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Women in Science, Technology, Engineering and Mathematics (STEM): Pre-College and College Factors of Success

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To the Graduate Council:

I am submitting herewith a dissertation written by Jada Russell entitled "Women in Science, Technology, Engineering and Mathematics (STEM): Pre-College and College Factors of Success." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Higher Education Administration.

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WOMEN IN SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS (STEM): PRE-COLLEGE AND COLLEGE FACTORS OF SUCCESS

A Dissertation Presented for the
Doctor of Philosophy
Degree
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Jada Russell
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DEDICATION

To my husband
Brian Russell

My boys
Brian and Bryson Russell

My loving parents and family
Arlene Hamilton and Steven Johnson
Sister, cousins, sorority sisters

My fur babies
Roxy and Nash Russell

My UT family

"Live, Laugh and Love"

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ABSTRACT

Scholars have reported that the competitiveness and innovation of the United States' workforce in Science, Technology, Engineering and Mathematics [STEM] fields are critical to maintaining our nation's security and economic edge (Chen, 2009; Carlone & Johnson, 2007; Espinosa, 2011). Indeed, STEM is one of the fastest growing fields in the employment industry, according to the U.S. Department of Commerce (Langdon, et. al, 2011), and between 2008 and 2018, the number of STEM jobs is expected to increase 17%. Fostering learning pathways for all individuals interested in pursuing careers and education in STEM disciplines is necessary for us to meet the demands of the labor force and benefit from "diverse scientific inquiry" (Espinosa, 2011 p. 236).

The purpose of the study was to explore the relationship of various pre-college and college factors with persistence of women in STEM majors. This study used the High School Longitudinal Study of 2009 (HSLS:09) to explore the relationships between the variables. Pre-college and college factors that were more likely to influence persistence of women majoring in STEM were identified and categorized into three groups based on Perna's conceptual framework: individual habitus, school and community context, and higher education context (Perna, 2000). Block entry logistic regression was used to explore the relationship between variables within the three layers.

The findings from this study echoed the relationship of STEM GPA and participation with faculty as significant for persistence of women in STEM. Some of the findings were surprising and contrary to previous research. For example, socioeconomic status (SES) was only significant for one block of the three. Race and overall GPA were insignificant for all blocks they were included. The most surprising finding was participation in community-based project was negatively correlated with persistence of women majoring in STEM. Higher education institutions can use this information to develop strategic initiatives to support women majoring in STEM.

TABLE OF CONTENTS

CHAPTER I
INTRODUCTION AND STATEMENT OF THE PROBLEM

Introduction

The problem-solving skills that students learn by studying STEM are valuable skills that are transferrable to other fields. Scholars have reported that the competitiveness and innovation of the United States' workforce in STEM fields is critical to maintaining our nation's security and economic edge (Chen, 2009; Carlone & Johnson, 2007; Espinosa, 2011). Our former president, Barack Obama, once said

> "Science, Technology, Engineering and Mathematics (STEM) is more than a school subject, or the periodic table, or the properties of waves. It is an approach to the world, a critical way to understand and explore and engage with the world, and then have the capacity to change that world." (Gagnier & Fisher, 2016, p.1)

Indeed, STEM is one of the fastest growing fields in the employment industry, according to the U.S. Department of Commerce (Langdon, et. al, 2011), and between 2008 and 2018, the number of STEM jobs is expected to increase 17%; while, the growth for non-STEM jobs is expected to decrease. The President's Council of Advisors on Science and Technology (2012), projects the US will need an additional one million STEM professionals than what is currently produced, only 9.8% (Augustine, 2005; U.S. Department of Commerce, 2011). However, while approximately one-third of the entering college freshmen class expresses an initial interest in a STEM major, only about 14 percent of the total undergraduate population in 2007-2008 declared STEM majors (Snyder & Dillow, 2011). Chen discovered that 56 percent of undergraduate students who initially declared a STEM major in their freshman year dropped out of the pipeline over the next six years (2009). Our economic and innovative edge would suffer if we do not have enough skilled people prepared to work in the STEM fields.

If we are to nurture sufficient people to enter these fields and meet our nation's needs for such professionals, then fostering learning pathways for those who may be interested in pursuing careers and education in STEM disciplines is necessary (Espinosa, 2011). One factor in the current loss of undergraduates to the field rests with the fact that fewer women enter or persist in STEM disciplines. According to the United States Census Bureau's 2009 American Community Survey (ACS), women hold fewer than 25 percent of STEM positions in the workforce despite comprising half of the workforce in the U.S. economy. While over 6.7 million college-educated working men possessed STEM degrees in 2009, there were only 2.5 million women with the same degree attainment (Beede et al., 2011). Even with increasing numbers of college educated women in the overall workforce, the number of those in STEM careers still remains disproportionally low.

Adding to the low representation of women entering STEM fields, women with STEM degrees are more likely to work in education or healthcare rather than in STEM fields (Beede et al., 2011). This underrepresentation of women pursing and attaining degrees and in entering the STEM fields compounds their underrepresentation in the fields and contributes to the shortage of professionals to fill needed positions (Jackson, 2004). Increasing the number of students entering both the study of STEM fields and filling the need for professional work in the field has become a vital, strategic initiative for our nation. In order to accomplish this goal, tapping into the enormous potential resident in the increasing number of women going to college and seeking positions in the workforce is necessary. Why is increasing the number of women graduates in STEM disciplines important and relevant?

The cure for cancer is unknown, the cost of medical treatment for HIV/AIDS is still not affordable (Aguirre, 2012) and ongoing challenges of climate change (Karl, Melillo & Peterson,

2009) are only a few problems that scientists and researchers hope to resolve in the future. Those in the STEM workforce stand to solve some of the most challenging problems of the world today. On the basis of numbers alone, we need women. More importantly perhaps, we need the perspective that women might add to a largely male dominated profession. For example, without the presence of women, “a predominantly men group of engineers tailored the first generation of automotive airbags to adult men bodies, resulting in avoidable deaths for women and children” (Margolis & Fisher, 2002, pp. 2-3). Scientific and technological products, services and solutions are likely to be better designed to resolve and move us to improved lives with a more diverse workforce.

Who knew that a young black woman from White Sulphur Spring, Virginia would become the first physicist and mathematician responsible for computing trajectories to send astronauts into space? Katherine Johnson’s story was highlighted in a movie *Hidden Figures*. There are many untold stories of women who have made an impact in society through their contributions in STEM without being recognized for their amazing work. Without women as a contributing force to STEM fields, the world and the field cannot benefit from diverse voices, perhaps unique perspectives and potential contributions to society. Therefore, we all suffer without women present in STEM fields of study and practice.

There are disparities among graduation rates of underrepresented populations in STEM, especially for women. Women have surpassed men in college access and persistence for many college outcomes, yet women remain less likely to graduate in STEM fields (Bettinger & Long, 2005). The total number of science and engineering degrees, inclusive of social sciences, conferred during 1997 to 2006 was 1,473,735; of those, 854,766 were women (National Science Board [NSB], 2006). Removing the number of graduates from social science majors causes drastic changes in percentages, with men having received 61 percent and women 39 percent of degrees (NSB, 2006). The dropout rate for women pursuing STEM degrees is also a concern. Approximately 32 percent of women compared to 26 percent of men left STEM fields by switching to a non-STEM major. In comparison, approximately 24 percent of men compared to 14 percent of women left STEM fields by dropping out of college (Chen, 2013). We sacrifice the benefits of "diverse scientific inquiry" without equal representation of all individuals (Espinosa, 2011 p. 236). The contributions of women in STEM fields of study will remain unknown until they are equally represented to the total population as STEM graduates.

