely on work in order to pay for college, resulting in delayed enrollment or part-time enrollment (Anderson & Kim, 2006). As previously implied, those students who work during college are at decreased odds of completing a degree. Financial need may explain part of why students enter PSE part-time or not at all. Furthermore, many low-income students begin their PSE education at community colleges where the transfer rates of student from 2-year to 4-year institutions, specifically in a STEM fields of study, are small (Crisp & Nora, 2012).

Students from lower socio-economic levels also need to acquire social capital to help them learn how to navigate the post-secondary education system, whereas students from higher socio-economic levels already possess this capital (Swail & Perna, 2002). Overall, students from the higher socio-economic levels possess cultural and social capital conducive to pursuing and succeeding in post-secondary education and have existing resources in the form of economic capital to pay for college (Thomas, 2000). All these advantages are particularly important to engage in long STEM education pathways (i.e., usually involving graduate studies), which may explain the persistent SES discrepancies in STEM outcomes revealed in this study.

Strengths of the Study

The primary strength of this study is the use of Educational Longitudinal Survey, ELS: 2002 data. Unlike previous studies using the ELS: 2002, this study uses the most recent data available to examine post-secondary education and occupational outcomes. Until recently, ELS only provided survey data through the second wave of 2006. This study also employs data collected from the final wave of the survey, 2012, which allows for the use of educational outcomes as it relates to credentialed field of study and well as occupational information.

Additionally, the use of ELS: 2002 data also allows for a longitudinal analysis of students' trajectories from high school through adulthood (age 26). Survey data was collected from a cohort of 10th grade students in 2002 and follow-up surveys were administered to the same cohort students in 2004, 2006, and 2012 thus covering 10 years of respondents' life course. The ability to analyze cohort data allows the researcher to assess the predictive value of high school factors at each stage of the educational and STEM pipeline (i.e., post-secondary education pathways, choice of initial major, educational attainment, degree completion, and occupation).

Limitations of the Study

This study has several limitations. First, student data is self-reported and program participation is not based on transcripts. In addition, participation in AP courses does not indicate which subject areas advanced coursework was completed. Since the argument of this study is that any participation in advanced curriculum courses is beneficial for enhancing one's academic capital by exposing the student to challenging coursework and creating dispositions toward learning (habitus), this limited information does not affect the design of the study.

Second, some issues are related to the identification of the college outreach program. As from the survey question, participants could be enrolled in GEAR-UP or some other similar program. While Talent Search and Upward Bound are specifically identified, GEAR-UP is suggested to be associated with other programs, which are not named. Participants who selected GEAR-UP as a college-access program may actually be participants in another similar program. Since the analysis is not based on separate outreach programs, and the survey question clearly refers to programs that 'help economically disadvantaged high school students to prepare for entering and succeeding in college,' it is likely that students did not misinterpret the question. Another concern could be that GEAR UP is a comprehensive program, and some respondents may not have been aware of participation in the program and thus missed self-reporting it, and therefore are labeled as non-participants in the research sample. Furthermore, this study did not examine other programs such as AVID (Advancement Via Individual Determination) that incorporate an advanced curriculum requirement as part of the college outreach component. Additionally, the data available for this study did not contain participation in specific STEM-related college outreach programs. For instance, GEAR UP has a STEM program to promote the development of first-generation and low-income students' interests and abilities in the areas of science, technology, engineering, and mathematics. Such information is not available in ELS.

A third limitation is related to the examination of racial/ethnic groups in this study. Included in this study are the groups of White, Black/African American, Hispanic, Multiracial, and Asian. The omission of Native Americans is due to the small representation within the sample, not allowing for reliable analysis of the data. Although Native American respondents were omitted from the analysis, the rich data available for the other racial groups produced relevant analysis by race/ethnicity.

The fourth limitation is related to use of survey data. The data analysis of this study does not allow for examining a causal relationship among variables. While the logistic regression models provide an opportunity to predict the likelihood of an outcome occurring, the interpretation of results is made in terms of association between variables and cannot be used to identify specific factor as the cause of the outcome.

Despite these limitations, this study provides valuable information related to the pathways of students involved in high school programs that build or enhance their academic and social capital, and shape their dispositions toward learning and/or challenging academic coursework. The study likely emphasizes the importance of capital and habitus in post-secondary education pathways and occupational outcomes.

Significance of Study

This study was designed to assess how different forms of capital measured through student participation in specific high school programs influence post-secondary education pathways, STEM field of study, and STEM occupation outcomes. Studies that focus on advanced curriculum and STEM-related outcomes indicate specifically that students who show aptitude in relation to science and mathematics overcome the barriers associated with traversing the STEM pipeline. These students possess academic capital. Other studies that addressed outreach program participation focused on increasing college access and enrollment of participants by helping students to acquire social capital. Social capital, as it pertains to this study, represents the resources available to high school students through program participation and the utilization of those resources on post-secondary education pathways and outcomes. Underrepresented minority students and first-generation college students who participated in outreach programs have been found to benefit from such participation with higher post-secondary education participation, persistence, and graduation. Therefore, the study is particularly relevant to understanding the long-term effects of academic and social capital acquired in high school.

The notions of capital and habitus were employed in this study to understand the benefit of high school program participation on STEM outcomes. The possession of capital can improve opportunities of being successful in the social world. According to Bourdieu (1986), social capital is the availability of resources based on one’s membership in a particular group or network. Social capital is attributed to family membership and one’s position within the social structure, however can be improved upon through other group membership. Cultural capital is also inherited from family and social status, but is coupled with how well one interacts with and understands social cues associated with the dominant culture. As a result, academic capital is a byproduct of higher levels of cultural capital. Those who exhibit the behaviors of the dominant culture, particularly within the education system, are rewarded with increased academic achievement and the skills necessary to benefit from the school experience. In relation to cultural capital, Bourdieu (1977) views habitus as the internal dispositions of perception and action that influences all subsequent experiences. Entrenched in one’s family and social structure, habitus influences the educational experience as it relates to one’s perception of academic ability and value. The current study has a significant methodological contribution that consists in relating the concepts of capital and habitus to particular high school programs.

This study is based on the assumption that capital obtained or enhanced through high school program participation influences the post-secondary education pathways and especially the STEM-related outcomes. With a concern over the future shortage of a qualified U.S.-born STEM workforce, this research study has relevant implications to STEM education because it suggests that possession and acquisition of capital may associate with high school programs thus influencing student entry into the STEM pipeline. This study adds to the growing body of research on post-secondary education pathways and STEM-related outcomes for students who engage in advanced curriculum programs and college outreach programs during high school. With the increased focus of governmental agencies, educational institutions, and business organizations on increasing the influx of students into STEM fields in order to meet the demands of the U.S. STEM workforce, it is imperative that studies such as this are conducted.