Our world is increasingly complex and faced with new problems that have never been solved. The problems that humanity will face in the future requires the nation to be equipped with the skills to solve problems, gather research and make sense of that evidence. All of these skills can be acquired by studying STEM. Increasing the number of women who pursue and persist to graduation in STEM fields and subsequently enter the field is a concern of a number of stakeholders. One critical stakeholder is higher education. Increasingly, it is being held accountable to the public for funding received and for students' return on investment. Given the national need for increasing the workforce in STEM fields, it is not surprising that citizens, companies, and other stakeholders look to institutions of higher education to address this national need, and it is responding to this call to address this need with research and strategic initiatives to increase the number and persistence of students graduating from STEM fields.

Anecdotal evidence and small-scale studies have laid the foundation for what we know about the persistence in STEM fields of underrepresented populations, such as women, racial minorities, first generation students and those from low socioeconomic background (Anderson & Kim, 2006; Hill, Corbett & Rose, 2010; Griffith, 2010; Kokkelenberg & Sinha, 2010; Shaw &

Barbuti, 2010). While STEM attrition rates are higher among students who are less academically prepared (Astin and Astin, 1992; Kokkelenberg and Sinha, 2010; Shaw and Barbuti, 2010, Whalen and Shelley, 2010), several researchers have found that high performing students also have high attrition rates in STEM (Seymour and Hewitt, 1997; Lowell, 2009). Motivation, confidence, and beliefs about one's ability to learn STEM subjects have been related to STEM attrition (Burtner, 2005). Lastly, the importance of financial aid in retaining students plays a critical role in persistence to graduation particularly for low-income, first generation, and underrepresented students. (Fenske, Porter, and DuBrock, 2000; Whalen and Shelle, 2010). Indeed, we know a good deal more about why underrepresented students, inclusive of women, do not enter or persist to graduation in STEM. In contrast, we know little to nothing about the women who enter STEM fields, persist to graduation and enter the STEM fields. What is it about them that allows them to defy the odds, to stand out. Would knowing this allow us to nurture and develop such qualities, characteristics or attitudes in other women?

Statement of the Problem

We know the graduation rates in STEM are not sufficient in number or diversity to meet the growing needs of the workforce. There are disparities among graduation rates of underrepresented populations in STEM, especially for women. While we have a sense of the impediments to the entry and persistence to graduation of women in STEM, we know little about the pre-college and college factors of those who persist as STEM majors. Knowing such information may allow us to intentionally support women who enter the STEM field to persist in their major.

Purpose Statement

The purpose of the study is to explore the relationship of various pre-college and college factors with persistence of women in STEM majors. Factors influencing the persistence of women in STEM are explored in an effort to create a profile of women likely to persist in STEM majors. Higher education administrators and other stakeholders will benefit by having the data that is intended to support policies to support women early and often in their academic journey as STEM majors. The policies developed in response to this information will increase the persistence of this particular population in an effort to diversify the STEM workforce. Diversification of the workforce will increase the richness of scientific innovation.

Research Questions

RQ1. Is there a relationship between race, and socioeconomic status and persistence for women majoring in STEM?

RQ2. Is there a relationship between high school GPA, science interest indicators, high school locale and type and persistence for women majoring in STEM?

RQ3. Is there a relationship between participation in summer camp, research and community-based projects and persistence for women majoring in STEM?

Methods and Procedures

In a quest to find out the differences in precollege and college factors among women who persist and do not persist in STEM major, I decided to use the High School Longitudinal Study of 2009 (HSLS:09) to explore the relationships between the variables. Using the HSLS 2009 national data set, I sought to identify variables that are more likely to influence persistence for women majoring in STEM fields. The sample size for this study included only female first-time degree-seeking full time students at four-year institutions who initially expressed an interest in

STEM as a major. Out of 23,503 students initially included in the HSLS:09, 11,524 students were selected based on gender. In the group of 11,524 female first time degree-seeking full time students there were 1,187 who initially considered a STEM major (mathematics, physical sciences, biological life sciences, inclusive of agriculture, natural resources and biological sciences, engineering, inclusive of engineering technologies, science technologies, and computer and information sciences). Upon deleting all participants with missing data in any of the variables chosen for this study, the total of the data subset was 946. This study employed logistic regression to explore the relationship among variables relationship for women persistence in STEM majors. Logistic regression allowed the comparison of the effects of different variables on dropping out or persisting in STEM major.

Conceptual Framework

Oftentimes researchers select a framework that uses either an economic or sociological approach to describe the college going culture that includes the process for college recruitment, selection, attendance, persistence and graduation. Researchers have found models that integrate aspects of both economics of human capital, and sociological notions of cultural and social capital to be most beneficial (Perna, 2000; St. John & Asker, 2001; St. John & Paulsen, 2001). Researchers found that the creation of this integrated conceptual framework offers a more reflective approach to the ideas of access, persistence, success and opportunity that considers the multiple pathways of the college-going process (Perna & Thomas, 2006). Perna responded to the need to have an integrated model of economic and sociological approaches by creating a blended conceptual model. This conceptual model includes four layers of influence that shape an individual’s assessment of the benefits and costs associated with pursing a higher education.

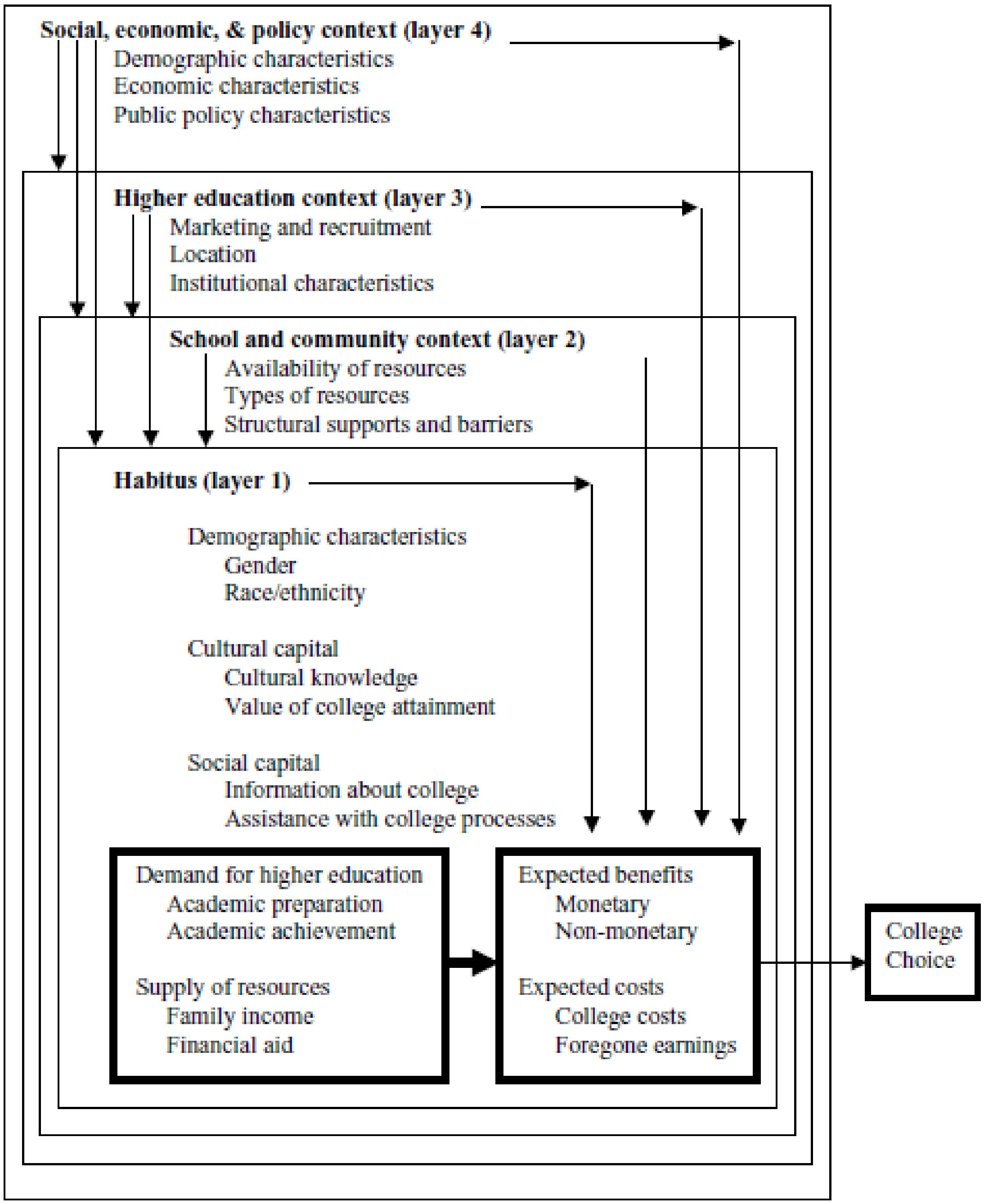

Figure 1: Perna's conceptual model of student college choice

For the purposes of this research study, I will focus on the first three layers of the conceptual model as these variables are found in the national dataset used for this study. The three layers are (a) individual habitus; (b) school and community environment; (c) the context of higher education (Perna, 2006).

The first layer of Perna's (2006) conceptual model, referred to as the individual habitus, includes the effects of race or ethnicity, gender, cultural, and social capital on college completion. Habitus is defined by Perna (2006) as the set of internalized thoughts, beliefs, and perceptions that one captures from the immediate environment. It is an individual's expectations, attitudes, and aspirations related to college (Perna, 2006). The habitus can be described as the subconscious thoughts that guide our actions. Examples of this layer as it relates to this study are gender and racial differences among STEM entrants, the role of parents in the college-going process, and the effects of social economic status on college success. In addition, the effects of the secondary school and community environment influence the college going culture.

The organizational habitus relates to the secondary school and community environment, which is the second layer of Perna's (2006) conceptual model. This layer considers the impact of social structures on the facilitation or limitation of the college-going culture. This organizational habitus suggests ways to understand the roles of schools in reproducing social inequalities (McDonough, 1997). The idea of attending college varies based on the school and community culture of support, availability of resources (Haveman and Smeeding, 2006), and academic preparation (Griffith, 2010). For example, Griffith (2010) found that high school students who persisted as STEM majors completed more AP courses, had a higher GPA in high school and higher SAT scores. These findings suggest the importance of secondary educational preparation, yet not all students have an equal access to all of these resources. The impact of school officials, academic readiness, and school characteristics all affect the enrollment and persistence of students in higher education. Disparities in resources exist among various school districts. Schools in affluent communities tend to have more resources that are available to offer smaller class sizes, more advanced placement courses, hire more credentialed teachers, purchase newer technology and books and other items to help prepare students for success (Wenglinsky, 1997). Schools in the inner city are often under sourced which contribute to the under preparedness for students attending these schools in STEM fields (Adelman, 2006; Flores, 2007; Oakes, 1990).

The third layer of Perna's (2006) conceptual model is the context of higher education. This layer recognizes the influence of higher education on the student's selection of the institution based on its institutional characteristics, location, and marketing and recruitment efforts. Higher education institutions do have a role in shaping student college choice. Higher education institutions passively convey information about their desired student based on their geographic proximity to students' homes (McDonough, Antonio, and Trent, 1997), targeted marketing and recruitment efforts (Chapman, 1981), and institutional characteristics that align with the students (Nora, 2004). For example, institutions have provided over night recruitment trips and scholarship opportunities for underrepresented minorities, students from low SES families and first-generation college students.

Combinations of aspects from each layer influence the student's decision to attend college. Researchers have recently begun to employ this integrated theoretical framework to understand the college-choice process of particular groups (Freeman, 1997; Paulsen 2001; Perna, 2006). I will use this integrated theoretical framework to explore the significance of various variables on women persisting as STEM majors. I will assess the benefit and costs of investment in college using this integrated model. Using this integrated approach including aspects of both human capital and sociological approaches will generate a comprehensive understanding of student college-choice of STEM. Taking into consideration the many variables surrounding college-choice will allow for a more accurate depiction of this phenomenon (Perna, 2006). Through this integrated conceptual framework, I can explore the college-going phenomenon, taking into consideration the differences that occur across race, gender, socioeconomic status and type of institution.

This theoretical framework allows me to work within the understanding that a student's decision or desire for educational attainment in a STEM field is not universal. For the purposes of this research study, variables used for this study will be categorized into one of the three layers: (a) individual habitus; (b) school and community environment; (c) the context of higher education (Perna, 2006). The organization into these layers will allow me to analysis the effects of each layer on women's persistence in STEM majors. This will give higher education professionals the opportunity to create policies that address variables that exist in each layer to increase women's persistence in STEM majors.

Significance of Study

Evidence of the lack of women graduating with STEM-related degrees remains a problem. A quantitative study allowed the opportunity to explore the effects of various variables on the outcome of graduation rates of students pursuing STEM-related degrees. Higher education administrators, faculty and staff will generate ideas to promote attraction, recruitment and persistence of women in STEM fields from the recommendations of this study. This research will inform policymakers, administrators and practitioners to effectively promote student success and aid in the persistence of women in STEM majors.

> As educators, we must demand commitment to diversity in full by keeping underrepresented populations at the center of related discussions…This requires creative

> and fiscal management and a challenge to the status quo of institutional practice….we must push for the sake of diverse scientific inquiry and for the sake of those who will shape the future of our scientific and technological world. (Espinosa, 2011, p. 236)

Reflexivity Statement

Growing up as an African American woman in Memphis, TN where my mother was an adjunct faculty member for the Department of Biology for the local community college, I never thought of my desire to walk in her shoes as something rare. While attending grade school in Memphis, TN I never thought of my desire to major in science as anything strange or different. Oftentimes the local health care professionals, scientists, engineers and others working in STEM related fields looked like me or other members in my family. I didn't realize that my desire to major in STEM was rare to achieve until I began to navigate spaces where black women from a lower socioeconomic status were uncommon.