Maintaining the strength of United States in the fields of science, technology, engineering, and mathematics has been considered key to keeping the U.S. globally competitive and prosperous. An imperative of maintaining a highly qualified U.S. STEM workforce consists in the identification of high school programs that promote and produce students who are not only interested in but are academically and socially prepared for the college and work experience associated with STEM fields. This goal is particularly important because the STEM workforce is largely relying on foreign-born students who come to the U.S. to complete their education but some have to return to their home country thus creating a shortage of qualified STEM workers. With a growing minority population pursuing post-secondary education, there is hope that they will enter STEM fields of study and STEM occupations. While many students pursue STEM-related education and occupations, the fact remains that females and minorities are underrepresented in STEM-related fields and thus present an untapped source of workers that could fulfill the needs of U.S. STEM occupations.

Another significance of this study is to propose that advanced curriculum is an agent of capital building that has implications on the pursuit of post-secondary pathways and STEM careers. Previous research suggests advanced mathematics and science courses as high predictors of success in the STEM pipeline. This study expands on the notion that academic capital attained through participation in advanced curriculum contributes to student habitus as it relates to dispositions toward learning. Therefore, it is not only the advanced mathematics and science courses that contribute to the pursuit of STEM careers but the overall development of ‘habits’ of learning, regardless of subject content, that leads to higher ability to deal with challenging coursework and thus support students in pursuing STEM careers. More studies are needed to not only address the impact of advanced coursework overall, but also to examine what other programs may positively influence post-secondary pathways, specifically designed for those students who are underrepresented in the STEM pipeline.

Implications for Practice

High School Capital

Academic preparation, economic status, and parental education have been attributed to the completion of post-secondary education. The results of this study suggest that academic and social capital acquired through participation in advanced curriculum programs do indeed positively influence PSE pathways and outcomes as they relate to STEM fields. However, the results are not as pronounced for those students who build capital through participating in college outreach programs. Results from this study indicate student participation in college outreach programs may improve enrollment in PSE but not necessarily the completion of post-secondary education, especially in STEM fields. Therefore, study findings suggest a need to improve high school program design, and consider stimulating STEM interest and persistence among outreach programs participants as well.

Program administrators have a duty to not only open the door to PSE but provide additional preparation to further the completion of college degrees. While college outreach programs may provide mentoring and tutoring, to what extent are these activities occurring, how often, and in the preparation for what -- high school graduation or access and successful completion of PSE? Tutoring needs to involve higher academic preparation as it relates to college success, understanding what resources are available at higher education institutions, developing effective study skills, and helping students identify their academic strengths and weaknesses. Program administrators need to assess the needs of students individually as opposed to providing a bandage to cover the needs of all students. Background differences demand an individual approach instead of a broad approach to intervention.

Additionally, the incorporation of some forms of advanced academic preparation in college outreach programs may lead to improvement in the pursuit of STEM-related fields of study by females and underrepresented minorities (URM’s). Contradictory to the findings of this study, females and URM’s have been historically underrepresented in advanced curriculum programs (MacPhee, Farro, & Canetto, 2013).However, findings also show decreased participation by both groups in STEM-related pathways, which have been linked to academic preparation. One recommendation would be to strengthen the collaboration between the administrators of secondary schools and outreach programs to focus on promoting increased access of advanced curriculum to females and minority students. Increasing the pool of students in advanced academic programs is a good strategy to increasing their presence in STEM post-secondary education and occupations.

Racial Differences

Results of this study indicate students with different racial backgrounds pursue and persevere through the STEM pipeline differently. High schools need to develop strategies to attract those students into challenging academic courses. When entering post-secondary education, specifically in a STEM-related field, they may need additional support to successfully complete these pathways. Needed is a strategic support system developed and implemented by higher education institutions to foster the influx of students into STEM-related fields and provide an environment conducive to different racial groups. Since previous research has suggested Hispanic students and Black/African American students face in college obstacles related to racism and discrimination (Brown, Morning, & Watkins, 2005; Castillo et al., 2006), institutions must engage in practices to address these issues and also provide resources to further the involvement of minority students in fields of study in which they were traditionally underrepresented.

For instance, colleges and universities can build academic and racial communities to support the PSE transition of minority students pursuing studies in STEM-related fields. Academic advisors should be equipped with information useful to students within the university setting as well as from external resources. The development of racial communities within colleges and universities may seem segregated, however, research (Fries-Britt, Younger, & Hall, 2010) suggests that familiarity and in-group membership had been beneficial to minority groups in the completion of college degrees. Historically Black Colleges and Universities and Hispanic Serving Institutions have had high rates of success and therefore, the concept of community for racial groups needs to be addressed especially at primary white institutions.

Post-Secondary Support and Career Development

Career development opportunities have been positively associated with student persistence in the STEM-related majors and should be further reviewed by secondary and post-secondary institutions as a means to increase interest and persistence through the STEM pipeline. Career development is critical for growing the interest in STEM disciplines, particularly for female and underrepresented minority (URM) students (Byars-Winston, 2014). Female students in STEM fields have identified a chilly environment as one factor associated with their exit from these fields. Underrepresented minority students have attributed their lack of interest in STEM fields to a lack of role models and mentors within STEM fields. Both groups have identified the lack of college professors who are similar in gender or race as a reason for leaving the STEM pipeline. Therefore, higher education institutions need to adopt initiatives to address some of these issues.

For instance, increased course-based research opportunities and active learning environments for early undergraduate students may increase retention in STEM programs. Active learning environments abandon the traditional introductory lecture courses and promote student-involved learning. Creating learning communities for undergraduate students, specifically in STEM fields, allows students to congregate, work, and learn together while developing a STEM identity (Graham, Frederick, Byars-Winston, Hunter, & Handelsman, 2013). By expanding in- and out-of-classroom experiences emphasizing academic and career development, living-learning environments at some colleges have proven to increase the interest and persistence of females throughout the STEM pipeline resulting in increased graduation and entry into the STEM workforce (Szelenyi, Denson, & Inkelas, 2013).

In addition, mentoring as a career development opportunity has been found to provide students with a social and academic connection to their field of study. Informal mentoring in which college professors institute a collaborative work environment provides such opportunities for students to develop a sense of belonging within the college community and major department (Holland, Major, & Orvis, 2011).