My first encounter where I noticed that I was treated differently was during my senior year of high school. Because of my interest in attending college and majoring in STEM my mom cultivated this interest by registering me for many organizations that promoted my interests. One of these organizations was the Metropolitan Inter-Faith Association (MIFA). As a program participant, I had the opportunity to conduct research in the black community with a Family Nurse Practitioner. My research project titled "What are Risk Factors of Cardiovascular Disease in African-American Women?" won third place in the biology category of the National Association for the Advancement of Colored People: Afro-Academic, Cultural, Technological and Scientific Olympics (NAACP ACT-SO) competition. Many of the other representatives for the Memphis chapter of NAACP were from two parent households, attended schools in affluent communities and had mentors in their field since childhood. I realized that my personal life wasn't consistent with the other program participants. Both of my parents were in my life but I lived with my mother. My high school was average in comparison to those who attended private schools that offered more Advanced Placement (AP) courses, had higher class average ACT scores and families with increased financial resources. Although I'm not the first to attend college in my family, there are more family members who did not attend college than who graduated. This was different than those who competed with me at the ACT-SO competition. In comparison to my peer competitors, I noticed that my family's socioeconomic status did influence my access to some of the resources and opportunities they had previously. However, in this setting my race and gender were not the most salient identity to impact my interest in STEM. This would later change once I entered college.

I attended college at a predominantly white institution in Tennessee where I was the only African American in most of my classes. My internal conflict with my choice of major became obvious during my time pursuing my undergraduate studies. One of the pivotal moments during my undergraduate journey was while talking with a classmate at a study session. He assumed that I was an athlete and accepted to UT merely because of my athletic abilities. This was something that was foreign to me because I never participated in any sports, dance or cheerleading. I don't have one athletic bone in my body. All of my previous clubs in high school were academic or religious affiliated. As a member of Mu Alpha Theta, a math honor society, National Honor Society, Crusaders Club and Student Government, I rarely interacted with students who played sports. I quickly learned that his assumption about my athletic abilities was prevalent among the rest of my college friends. Was this assumption based on my gender or race?

Most of my science classes were filled with white men students, who often formed study groups together. Their study groups usually fit the representation of the science classes, not inclusive of others with racial or gender differences. The few black men who were in my classes would try to fit in with the all-white men study group. Some were more successful than the white women fitting into these spaces. The women in many of my classes tried to fit in with the guys. They would often distance themselves from other women in the class so there weren't too many of us in one study group. Women had to prove their worth in study groups with men.

Eventually a study group of all women science majors was formed, but I wasn't invited to join this study group. I accidentally learned about the all-women study group when I overheard them talking about an exam that one of them received from her big, a term that is commonly used to describe an older sister of a sorority. After that incident, I never heard anything else about this study group. There was a group of us who weren't invited to join this study group, coincidentally, we were all black women. Eventually all of the women who weren't invited to the all-white women study group formed their own.

The intersectionality of socioeconomic status, race and gender made for an isolating experience as a STEM major at Predominantly White Institution (PWI). Each of these identities had an impact on my pursuit of higher education. I feel that the impact of each of these characteristics and others should be taken into consideration when observing graduation rates, specifically in STEM for African American women. This is why I feel that the choice of a blended theoretical framework using an economic and sociological approach is the best to understand this college-going and choice of major phenomenon.

Definitions

For the purposes of this study, the following definitions were used. The work from Espinosa (2011) informed the foundation of the definitions.

Minority- The part of a population that differs from the larger population because of some characteristic.

Underrepresented- Refers to a subset of the population whose proportion is smaller than the dominant. Members of these groups were previously marginalized, inclusive of women, African Americans, Hispanics, American Indian and Asian racial groups, first generation, economically disadvantaged.

STEM- All majors related to Science, Technology, Engineering and Mathematics. These areas of study include mathematics, physical sciences, natural sciences agricultural and related sciences, natural resources and conservation, biological and biomedical sciences, engineering, engineering technologies, science technologies, and computer and information sciences, as defined by the National Center for Education Statistics (NCES).

Persistence-For the purpose of this study, persistence is used to describe the likelihood of a student graduating from a four-year institution in a STEM field of study.

Pre-College Characteristics- This refers to all aspects of a student's profile. For the purpose of this study, these characteristics have been limited to high school GPA, Science and Math coursework, academic performance, parent's educational attainment, socioeconomic status, race, ethnicity and gender.

Organization of the Study

I organized this dissertation into five chapters beginning with Chapter One that contains the background and context for the study, purpose, research questions, theoretical framework and significance. Chapter Two follows with a detailed review of salient literature related to what we know about STEM diversity in higher education, specifically African American and Caucasian women and men. In Chapter Three, I described the methodology used and limitations of the study followed by a description of the findings in Chapter Four. Lastly, Chapter Five provides a summary of the findings in relation to the literature, conclusions, implications of the findings and recommendations for future research.

CHAPTER II

LITERATURE REVIEW

Introduction

The purpose of this study is to explore the relationship of various pre-college and college factors and persistence of women in STEM majors. We do know that students' persistence in higher education is shaped by factors—some unique to the student and their family; to their secondary school and community environment; and higher education context (Perna, 2006). This literature review has been organized using Perna's conceptual framework using three layers: (a) individual habitus; (b) school and community environment; (c) the context of higher education. The literature review will provide context for the effects of various pre-college and college factors on persistence in higher education and STEM majors.

Individual Characteristics

Gender

The number of women enrolled in higher education has continued to rise over the course of the last few decades. Between 2004 and 2014, enrollment of women rose 15 percent, while the percent of men rose 19 percent. Although the enrollment of women increased by a smaller percentage, the majority (56 percent) of students in 2014 were women (Snyder, De Brey, & Dillow, 2016). Women have surpassed men in college access and persistence, yet women remain less likely to major, persist to graduation, and enter careers in STEM fields (Bettinger & Long, 2005). Gender differences in attitudes toward mathematics careers and ability become apparent as early as kindergarten (Ceci et al., 2014). Test scores, specifically for science and mechanical subjects, begin to show gender gaps as early as 15 years of age (Speer, 2017). These differences translate into the underrepresentation of women among STEM graduates and in the workforce.

Gender differences in the number of bachelor's degrees awarded are evident. In addition to the social sciences fields, the total number of science and engineering degrees conferred during 1997 to 2006 was 1,473,735; of those, 58 percent were to women (NSB, 2006). Without including the social sciences, there is a drastic change in the number of degrees conferred, with men receiving 61 percent and women 39 percent (NSB, 2006). Chen (2009) found that, between 1995-1996 and 2001, 53 percent of students who indicated STEM at entry persisted in the field and the other 47 percent switched to a non-STEM field or left college. Approximately 32 percent of women compared to 26 percent of men left STEM fields by switching to a non-STEM major. In a later study, Chen (2013) discovered that approximately 24 percent of men, compared to 14 percent of women left STEM majors, dropping out of college. Not only are there differences in STEM and non-STEM related fields, but there are also gender differences among STEM fields.

Women have greater representation than men in undergraduate degree completion but are not equally represented to men in all STEM fields. In 2014, there were 1,890,941 degrees awarded in STEM fields, of which 57% were awarded to women. However, the representation of women in all STEM fields remains lower for some fields than others. There is a greater disparity among women in most mathematically intensive fields in STEM. Women earned 1,077,836 bachelor's degrees in STEM majors in 2014. Women earned the following percentages in each major in 2010: computer science (18.2 percent), engineering (18.4 percent), physical sciences (40.8 percent), mathematics (47.8 percent), and biological sciences (55.8 percent). The completion rates for women in computer science and engineering were drastically lower than those for physical sciences, mathematics, and biological sciences (Department of Education, 2014). There is a greater disparity among bachelor's degrees awarded to women and men in engineering and computer science fields. A substantial 59% of degrees were awarded to women in biological/biomedical sciences, but women in math-intensive fields made up only 43% of degrees in mathematics and statistics, 18% of degrees in computer and information sciences, 20% of degrees in engineering, and 40% of degrees in the physical and technological sciences (Shettle, Roey, Mordica, Perkins, Nord, Teodorovic, Brown, Lyons, Averett, & Kastberg, 2017).

Women are also underrepresented among graduate degree recipients in STEM fields. Women received 29% of graduate degrees in mathematics and statistics, 19% in computer and information sciences, 23% in engineering and 34% in physical and technological sciences doctorate degrees (U.S. Department of Education, NCES 2014). Alternatively, women received 54% of doctoral degrees in the biological and biomedical sciences, and surprisingly, 48% of all earned medical degrees since 2012 (U.S. Department of Education, NCES 2014). Researchers have suggested that women's absence in some STEM fields and not others may be because of their perception of the career versus a reflection of their skills and abilities (Diekman, Brown, Johnson, & Clark, 2010).

Women are underrepresented not only among undergraduate and graduate students in math intensive fields but also in the pursuit of careers in these fields. Diekman, Brown, Johnson, and Clark (2010) argue that women are more likely to pursue careers that are communal—defined as the desire to care about other people—meaning that women have the desire to pursue career fields where they see a direct correlation of giving back and helping people (Bakan, 1966). Diekman, Brown, Johnson, and Clark (2010) found that gender differences in self-efficacy, differential support for pursuing careers in STEM, and perpetuation of cultural norms discouraged women to pursue STEM. However, these reasons are incomplete in explaining the large disparity of women in particular STEM fields, especially given that women are equally represented in other previously male-dominated fields such as medicine, business, and law.

Diekman, Brown, Johnson, and Clark argue that there is something more that prevents women from pursuing careers in some STEM fields (2010). Their study of 333 introductory psychology students and 27 paid participants from STEM classes suggested that communal goal endorsement was a very important factor for persistence. Communal goal endorsement allows students to have a team environment and community support system. The lack of this community in STEM majors might explain women's lack of interest in pursuing STEM careers (Diekman, Brown, Johnson, & Clark, 2010).

Race or Ethnicity

The college participation rate has been steadily increasing in our nation. The total college enrollment has been growing with an 18-percent rise from 1985 to 1992. Between 1994 and 2004, there was a 21-percent increase; and between 2004 and 2014, there was a 17-percent increase from 17.3 million to 20.2 million. Over a period of four decades, the total enrollment of White undergraduate students has increased over the years. Although the total enrollment of White students has increased, the increased enrollment of racial minorities has resulted in a decrease in the percentage of White enrollment from 84 percent to 59 percent (Snyder, de Brey & Dillow, 2016). From 1976 to fall 2014, Hispanic enrollment as a percentage of total enrollment has moved from 4 percent to 16 percent, Asian/Pacific Islander went from 2 percent to 6 percent, and Black enrollment increased from 10 percent to 15 percent. Even with the overall increase in enrollment and participation of racial minorities over the past few years, this increase isn't reflective of the total growth of these populations.

Growth is also needed for racial minorities in pursuit of degrees in STEM (Griffith, 2010; Perna et al., 2009). President's Council of Advisors on Science and Technology (2012), projects the US will need an additional one million STEM professionals than what is currently produced

(Augustine, 2005). STEM majors account for about 16 percent of the total number of bachelor's degrees conferred (Griffith, 2010). Asians represent the majority at 30 percent of the total number of STEM bachelor's degrees conferred. Other minority groups experienced much lower percentages of degrees conferred, with Black percentage rates at 11 percent and Hispanic percentage rates at 14 percent.

Minority students, not inclusive of Asian students, also enter STEM majors in smaller numbers and leave in higher numbers than their majority white counterparts. Only 13 percent of minorities choose to major in STEM, and only 24 percent of those students will persist in STEM (Fotlz, Gannon, & Kirschmann, 2014). After the third year, minority students are not progressing through the STEM program at equal rates as their White counterparts (Anderson & Kim, 2006). The first two years enrolled in college are pivotal. Watkins and Mazur (2013) discovered that most often minority students drop out of STEM majors within the first two years of college. Chen (2013) discovered that Blacks had the highest proportion of all racial groups who left STEM fields by switching majors.

The intersectionality of gender and race suggests different findings. When focusing on women of color in these fields, researchers' findings suggest that Asian women received the highest percentage of degrees for all the women of color in STEM (Carolene & Johnson, 2007; Espinosa, 2011; Herrera & Hurtado, 2011; Johnson 2012). Asian women account for 12 percent of the degrees conferred to women of color, followed by African American women with 9 percent, Hispanic with 7 percent, and American Indian with .4 percent of total degrees conferred (NSB, 2006). Asian women were the most represented among science graduates with bachelor's degrees other than White women. Although Asian women have a larger representation in STEM bachelor's degrees conferred, even this population remains small and not all women of color are represented equally when comparing STEM graduation rates (Carolene & Johnson, 2007; Espinosa, 2011; Herrera & Hurtado, 2011; Johnson 2012).

Socioeconomic Status and Parent Educational Attainment

Haveman and Smeeding (2006) found that some students from low socioeconomic status (SES) are not academically prepared, are not well informed about the cost of higher education, and less prepared to begin the college application process. Students from low SES and who are racially diverse have lower scores on standardized tests (Lee, 2002), are more likely to repeat a grade (Campbell, Hombo & Mazzeo, 2000) or drop out of high school (Swanson, 2003), and are less likely to enroll in and graduate from college (Harvey & Anderson, 2005). Even students from high SES families with similar test scores and class ranks as those from low SES families are more likely to attend four-year college (Kane, 2004).

Despite the odds, some students from low SES families proceed to enroll in higher education institutions. However, even in these environments, students from low SES families experience greater difficulties in persisting to graduation. Students from low SES families can experience emotional distress, issues with self-belonging, self-perception and motivation that are barriers for persistence (Jury, Smeding, Stephens, Nelson, Aelenei, & Darnon, 2017). While in college, low SES students are more likely to experience emotional distress and depression. They are more likely to feel guilty about their educational attainment. This feeling relates to low SES students having an outer group experience that makes it challenging for them to connect to their higher education experience. Low SES students also have to combat negative stereotypes that are often projected onto them because of their SES regarding their academic abilities and competence by faculty, staff and students (Fiske, Cuddy, Glick, & Xu, 2002). Researchers have discovered that forms of motivation differ based on SES. Low SES students are more likely to be afraid of failure and adopt performance-avoidance goals in college (Jury, Smeding, Stephens, Nelson, Aelenei, & Darnon, 2017). Some of the unfortunate experiences of low SES students are also present for first generation college students.