Implications for Policy

Funding

As indicated in this study, if participation in college outreach programs such as Talent Search, Upward Bound, and GEAR UP is not providing sufficient skills necessary to persevere through college, specifically in demanding fields such as STEM, then the reallocation of funds in high school may be necessary. The intent of these programs is to increase college access for first-generation and low-income students. Should these funds be funneled into other programs that provide promise to aid low-income and first generation students?

With recent cuts to PELL grants and additional free monies for college, specifically, low-income students may become disenchanted and discouraged by the high expenses related to continuing education. In fact, previous research has suggested that students who begin college but do not complete face larger economic deficits related to the expense of post-secondary education (Schneider & Yin, 2011). The looming debt associated with attending college has been attributed to the departure of many low-income students (Anderson & Kim, 2006). With this being the case, college outreach programs should look at increasing the benefits associated with completions, such as implementing a completion stipend. Additionally, the federal government should look at the forgiveness of loans when low-income students earn a credential and enter the workforce in high need fields such as STEM. Currently, loan forgiveness programs are available to both doctors and teachers who work in low-income communities. If a decrease in the economic outlay of low-income students would improve graduation rates, then it may also change the pattern of social reproduction. The potential of such a policy implementation is far reaching beyond the economic impact on the individual.

Recruitment

Since many students initially enroll in 2-year colleges, specifically Black/African American and Hispanic students, it is imperative that collaboration between community colleges and university in the field of STEM is initiated. Incorporation of a 2-year pre-STEM orientation program at community colleges that feeds into 4-year universities may improve the transfer rate from 2-year to 4-year institutions as well as the completion rate for minority students. Expansion of funded programs similar to the National Science Foundation STEP (STEM Talent Expansion Program) program to improve collaborations between institutions could lead to improved retention and completion rates of students in STEM programs. Unfortunately, the STEP program is no longer accepting proposals and many NSF-funded opportunities are directed to research and scholarships, not at activities directly impacting student participation in STEM majors (NSF, 2014b). While in existence, STEP programs were implemented at multiple institutions. The University of Nebraska at Omaha with the Metropolitan Community College incorporated a collaborative plan to increase the transfer and completion of STEM majors with a 93% success rate over a 5-year period. While research indicates the success of transfer programs from 2-year to 4-year colleges is questionable, the collaboration at the University of Nebraska provides a roadmap of working programs. The development of pre-STEM courses at the Metropolitan Community College, a walk-in tutoring math and science lab, early undergraduate research opportunities, and scholarship opportunities for STEM majors were the results of the collaboration between the two schools and were attributed to the success of their STEM programs (Heidl, 2011).

Implications for Further Research

This quantitative study was conducted to address the impact of high school capital acquired through advanced curriculum and college outreach programs on STEM-related outcomes such as pursuing a STEM major field of study and entering STEM occupations. This study contributes to filling a gap in the existing literature covering this topic. Based on the findings of this study, areas for future research are as follows:

First, based on the literature review, most studies related to STEM outcomes focus on advanced mathematics and science courses as well as the number of AP exams taken during high school. The International Baccalaureate program is a comprehensive curriculum program intended to improve the breadth of learning across multiple disciplines. With the more rounded nature of the IB program, further research could address the differences between AP and IB in relation to STEM outcomes. As previous studies have addressed, academic preparation is a key component to success throughout the STEM pipeline. IB provides the academic rigor necessary for post-secondary success and advances the social competencies of students.

Second, most studies conducted on STEM outcomes are quantitative in nature. More qualitative studies need to be conducted in order to understand the factors associated with entry and exit from the STEM pipeline. Qualitative research would reveal the experiences of students who have entered the STEM pipeline, persevered through the STEM pipeline or exited the STEM pipeline. Understanding the barriers experienced by students as they traverse the STEM pipeline would aid secondary and post-secondary institutions improve resources intended to increase retention.

Third, in relation to this current study, further research can be conducted with regards to outreach programs. This study aggregated participation of outreach programs. Expanding this study in order to investigate individual outreach programs would provide relevant information for improving the program design. Specifically, it would be useful to conduct comparative analysis of student participating in Talent Search, Upward Bound, and GEAR UP with respect to STEM pathways and outcomes. While the purpose of each program being similar, increasing post-secondary access to first generation and low-income students, the unique components of each program may provide a different educational outcome.

Furthermore, incorporating analysis of students engaged in programs such as AVID, which includes an advanced curriculum component, or programs with a STEM focus, such as the federally funded Upward Bound Math and Science program, would further provide useful research information, particularly in comparison to Talent Search, Upward Bound, and GEAR UP. While programs such as the Upward Bound Math and Science program are less prevalent, these programs are growing and their contributions to STEM outcomes should merit further analysis. Although the background of regular outreach program participants is similar, how each program enhances the social capital and instills educational values is important in STEM outcomes research and worth exploring.

Fourth, this study found that belonging to the highest socio-economic level improved the likelihood of pursuing and succeeding through the STEM pipeline. Although numerous studies have been conducted on the impact of socio-economic status on post-secondary success, it is imperative to expand this research as it relates specifically to post-secondary STEM outcomes. Findings from this study show significant differences between the second highest and highest economic quartiles with respect to pursuing

STEM fields of study and entering STEM occupation. While the post-secondary enrollment rates of the highest two economic quartiles are not extensively different, the differences increase in association to STEM pursuits. Further research is necessary to better understand the disparities that exist between the higher economic levels with respect to STEM outcomes.

Finally, research is needed to identify academic environments beyond advanced curriculum that are conducive to success in the STEM pipeline. For instance, career and technical education programs have undergone recent resurgence in the U.S. What formally was called vocational education has evolved into advanced technical programs. Providing such educational opportunities in the fields related to engineering, robotics, and computer science, these schools are developing interest in STEM-related occupations through project-based learning environments. Further investigation may identify different factors associated with the increased exposure to STEM studies through career and technical centers that provide the preparation necessary for the successful negotiation of educational pathways through the STEM pipeline.

Conclusion

Previous research on STEM-education pathways and outcomes has primarily focused on math and science academic preparation, gender differences, and racial/ethnic differences. The findings from this dissertation make a significant contribution to literature on STEM pathways and outcomes as it examined the acquisition of capital during high school through participation in advanced curriculum and college outreach programs. Furthermore, studies like this one can provide longitudinal information related to the concern of students ‘leaking out’ of the STEM pipeline.

Secondary schools, post-secondary institutions, and outreach program coordinators, could use the results of this study to further understand student differences related to STEM interest and persistence. Secondary schools and outreach programs should provide increased academic preparation for students underrepresented in the STEM pipeline. Post-secondary institutions should provide high school students, especially females and minorities, opportunities to develop educational connections to the college community. The findings of this study justify the concern over a shortage of a qualified U.S.-born STEM workforce. Increasing the diversity of students who are not only interested in STEM, but are also academically prepared to successfully traverse the STEM pipeline is one means of fulfilling the demand for a highly qualified STEM workforce.

Appendix A

Summary of ELS: 2002 Data

Summary of ELS: 2002 Data

ELS: 2002 used stratified sampling to obtain a national representation of 10th grade students within the US. The population was divided into regions, or strata's, and a simple random sample was conducted for each region. Further division or sub-stratification, was accomplished by metropolitan status: urban, rural, and suburban. Additionally, the sample was divided to account for representation of public schools and catholic or other private schools.

Once the schools were selected, a stratified random selection of students from each school was conducted. The strata used in student selection were Hispanic, Black, Asian, and other race/ethnicity. Quality assurance checks were conducted with each list of students to ensure proportionality and eligibility of students within the sample. Asians students were oversampled to safeguard comparisons between groups. A total of 17,591 students were selected for participation in ELS: 2002.

Table A1 summarizes sample sizes and response rates for ELS: 2002 from base year through the third follow-up.

Table A-1: Summary of ELS: 2002 sample size and response rates

Survey	Selected	Participated	Response Rate
Base year school	1,221	752	61.6%
Base year student	17,591	15,362	87.3%
First Follow-up	16,515	14,989	90.8%
Second Follow-up	15,892	14,159	89.1%
Third Follow-up	15,724	13,250	84.3%

SOURCE: U.S. Department of Education, National Center for Educational Statistics, Education Longitudinal Study of 2002 (ELS: 2002).

Appendix B

IRB

UNIVERSITY OF TEXAS ARLINGTON | OFFICE OF RESEARCH ADMINISTRATION REGULATORY SERVICES

Institutional Review Board
Notification of Exemption

November 19, 2014

Rachel Lomax
Dr. Maria Trache
Educational Leadership & Policy Studies

Protocol Number: 2015-0242

Protocol Title: *Pathways to STEM Occupations: Advanced Curriculum and College Outreach Programs*

EXEMPTION DETERMINATION

The UT Arlington Institutional Review Board (IRB) Chair, or designee, has reviewed the above referenced study and found that it qualified for exemption under the federal guidelines for the protection of human subjects as referenced at Title 45CFR Part 46.101(b)(4).

- (4). Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available **or** if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

You are therefore authorized to begin the research as of **November 18, 2014.**

Pursuant to Title 45 CFR 46.103(b)(4)(iii), investigators are required to, "promptly report to the IRB ***any*** proposed changes in the research activity, and to ensure that such changes in approved research, during the period for which IRB approval has already been given, are **not initiated without prior IRB review and approval** except when necessary to eliminate apparent immediate hazards to the subject." Please be advised that as the principal investigator, you are required to report local adverse (unanticipated) events to the Office of Research Administration; Regulatory Services within 24 hours of the occurrence or upon acknowledgement of the occurrence. All investigators and key personnel identified in the protocol must have documented Human Subject Protection (HSP) Training on file with this office. Completion certificates are valid for 2 years from completion date.

The UT Arlington Office of Research Administration; Regulatory Services appreciates your continuing commitment to the protection of human subjects in research. Should you have questions, or need to report completion of study procedures, please contact Alyson Stearns at astearns@uta.edu. You may also contact Regulatory Services at 817-272-3723 or regulatoryservices@uta.edu.

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Appendix C

Classification of STEM occupations

STEM Occupations

150000 "Computer and mathematical occupations"
151000 "Computer specialist"
151011 "Computer and info scientist, research"
151021 "Computer programmers"
151031 "Computer software engineer, applications"
151032 "Computer software engineer, systems"
151041 "Computer support specialists"
151051 "Computer systems analysts"
151061 "Database administrators"
151071 "Network/computer systems administrator"
151081 "Network system/data analyst"
151099 "Computer specialists, all other"
151100 "Computer Occupations"
151111 "Computer and Information Research Scientists"
151121 "Computer Systems Analysts"
151122 "Information Security Analysts"
151131 "Computer Programmers"
151132 "Software Developers, Applications"
151133 "Software Developers, Systems Software"
151134 "Web Developers"
151141 "Database Administrators"
151142 "Network and Computer Systems Administrators"
151143 "Computer Network Architects"
151151 "Computer User Support Specialists"
151152 "Computer Network Support Specialists"
151199 "Computer Occupations, All Other"
152000 "Mathematical science"
152011 "Actuaries"
152021 "Mathematicians"
152031 "Operations research analysts"
152041 "Statisticians"
152091 "Mathematical technicians"
152099 "Mathematical Science Occupations, All Other
172000 "Engineers"
172011 "Aerospace engineers"
172021 "Agricultural engineers"
172031 "Biomedical engineers"
172041 "Chemical engineers"
172051 "Civil engineers"
172061 "Computer hardware engineers"
172071 "Electrical engineers"
172072 "Electronics engineers, except computer"
172081 "Environmental engineers"
172111 "Health/safety engineer, except mining"
172112 "Industrial engineers"
172121 "Marine engineers and naval architects"
172131 "Materials engineers"
172141 "Mechanical engineers"
172151 "Geological engineer, including mining"

172161 "Nuclear engineers"
172171 "Petroleum engineers"
172199 "Engineers, all other

191000 "Life scientists"

191011 "Animal scientists"
191012 "Food Scientists and Technologists"
191013 "Soil and plant scientists"
191021 "Biochemists and biophysicists"
191022 "Microbiologists"
191023 "Zoologists and wildlife biologists"
191029 "Biological scientists, all other"
191031 "Conservation scientists"
191032 "Foresters"
191041 "Epidemiologists"
191042 "Medical scientist, except epidemiologist"
191099 "Life scientists, all other"
192000 "Physical scientists"
192011 "Astronomers"
192012 "Physicists"
192021 "Atmospheric and space scientists"
192031 "Chemists"
192032 "Materials scientists"
192041 "Environmental scientist, includes health"
192042 "Geoscientist, except hydrologists"
192043 "Hydrologists"
192099 "Physical scientists, all other

251021 "Computer science teachers, postsecondary"

251022 "Mathematical science, postsecondary"
251032 "Engineering teachers, postsecondary"
251041 "Agricultural science, postsecondary"
251042 "Biological science, postsecondary"
251043 "Forestry/conservation sci, postsecondary"
251051 "Atmospheric science, postsecondary"
251052 "Chemistry teachers, postsecondary"
251053 "Environmental science, postsecondary"
251054 "Physics teachers, postsecondary"

Note: All other occupations are classified as non-STEM occupations

Appendix D

Student questionnaire: Survey items used to derive the design variable

Student questionnaire: Survey items used to derive the design variable

23. Talent Search, Upward Bound, and Gear Up are programs that help economically disadvantaged high school students to prepare for entering and succeeding in college. At any time during high school, have you participated in these programs or a similar program?