The commonly accepted definition for “first generation” is a student whose parents have not completed a higher education degree program (Choy, 2001). First-generation college students are more likely to have lower college persistence rates than their counterparts (Riehl, 1994) and are less likely to complete their degree within the four-year time span (Ishitani, 2003). The cultural knowledge and support to pursuit higher education varies based on a parent’s education attainment (Ishitani, 2003; McDonough, 1997; Perna & Titus, 2004). In 2001, first generation college students represented 34% of those entering four-year institutions and 53% of students at two-year colleges (2001).

First generation college students are disadvantaged by the lack of experience in higher education of their immediate family. Students from first-generation family’s often lack academic preparation and knowledge about the college going process (York-Anderson & Bowman, 1991) and tend to have unrealistic expectations about college (Brooks-Terry, 1988). Students whose parents lack experience with the college-going process are less likely to understand the cost and economic benefits of a higher education investment (Perna, 2004). First generation parents are likely to initiate the college-going trajectory later than those parents who did attend college. For instance, those with families that have a college going culture begin to invest in the process as early as preschool by investing in summer enrichment programs, traveling abroad and private schooling. By the time first-generation racial minorities reach high school, they are years behind others who initiated the college-going process much earlier (Zalaquett, 1999). The role of the school and community environment is also important in this retention and persistence process.

School and Community Environment

School Officials

School officials—such as teachers, counselors, administrators and college-going peers—have been identified as influencers of the college-going atmosphere for high school students (Stanton-Salazar, 1997). Stanton-Salazar (1997) argues school officials are valuable people in the school and community who provide access to resources about college and facilitate the admission process. School officials have the responsibility of enhancing the traits of students whose families support their college going atmosphere, while creating and developing this atmosphere for some who lack these support systems (Stanton-Salazar, 1997). Some students, especially those from low-income backgrounds and racial minorities, are known to have their college choice restricted by the absence or limited engagement of school and community support. Most often students from low SES and racial minorities are relying on school officials as the sole source to provide information to navigate the college going process. Completing the Free Application for Federal Study Aid (FAFSA) forms, college applications and selection of which standardized tests the Suite of Assessments (SAT) or American College Testing (ACT) to submit to which college can appear daunting, overwhelming, and confusing for a high school student. The presence of a support system willing to assist with this process is important in the college going process—as are equal opportunities—for students to excel in their academics.

Academic Readiness

Researchers suggest that AP scores, high school GPA, and standardized test scores are a few of the pre-college factors that have a positive correlation for selecting STEM as a major and success in college (Espinosa, 2011; Maple & Stage, 1991). Academic preparation in secondary school is an important prerequisite that enables students to pursue careers in STEM (Adelman, 1999). One of the components of high school academic preparation is completion of Advanced Placement (AP) courses (College Board, 2009).

In American high schools that offer AP courses, some students have enrolled in at least one AP course during their secondary education. Every decade, the number of high school students participating in AP has doubled (Lichten, 2000). Even though studies have shown the benefits of AP or International Baccalaureate (IB) courses, the demographics of those taking AP STEM courses is not equal among boys and girls. Girls take fewer AP exams in STEM subjects like calculus, physics, computer science, and chemistry; and those who do score lower than boys on average. In 2009, a total of 391,777 boys and 350,465 girls completed STEM-related AP exams (College Board, 2009). The level of mathematical or academic competency of students entering college has been identified as one of the strongest predictors of retention to graduation in STEM (Maple & Stage, 1991; Morgan, Gelbsiger, & Weeden, 2013; Redmond-Sanogo, Angle, & Davis, 2016), with math skills having been found to be one of the strongest pre-college factors for success in STEM fields. Girls are disadvantaged by not taking AP courses in STEM fields before attending college.

Furthermore, Chen (2013) argued that students' pre-college academic preparation is one of the strongest predictors of leaving STEM. In her study, she found a significant difference in STEM attrition rates based on completion of math courses and GPA. For instance, 46 percent of STEM entrants with a high school GPA of less than 2.5, and 41 percent of those who did not complete Algebra II/trigonometry or higher math courses in high school dropped out of STEM and college. In comparison, only 14 percent of STEM entrants with a high school GPA of 3.5 or higher and 12 percent of those who took calculus in high school dropped out of STEM and college. Not only do STEM entrants leave STEM fields by dropping out of college, but some switch to a different major.

Chen (2013) also discovered that 33 percent of STEM entrants with a high school GPA in the mid-upper range (3.00-3.49) switched to a different major—in comparison to 26 percent of students in the top range (3.5 or higher). Her analysis also revealed that a lower percentage of students who completed high school calculus (24 percent) switched majors, whereas those who completed Algebra II/trigonometry or precalculus had a higher percentage (32-33 percent) to remain in STEM. Students initiative to take more STEM related courses in high school is also correlated to students participating in pre-collegiate enrichment programs.

In a study of pre-engineering students, one group of students did not experience pre-collegiate engineering activities and another group did experience pre-collegiate engineering activities. The study found that there were significant differences in engineering students' self-efficacy. Those who participated in pre-engineering classes, summer camps, math and science interest groups were found to be more likely to enroll in and persist through STEM majors in college (Edzie, 2014). Espinosa (2011) also found positive correlation with females pursuing STEM majors who also participated in pre-collegiate STEM related activities. Her findings from this study called for more opportunities for females to experience real world applications of the influence of STEM on environmental, social and economic problems. Completion of science and mathematics courses during high school (Morgan, Gelbsiger, & Weeden, 2013; Redmond-Sanogo, Angle, & Davis, 2016), taking Advanced Placement courses (Hoepner, 2010; Maple & Stage, 1991), and engaging in out-of-school programming (Ault, 2008; Edzie, 2014), are all ways academic readiness contribute to factors for women pursuing STEM fields of study.

School Characteristics

The presence of school officials and academic readiness is important for success in college; however, not all students have equal access to all of these resources. For example, East St. Louis is an urban area located in St. Clair County, Illinois. The city has a population of approximately 98 percent black. Most of the city is filled with dilapidated buildings, spillage of sewer water in several domestic areas and no regular trash collection. For instance, students at East St. Louis High School—where science labs are 30 to 50 years outdated with no access to running water—have a huge disadvantage to college academic readiness (Kozal, 2012). School officials are also sparse in this school. In one week, the school laid off 280 teachers and 25 teacher aides. This made the class size of kindergartners and primary classes jump to 30 and 40 students per class. Kozal (2012) argues, "If you have a high school teacher with five classes each day and between 150 and 175 students, it's going to have a devastating effect" (p.83). Disparities in resources exist among various school districts. The disparities seen in East St. Louis are parallel to those in other inner-city areas. These disparities contribute to the under-preparedness of particular students in STEM fields (Adelman, 2006; Flores, 2007; Oakes, 1990).