Yes....... O → **GO TO QUESTION 24**
No........ O → **SKIP TO QUESTION 25**

24. Please mark the school years during which you participated in Talent Search, Upward Bound, or a similar program.

(MARK ALL THAT APPLY ON EACH LINE)

	9th grade	10th grade	11th grade	12th grade	Did not participate
a. Talent Search	O	O	O	O	O
b. Upward Bound	O	O	O	O	O
c. Other similar program (including Gear Up)	O	O	O	O	O

33. Have you ever been in any of the following kinds of courses or programs in high school?

(MARK ONE RESPONSE ON EACH LINE)

	Yes	No
a. Advanced Placement (AP)	O	O
b. International Baccalaureate (IB)	O	O
c. Courses or a program which you take at a separate area or regional vocational school part-time	O	O
d. Remedial English	O	O
e. Remedial math	O	O
f. Bilingual or bicultural education	O	O
g. English as a Second Language (ESL)	O	O
h. Dropout prevention, Alternative or Stay-in-School Program	O	O
i. Special Education Program	O	O
j. Course via distance learning	O	O
k. Career academy	O	O
l. Special program to help students plan or prepare for college	O	O

References

Ackerman, P. L., Kanfer, R., & Calderwood, C. (2013). High school advanced placement and student performance in College: STEM majors, non-STEM majors and gender differences. *Teachers College Record, 115*(10), 1-43.

Adelman, C. (2006). *The toolbox revisited: Paths to degree completion from high school through college*. Washington DC: Office of Educational Research and Improvement, U.S. Department of Education.

Adler, P. S., & Kwon, S. (2002). Social capital: Prospects for a new concept. *The Academy of Management Review, 27*(1), 17-40.

Anderson, E. L. & Kim, D. (2006). *Increasing the success of minority students in science and technology* (No.4). Washington DC: American Council on Education.

Arbona, C. & Nora, A. (2007). The influence of academic and environmental factors on Hispanic college degree attainment. *The Review of Higher Education, 30*(3), 247-269.

Bausmith, J. M., & France, M. (2012). The impact of gear up on college readiness for students in low income schools. *Journal of Education for Students Placed at Risk, 17*(4), 234-246.

Blickenstaff, J. C. (2005). Women and science careers: Leaky pipeline or gender filter? *Gender and Education, 17*(4), 369-386.

Bong, M. (1999). Personal factors affecting the generality of academic self-efficacy judgments: Gender, ethnicity, and relative expertise. *The Journal of Experimental Education, 67*(4), 315-331.

Bonous-Hammarth, M. (2000). Pathways to success: Affirming opportunities for science, mathematics, and engineering majors. *The Journal of Negro Education, 69*(1/2), 92-111.

Bourdieu, P. (1977). *Outline of a theory of practice.* Cambridge, MA: Cambridge University Press.

Bourdieu, P. (1984). *Distinction: A social critique of the judgment of taste*. Cambridge, MA: Harvard University Press.

Bourdieu, P. (1986). The forms of capital. In J. Richardson (Ed.) *Handbook of theory and research for the sociology of education* (pp.241-258). New York, NY: Greenwood

Bourdieu, P. (1990). *The logic of practice.* Translated by R. Nice. Stanford, CA: Stanford University Press.

Bourdieu, P. & Passeron, J. (1990). *Reproduction in education, society and culture*. Beverly Hills, CA: Sage.

Brown, A. R., Morning, C., & Watkins, C. (2005). Influence of African American engineering student perceptions of campus climate on graduation rates. *Journal of Engineering Education, 94*(2), 261-271.

Bunnell, T. (2009). The international baccalaureate in the USA and the emerging 'culture war'. *Discourse: Studies in the Cultural Politics of Education, 30*(1), 61-72.

Bush, V. (1945). *Letter to the President.* Retrieved June, 18, 2014 from http://www.nsf.gov/od/lpa/nsf50/vbush1945.htm.

Byars-Winston, A. (2014). Toward a framework for multicultural STEM-focused career interventions. *The Career Development Quarterly, 62,(4), 340-357.*

Cabrera, A. F., Deil-Amen, R., Prabhu, R., Terenzini, P. T., Lee, C., & Franklin Jr., R. E. (2006). Increasing the college preparedness of at-risk students. *Journal of Latinos and Education, 5*(2), 79-97.

Caldas, S. J., Bankston, C. L., & Cain, J. S. (2007). A case study of teachers' perceptions of school desegregation and the redistribution of social and academic capital. *Education and Urban Society, 39*(1), 194-222.

Cannady, M. A., Greenwald, E., Harris, K. N. (2014). Problematizing the stem pipeline metaphor: Is the stem pipeline metaphor serving our students and the stem workforce? *Science Education, 98*(3), 443-460.

Castillo, L.G., Conoley, C. W., Choi-Pearson, C., Archuleta, D. J., Phoummarath, M. J., & Van Landingham, A. (2006). University environment as a mediator of Latino ethnic identity and persistence attitudes. *Journal of Counseling Psychology, 53*(2), 267-271.

Cates, J. Y. & Schaefle, S. E. (2011). The relationship between a college preparation program and at-risk students' college readiness. *Journal of Latinos and Education, 10*(4), 320-334.

Chajewski, M. M., Mattern, K. D., & Shaw, E. J. (2011). Examining the role of advanced placement exam participation in 4-year college enrollment. *Educational Measurement Issues and Practices, 30*(4), 16-27.

Chapman, D. W. (1981). A model of student college choice. *The Journal of Higher Education, 52*(5), 490-505.

Chen, X. & Weko, T. (2009). *Students who study science, technology, engineering, and mathematics (stem) in postsecondary education*. NCES 2009-161. Washington, D.C.: U.S. Department of Education, National Center for Education Statistics.

Cole, D. & Espinoza, A. (2008). Examining the academic success of latino students in science, technology, engineering and mathematics (STEM majors. *Journal of College Student Development, 49*(4), 285-300.

Collier, W. V. (2007). Empty promises in the stem fields. *Diverse: Issues in Higher Education, 24*(17), 29.

Constantine, J. M., Seftor, N. S., Martin, E. S., Silva, T., & Myers, D. (2006). *A study of the effect of the Talent Search program on secondary and postsecondary* *outcomes in Florida, Indiana, and Texas: Final report from phase II of the national evaluation*. Washington DC: Office of Planning, Evaluation and Policy Development, U.S. Department of Education.

Cover, B., Jones, J. I., & Watson, A. (2011). *Science, technology, engineering, and mathematics (STEM) occupations: a visual essay*. Washington DC: Monthly Labor Review, U.S. Bureau of Labor Statistics. Retrieved June 25, 2014 from www.bls.gov/opub/mlr/ 2011/05/art1full.pdf.

Cowan-Pitre, C. & Pitre, P. (2009). Increasing underrepresented high school students' college transition and achievements: TRIO educational opportunity programs. *NASSP Bulletin, 93*(2), 96-110.

Crisp, G. C., Nora, A., & Taggart, A. (2009). Student characteristics, pre-college, college, and environmental factors as predictors of majoring in and earning a STEM degree: An analysis of students attending a Hispanic serving institution. *American Educational Research Journal, 46*(4), 924-942.

Crisp. G. & Nora, AS. (2012). Overview of Hispanics in science, mathematics, engineering and technology (STEM): K-16 representation, preparation and participation. *White paper for the Hispanic Association of Colleges and Universities, July.*

Daily, S. B. & Eugene, W. (2013). Preparing the future stem workforce for diverse environments. *Urban Education, 48*(5), 682-704.

Domina, T. (2009). What works in college outreach: Assessing targeted and schoolwide interventions for disadvantaged students. *Educational Evaluation and Policy Analysis, 31*(1), 127-152.

Dowd, A. C., Malcom, L.E., & Macias, E. E. (2010). Improving transfer access to STEM bachelor's degree at Hispanic serving institutions through the America

COMPLETES-act. *Center for Urban Education. Los Angeles: University of Southern California.*

Dufur, M. J., Parcel, T. L., & Troutman, K. P. (2013). Does capital at home matter more than capital at school? Social capital effects on academic achievement. *Research in Social Stratification and Mobility, 31,* 1-21.

Dumais, S.A. (2002). Cultural capital, gender, and school success: The role of habitus. *Sociology of Education 75*(1), 44-68.

Dyce, C.M., Albold, C., & Long, D. (2013). Moving from college aspiration to attainment: Learning from one college access program. *The High School Journal, 96*(2), 152-165.

Enberg, M. E., & Wolniak, G. C. (2013). College student pathways to the STEM disciplines. *Teachers College Record, 115*(1), 1-27

Foust, C., Hertberg-Davis, H., & Callahan, C. M. (2009). Students perceptions of the non-academic advantages and disadvantages of participation in advanced placement courses and international baccalaureate programs. *Adolescence, 44*(174), 289-312.

Fries-Britt, S. L., Younger, T., & Hall, W. D. (2010). Lessons from high-achieving students of color in physics. *New Directions for Institutional Research, 148,* 75-83.

Gaddis, S. M. (2012). The influence of habitus in the relationship between cultural capital and academic achievement. *Social Science Research, 42*(1), 1-13.

Gall, M. D., Gall, J. P., & Borg, W. R. (2007). *Educational research: An introduction* (8th ed.). Boston, MA: Prentice Hall.

Gardner, D. P. (1983). *A nation at risk*. Washington, DC: The National Commission on Excellence in Education, US Department of Education. Retrieved June 18, 2014 from http://www2.ed.gov/pubs/NatAtRisk/index.html.

Glass, J. L., Sassler, S., Levitte, Y., & Michelmore, K. M. (2013). What's so special about STEM? A comparison of women's retention in STEM and professional occupations. *Social Forces, 92*(2), 723-756.

Glennie, E. J., Dalton, B. W., & Knapp, L.G. (2014). The influence of precollege access programs and postsecondary enrollment and persistence. *Educational Policy,* 1-21.

Gonzalez, K. P., Stoner, C., & Jovel, J. E. (2003). Examining the role of social capital in access to college for Latinas: toward a college opportunity framework. *Journal of Hispanic Higher Education, 2*(1), 146-170.

Gonzalez, L. M. (2012). College-level choice of Latino high school students: A social-cognitive approach. *Journal of Multicultural Counseling and Development, 40*, 144-155.

Goyette, K. A. & Mullen, A. L. (2006). Who studies the arts and sciences? Social background and the choice and consequences of undergraduate field of study. *Journal of Higher Education, 77*(3), 497-538.

Graham, M. J., Frederick, J., Byars-Winston, A., Hunter, A. B., & Handelsman J. (2013). Increasing persistence of college students in STEM. *Science Education, 273, 1455-1456.*

Hargrove, L. Godin, D., & Dodd, B. (2008). *College outcomes comparison by AP and non-AP experiences* (Research Report 2008-3). New York, NY: College Board.

Holland, J. M., Major, D. A., & Orvis, K. A. (2012). Understanding how peer mentoring and capitalization link STEM students to their majors. *The Career Development Quarterly, 60*(4), 343-354.

Hrabowski III, F. A. (2012). Broadening participation in the American stem workforce. *Bioscience, 62*(4), 325-326.

Jackson, C. K. (2014). Do college-preparatory programs improve long-term outcomes? *Economic Inquiry, 52*(1), 72-99.

Joy, L. (2006). Occupational differences between recent male and female college graduates. *Economics of Education Review, 25*(2)*,* 221-231.

Kerr, B. A., & Colangelo, N. (1988). The college plans of academically talented students. *Journal of Counseling and Development, 67*(1), 42-48.

Klugman, J. (2012). How resource inequalities among high schools reproduce class advantages in college destinations. *Research in Higher Education, 53*(8), 803-830.

Kretchmar, J., & Farmer, S. (2013). How much is enough? Rethinking the role of high school courses in college admission. *Journal of College Admissions, 220*(summer), 28-33.

Lamont, M., & Lareau, A. (1988). Cultural capital: Allusions, gaps and glissandos in recent theoretical developments. *Sociological Theory, 6*(1), 153-168.