Black, Hispanic, and low-income students are more likely to live in inner cities where the school districts are under-resourced, in comparison to their White counterparts who attend school districts in affluent communities. Schools that serve Blacks and Hispanics are also less likely to receive local and state funding to educate students (Flores, 2007). Schools with more funding tend to have more resources that are available to offer small class sizes and Advanced Placement courses; have higher and more credentialed teachers; and purchase newer technology, books, and other items to help prepare students for success (Wenglinsky, 1997)—all proven factors needed for success. Researchers also argue that there is a relationship between racial-mathematical socialization, mathematical identity and racial identity (English-Clarke, Defore & Martin, 2012). This means that children are more aware of the stereotypes as it relates to their academic abilities, specifically for mathematics. This racial discrimination impedes the desire of African-American youth to engage in STEM related subjects. Individual habitus and school and community layers are very important in the success of women in STEM, but so is the role of the higher education institution in this process.

Context of Higher Education

Higher Education Selection

Higher education institutions strive to be leaders in promoting social mobility and improving citizenship. Despite their efforts some populations are marginalized in the recruitment process. Recruitment practices tend to encourage or discourage particular groups of students to apply. Usually students self-select to apply based on their perceived alignment of their gender, race, socioeconomic status, sexual orientation, religion or academic performance during the recruitment process (Chapman, 1981). For example, the images shared on printed materials, layout of the webpage, attendance of admissions counselors at particular college fairs and scholarship criteria are examples of the influence of institutions on the student's selection process by promoting to particular groups of students.

Higher education institutions choose to attract and admit students who fit their academic and social norms (Chapman, 1981). Students apply to institutions they believe have institutional history, culture, missions and values that align with their own hoping to improve their satisfaction by attending that institution. This idea of institutional fit greatly influences the higher education selection process. (Young, 2008). For example, African Americans represent the majority population of students attending Historically Black Colleges and Universities (HBCU).

Researchers have attributed the success of students at these institutions based on the alignment of the student body with the institution's history, mission and culture (Astin, 1975, Bonous-Hammarth & Boatsman, 1996). Espinosa (2011) discovered that women are more likely to thrive at women's colleges. Student involvement is also an important aspect of the higher education practices to increase persistence to graduation.

Higher Education Involvement

Astin (1984) describes higher education involvement as the devoted amount of physical and psychological energy students dedicate to their academic experience. Spending time on campus, interaction with faculty members and joining organizations are all considered elements of higher education involvement. This type of involvement is also considered an investment for students in their experience. Although involvement is challenging to characterize or measure, the student's involvement is positively correlated with academic success (Astin, 1984). Research shows that engagement with peers to discuss course content, involvement in STEM-related student organizations, participation in research programs and being a member of a STEM community are very important for the success of women pursuing degrees in STEM fields (Espinosa, 2011, Kokkelenberg & Sinha, 2010, Ortiz 1988).

Despite the importance of this type of involvement, women pursuing degrees in STEM fields have described the climate of large public research institutions as having impersonal classrooms, with unapproachable professors, and competitive grading practices that encourage the "weed out" process (Seymour & Hewitt, 1997). Seymour and Hewitt (1997) concluded that some STEM faculty did not enjoy or value teaching, and valued their research above teaching. Their findings suggest the environment of STEM fields of study are unwelcoming and competitive. Women who entered STEM are more likely to leave, mainly because of negative interactions with faculty and male peers. The unwelcoming and competitive environment, often described as “chilly” conflicts with collaboration and interpersonal relationships that many women value (Seymour & Hewitt, 1997). There are more men than women faculty members teaching in STEM fields of study; however, the support from women faculty has been shown to be a crucial component of STEM success for women during college. Women faculty members provide a more nurturing environment that women pursuing STEM degrees value (Kokkelenberg & Sinha, 2010).

My Contribution

It is vital for institutions to be knowledgeable about how pre-college and college factors impact persistence of students pursing majors in STEM fields of study. Knowing risk factors will assist institutions in designing intervention programs to retain students at risk of dropping out of STEM and/or college (Espinosa, 2011). Higher education administrators need to know how various attributes affect student persistence in STEM major. It is also important for higher education administrators to know how various combinations of race, gender, socioeconomic status, parental education, high school course work, and high school GPA impact STEM persistence for women. Previous research has focused on the undergraduate experiences of students in STEM (Herrera & Hurtado, 2011; Seymour & Hewitt, 1994) and the experiences of only one population in STEM (Carlone & Johnson, 2007; Crisp, Nora, & Taggart, 2009; Espinosa, 2011). Most studies have limited durations that do not include pre-college and college factors (Hurtado, Newman, Tran, & Chang, 2010), have small sample sizes with results that are not generalizable (Crisp, Nora, & Taggart, 2009; Milem, Chang, & Antonio, 2005), and large sample sizes that do not use a national data set reflective of the entire population (Espinosa, 2011; Hurtado, Newman, Tran, & Chang, 2010).

The purpose of this research is to discover how pre-college and college factors affect the persistence of women in STEM majors. Women are usually underrepresented in quantitative studies (Maple & Stage, 1991). Using a national data set will allow the results to become generalizable. This study will serve as a benchmark for measuring student success to graduation for stakeholders and other policymakers. It will also help to inform predictive technology metrics used to predict the likelihood of student success. Higher education institutions are utilizing information received from predictive software to increase the persistence of current students. For example, the universities utilize predictive software to target students exhibiting high-risk profiles and predicted to drop out to focus some of their retention efforts on this group. Once the profile of successful women in STEM has been identified, higher education institutions can focus their retention efforts on students that are most at risk of dropping out of a STEM major of study.

CHAPTER III

METHODS AND PROCEDURES

The purpose of the study is to explore the relationship between pre-college and college factors influencing the persistence of women in STEM majors. Factors influencing the persistence of women in STEM are explored in an effort to create a profile of students likely to persist to graduation in STEM fields of study. Specific to these intentions, this research study seeks answers to the following research questions (RQ) outlined by Perna's conceptual framework:

RQ1. Is there a relationship between race and socioeconomic status and persistence for women majoring in STEM?

RQ 2. Is there a relationship between high school GPA, science interest indicators, high school locale and type and persistence for women majoring in STEM?

IRQ3. Is there a relationship between participation in summer camp, research and community-based projects and persistence for women majoring in STEM?

As an overview of the steps taken to achieve the purpose of this study and in quest of the answers to the research questions stated above, this chapter aims to: articulate the data sources and the descriptions of the research data; provide an introduction and brief summary of the variables used for this study; and give a short description of the proposed statistical procedure used in this study.

Data Sources

The National Center for Education Statistics (NCES) was established in 1974 as part of the U.S. Department of Health, Education, and Welfare for the purposes of collecting and providing statistics related to the United States educational system. As an agency within U.S.

Department of Education and the Institute of Education Sciences, NCES fulfills a national effort of collecting, analyzing, and reporting statistical data. Data collected from these surveys are used by policy makers, researchers and educational administrators to inform practice, policy and knowledge. In a quest to find out the differences among women in STEM fields, I selected the High School Longitudinal Study of 2009 (HSLS:09) to explore the relationships between the variables.