LeBeau, B., Harwell, M., Monson, D., Dupuis, D., Medhanie, A., & Post, T. R. (2012). Student and high-school characteristics related to completing a science, technology, engineering or mathematics (STEM) major in college. *Research in Science and Technological Education, 30*(1), 17-28.

Lowell, B. L. (2010). A long view of America's immigration policy and the supply of foreign –born STEM workers in the United States. *American Behavioral Scientist, 53*(7), 1029-1044.

Luo, T. & Holden, R. J. (2014). *Do different groups invest differently in higher education? Beyond the Numbers: Special Studies and Research 3*(13). Washington DC: U.S. Bureau of Labor Statistics. Retrieved July 1, 2014 from http://www.bls.gov/opub/btn/volume-3/pdf/do-different-groups-invest-differently-in-higher-education.pdf

Ma, Y. (2011a). Gender differences in the paths leading to a STEM baccalaureate. *Social Science Quarterly, 92*(5), 1169-1190.

Ma, Y. (2011b). College major choice, occupational structure and demographic patterning by gender, race, and nativity. *The Social Science Journal, 48*(1), 112-129.

MacPhee, D., Farro, S., & Canetto, S. S. (2013). Academic self-efficacy and performance of underrepresented STEM majors: Gender, ethnic, and social class patterns. *Analyses of Social Issues and Public Policy, 13*(1), 347-369.

Maltese, A. V. (2008). *Persistence in STEM: An investigation of the relationship between high school experiences in science and mathematics and college degree completion in STEM fields* (Doctoral Dissertation). Available from ProQuest Dissertation and Thesis Database. (AAT3326999).

Maltese, A. V. & Tai, R. H. (2011). Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among U.S. students. *Science Education, 95*(5), 877-907.

Martinez, M. & Klopott, S. (2005). *The link between high school reform and college access and success for low income and minority youth*. Washington, DC: American Youth Policy Forum and Pathways to College Network. Retrieved July 3, 2014 from http://www.aypf.org publications/HSReformCollege Access andSuccess.pdf

Mattern, K. D., Marini, J., & Shaw, E. J. (2014). *Are AP students more likely to graduate from college on time*? (College Board Research Report 2013-5). New York: The College Board.

McCauley, D. (2007). *The impact of advanced placement and dual enrollment programs on college graduation.* Texas: Applied Research Projects, Texas State University-San Marcos. Retrieved July 10, 2014 from https://digital.library.txstate.edu/handle/10877/ 3597.

Melguizo, T., & Wolniak, G. C. (2012). The earning benefits of majoring in stem fields among high achieving minority students. *Research in Higher Education, 53*, 383-405.

Menard, S. (2002). *Applied logistic regression analysis.* Thousand Oaks, CA: Sage Publications.

Min, P. G. & Jang, S. H. (2015). The concentration of Asian Americans in STEM and health-care occupations: An intergenerational comparison. *Ethnic and Racial Studies, 38*(6), 841-859.

Moakler, M. W. & Kim, M. M. (2013). College major choice in STEM: Revisiting confidence and demographic factors. *The Career Development Quarterly, 62*(2), 128-142.

Morgan, S. L., Gelbgiser, D., & Weeden, K.A. (2012). Feeding the pipeline: Gender, occupational plans, and college major selection. *Social Science Research, 42*(4), 989-1005.

Museus, S. D., Palmer, R. T, Davis, R. J., & Maramba, D. C. (2011). *Racial and ethnic minority students' success in STEM education. ASHE Higher Education Report, 36*(6). Hoboken, NJ: Wiley and Sons.

Myers, D., Olsen, R., Seftor, N., Young, J., & Tuttle, C. (2004). *The impacts of regular upward bound: Results from the third follow-up data collection.* Washington, DC: U.S. Department of Education.

National Center for Education Statistics. (2014). *The condition of education: Educational attainment.* Retrieved July 1, 2014from *http://nces.ed.gov/programs/coe/indicator_caa.asp.*

National Commission on Excellence in Education. (1983). *A nation at risk: the imperative for educational reform: a report to the Nation and the Secretary of Education, United States Department of Education.* Washington, D.C.: National Commission on Excellence in Education.

National Science Foundation. (2014). *Science and Engineering Indicators 2014*. Arlington, VA: National Center for Science and Engineering Statistics. Retrieved August 9, 2014 from http://www.nsf.gov/statistics/seind14/index.cfm/chapter-3/c3s6.htm.

National Science Foundation. (2013). *Women, minorities, and persons with disabilities in science and engineering: 2013*. Special report NSF 13–304. Arlington, VA: National Center for Science and Engineering Statistics. Retrieved July 3, 2014 from www.nsf.gov/ statistics/wmpd/ 2013/pdf/nsf13304_digest.pdf.

Nores, M. (2010). Differences in college major choices by citizenship status. *The Annals of the American Academy of Political and Social Science, 627*(1), 125-141.

Niu, S. X., & Tienda, M. (2013). High school economic composition and college persistence. *Research in Higher Education 54*(1), 30-62.

Obama, B. (2009). *Remarks by the President on the "Educate to Innovate" Campaign and Science Teaching and Mentoring Awards*. Washington DC: Office of the President. Retrieved June 20, 2014 from http://www.whitehouse.gov/photos-and-video/video/president-obama-kicks-educate-innovate#transcript.

Occupational Information Network. (2014). STEM disciplines. Retrieved November 20, 2014 from http://www.onetonline.org/find/stem.

Orr, M. K., Lord, S. M., Layton, R. A., & Ohland, M. W. (2014). Student demographics and outcomes in mechanical engineering in the U.S. *International Journal of Mechanical Engineering Education, 42*(1), 48-60.

Ou, S. & Reynolds, A. J. (2014). Early determinants of postsecondary education participation and degree attainment: Findings from an inner-city minority cohort. *Education and Urban Society, 46*(4), 474-504.

Pell Institute. (2009). *National Study finds TRIO programs effective at increasing college and enrollment and graduation*. Retrieved July 1, 2014 from http://www.pellinstitute.org/ downloads/publications-Studies_Find_TRIO_Programs_Effective_May_2009.pdf.

Portes, A. (1998). Social capital: Its origins and applications in modern sociology. *Annual Review of Sociology, 24*, 1-24.

Reason, R. D. (2009). An examination of persistence research through the lens of a comprehensive conceptual framework. *Journal of College Student Development, 50*(6), 659-682.

Robst, J. (2007). Education and job match: The relatedness of college major and work. *Economics of Education Review, 26*(4), 397-407.

Schneider, M. & Yin, L. (2011). The high cost of low graduation rates: How much does dropping out of college really cost? *American Institutes for Research.*

Shaw, E. J., & Barbuti, S. (2010). Patterns of persistence in intended college major with a focus on stem majors. *NACADA Journal, 30*(1), 19-34.

Shaw, E. J., Marini, J. P., & Mattern, K. D. (2012). Exploring the utility of advanced placement participation and performance in college admission decisions. *Educational and Psychological Measurement, 73*(2), 229-253.

Siobhan, M. C., McKillip, M.E., & Smith, K. (2013). *An investigation of college students' perceptions of advanced placement courses* (Research Report 2013-2). New York, NY: College Board.

Sokatch, A. (2006). Peer influences on the college=going decisions of low socioeconomic status urban youth. *Education and Urban Society, 39*(1), 128-146.

Sparfeldt, J. R. (2007). Vocational interests of gifted adolescents. *Personality and IndividualDifferences, 42*(6), 1011-1021.

Swail, W. S., & Perna, L. W. (2002). Pre-college outreach programs: A national perspective. In Tierney & Hagedorn (Eds.). *Increasing access to college: Extending possibilities for all students* (pp.15-34). Albany, NY: State University of New York Press.

Tabachnick, B. G., & Fidell, L.S. (2007). *Using multivariate statistics* (5th ed.). New York, NY: Pearson Education, Inc.

Texas Higher Education Coordinating Board. (2014). *IB Best Practices.* Retrieved June 22, 2014 from http://cbgm41.thecb.state.tx.us/search?site=WWW&client=wwwnew_frontend&proxystylesheet=wwwnew_frontend&proxyreload=1&output=xml_no_dtd&q=IB&btnG.x=13&btnG.y=6.

The College Board (2014a). *Releases*. Retrieve June 14,, 2014 from https://www.collegeboard.org/releases/2014/class-2013-advanced-placement-results-announced.

The College Board (2014b). *Advanced Placement.* Retrieved June 14, 2014 from https://apstudent.collegeboard.org/home?navid=gh-aps.

The International Baccalaureate Organization. (2014a). *Facts and figures*. Retrieved June 15, 2014 from http://www.ibo.org/facts/statbulletin/dpstats/documents/2013-MayDPStatistical Bulletin.pdf.

The International Baccalaureate Organization. (2014b). *Program outline*. Retrieved June 15, 2014 from http://www.ibo.org/iba/become/documents/DPAug-SeptEng.pdf.

Thomas, S. L. (2000). Deferred costs and economic returns to college major, quality, and performance. *Research in Higher Education, 41*(3), 281-313.

Tramonte, L. & Willms, J. D. (2010). Cultural capital and its effects on education outcomes. *Economics of Education Review, 29*(2), 200-213.

Trusty, J. (2002). Effects of high school course-taking and other variables on choice of science and mathematics college major. *Journal of Counseling and Development, 80*(4), 464-474.

Tyson, W., Lee, R., Borman, K. M., & Hanson, M. A. (2007). Science, technology, engineering, and mathematics (stem) pathways: High school science and math coursework and postsecondary degree attainment. *Journal of Education for Students Placed At Risk, 12*(3), 243-270.

U.S. Bureau of Labor Statistics. (2012). *STEM occupations*. Washington DC: U.S. Bureau of Labor Statistics. Retrieved June 21, 2014 from http://www.bls.gov/soc/Attachment_A_STEM.pdf.

U.S. Bureau of Labor Statistics. (2014). *College enrollment and work activity of 2013 high school graduates.* Washington DC: U.S. Bureau of Labor Statistics. Retrieved June 21, 2014 from www.bls.gov/news.release/hsgec.nr0.htm.

U.S. Department of Education. (2008). *Outcomes of the GEAR UP Program*. Washington DC: U.S. Department of Education. Retrieved June 27, 2014 from www.ed.gov/about/offices/ list/opepd/ppss/reports.html#title.

U.S. Department of Education, National Center for Education Statistics. (2014). *The Condition of Education 2014* (NCES 2014-083), *Immediate Transition to College.* Washington DC: U.S. Department of Education. Retrieved July 1, 2014 from http://nces.ed.gov/fastfacts/display.asp?id=51.

U. S. Department of Education. (2014a). *Upward Bound Program*. Washington DC: U.S. Department of Education. Retrieved June 27, 2014 from http://www2.ed.gov/programs/ trioupbound/index.html.

U.S. Department of Education (2014b). *Talent Search Program*. Washington DC: U.S. Department of Education. Retrieved June 27, 2014 from http://www2.ed.gov/programs/ triotalent/index.html.

U.S. Department of Education (2014c). *Gaining early awareness and readiness for undergraduate programs.* Washington DC: U.S. Department of Education. Retrieved June 27, 2014 from http://www2.ed.gov/programs/gearup/index.html.

Vilorio, D. (2014). *Intro to tomorrow's jobs*. Occupational outlook quarterly, Washington DC: Bureau of Labor and Statistics. Retrieved from http://www.bls.gov/opub/ooq /2014/spring/art01.pdf.

Wai, J., Lubinski, D., Benbow, C. P., & Steiger, J. H. (2010). Accomplishment in science, technology, engineering, and mathematics (STEM) and its relation to STEM educational dose: A 25-year longitudinal study. *Journal of Educational Psychology, 102*(4), 860-871.

Walker, S. A. & Pearsall, L. D. (2012). Barriers to advanced placement for Latino students at the high-school level. *Roeper Review, 34*(1), 12-25.

Walsh, R. (2011). Helping or hurting: Are adolescent intervention programs minimizing racial inequality. *Education and Urban Society, 43*(3), 370-395.

Xu, Y. J. (2013). Career outcomes of stem and non-stem college graduates: Persistence in majored-field and influential factors in career choices. *Research in Higher Education, 54*, 349-382.

Biographical Information

Since earning a Bachelor of Arts in Economics and a Master of Arts in Counseling, Rachel Lomax has spent the majority of her career in education as a junior high/high school math teacher and junior high school counselor. Her love of education led her to pursue a doctoral degree in Educational Leadership and Policy Studies at the University of Texas in Arlington. She has always desired to conduct research on students' pathways as it related to the field of mathematics as well as the pursuit of higher levels of attainment. Rachel has spent some of her recent time attending educational conferences where she has presented her scholarly work. Her future plans include to continue and advance her career in the field of education. Rachel desires to gain employment at a university as a college professor where she can continue working in education and further engage in her research.