The HSLS:09, the dataset used for this study, is the fifth in a series of NCES longitudinal studies. The HSLS:09 is a survey that followed 9th graders through their secondary and postsecondary years across 50 states and the District of Columbia. This dataset focuses on the decision-making process about postsecondary transition plans and the paths into and out of STEM fields (Ingels, Pratt, Herget, Burns, Dever, Ottem, and Leinwand, 2011). Students, parents, teachers and school administrators participated in this longitudinal study. The base-year data were collected in 2009 followed by a collection in the student’s 11th grade (2012), 12th grade (2013) and the last 3 years post high school graduation. In 2009, there were approximately 23,000 students who started the survey in the 9th grade who represented 944 schools.

The base year included questionnaires for parents, teachers, school counselors and school administrators; however, the first follow up included questionnaires for all except teachers. The questionnaire highlights students’ attitudes about science, technology, engineering, and math (STEM) and their exposure to STEM through various activities. This study is often used for STEM research as the questions are related to (STEM) courses, majors, and careers. The demographics, educational expectations, resources for supporting students and knowledge about postsecondary options of parent(s) were highlighted in this study. (Ingels, Pratt, Herget, Burns, Dever, Ottem, and Leinwand, 2011).

Data Subset

I used the HSLS 2009 national data set to identify the pre-college and college factors that are more likely to influence persistence of women majoring in STEM. The sample used for this study only included students who were women, first time degree-seeking, enrolled full time and initially expressed an interest in STEM. Out of 23,503 students initially included in the HSLS:09, 11,524 students were selected based on gender (X1SEX). In this group of females, first time degree-seeking, and full-time enrolled college students there were 1,187 who considered a STEM major upon entry into post-secondary education. The X4ENTMJST variable was used to identify those whose major entering postsecondary education was in a science, technology, engineering, or math (STEM) field. Upon deleting all participants with missing data in any of the variables chosen for this study, the total of the data subset was 946.

Major Classification

Table 3.1 exhibits classification of STEM fields of study based on the classification provided by the NCES (NCES, 2000). The STEM fields chosen for this study were as follows: mathematics, physical sciences, biological life sciences, inclusive of agriculture, natural resources and biological sciences, engineering, inclusive of engineering technologies, science technologies, and computer and information sciences. These categories were based on the 2000 edition of classification of instructional programs (CIP).

Table 3.1

Classification of STEM Field of Study

Discipline	Major
Mathematics	
Physical Sciences (Including Natural Sciences)	
Biological Life Sciences	Agriculture and related sciences
	Natural Resources and conservation
	Biological and biomedical sciences
Engineering/Technologies	Engineering
	Engineering Technologies
	Science Technologies
Computer and Information Sciences	

Note: Categories based on the 2000 edition of Classification of Instructional Programs (CIP)
http://nces.ed.gov/pubs2002/cip2000/ciplist.asp

Study Variables

Table 3.2 below exhibits the descriptive statistics for the dependent and independent variables that were used for this study followed by a text description.

Dependent Variables

The dependent variable was persistence in STEM. The dependent variable was reference major X4RFDGMJSTEM. As defined by HSLS 2009, this variable was the “reference undergraduate degree first major field of study is in a STEM field”. This variable was captured during the 2013 follow-up to indicate a student’s current major since they first indicated their initial major with X4ENTMJST. As indicated in Table 3.2 below, the classification frequency counts were: 611 STEM majors, 225 Non-STEM as the last major captured in the 2013 follow up. This is a dichotomous variable indicating STEM as yes and non-STEM as no.

Independent Variables

This study was grounded by layers defined by Perna. Independent variables were grouped by three layers such as individual habitus, school and community environment, and the context of higher education (Perna, 2006). Several independent variables were observed for this study. One way to categorize the independent variables was through the use of Perna’s layers: individual habitus, school and community involvement and context of higher education. The independent variables used for this study were organized by each of these layers illustrated in Table 3.2 below. Continuous variables include their mean, standard deviation, maximum and minimum values. The non-continuous or categorical variables include the count and percentage

Table 3.2
Women with Initial Major STEM: Descriptive Statistics

Variable Label		Mean	Std Dev	Max	Min	Count	%
DEPENDENT VARIABLES							
STEM Persistence (X4RFDGMJSTEM)							
	STEM					611	73.1
	Non-STEM					225	26.9
INDEPENDENT VARIABLES							
Individual Habitus							
Race (RACE2)							
	Asian, Hawaii/Pacific Islander, non-Hispanic					182	21.8
	Black or African American, non-Hispanic					59	7.1
	Hispanic					84	10.0
	Multi race					58	6.9
	White, non-Hispanic*					453	54.2
Socio-economic status (SESQ)							
	Quartile 1 (Lowest SES)					174	20.8
	Quartile 2					201	24.1
	Quartile 3					225	26.9
	Quartile 4 (Highest SES)*					233	27.9
School and Community Involvement							
Type of Secondary School (X1CONTROL)							
	Public*					605	72.4
	Catholic or other private					231	27.6
Location of Secondary School (X1LOCALE)							
	City					282	33.7
	Suburb					327	39.1
	Town/Rural*					227	27.1
Geographic Region of Secondary School (X1REGION)							
	Northeast					164	19.6
	Midwest					243	29.1
	South*					315	37.7
	West					114	13.6
GPA for STEM courses (X3GPASTEM)		3.38	.58	.50	4.00		
Overall GPA (X3GPATOT)		3.57	.44	4.00	1.00		
Context of Higher Education							
College preparation camp (S2CLGCAMP)							
	Participant*					92	11.0
	Non-participant					744	89.0
Research project with faculty (S4RESEARCH)							
	Participant*					282	33.7
	Non-participant					554	66.3
Community Based Project (S4COMMSRV)							
	Participant*					288	34.4
	Non-Participant					548	65.6
First Institution sector (X4PS1SECTOR)							
	Public Four-Year*					561	67.1
	Private Four-Year					275	32.9

Note: Variable names are in parenthesis.
*reference group in regression analyses
** The racial/ethnic groups for American Indian/Alaska Native, non-Hispanic; Hispanic, no race specified; and Native Hawaiian/Pacific Islander, non-Hispanic were omitted from the study because their total populations were below ten.

of each category in that variable. All non-continuous data were recoded into groups as dummy variables with reference groups.

The first layer of Perna's (2006) conceptual model, referred to as the individual habitus, included the effects of race or ethnicity, gender, cultural, and social capital on college completion. For the purpose of this study, race and socioeconomic status were chosen as variables to explore the individual habitus layer. As defined by High School Longitudinal Survey of 2009 (HSLS), race "categorizes the sample members' race/ethnicity by summarizing the following dichotomous race/ethnicity composites: X1HISPANIC, X1WHITE, X1BLACK, X1ASIAN, X1PACISLE and X1AMINDIAN" and the socioeconomic status variable "is calculated using parent/guardians' education, occupation and family income". The original dataset included participants who identified with the following racial/ethnic groups: American Indian/Alaska Native, non-Hispanic, Asian, non-Hispanic; Black/African-American, non-Hispanic; Hispanic no race specified; Hispanic, race specified; more than one race, non-Hispanic; Native Hawaiian/Pacific Islander, non-Hispanic; white, non-Hispanic. Racial/Ethnic groups with less than ten people were omitted from this study to protect their identity. The subset population for American Indian/Alaska Native, non-Hispanic; Hispanic, no race specified; and Native Hawaiian/Pacific Islander, non-Hispanic were all omitted from this study due to smaller numbers of participants. The white racial group is the largest, it was used as the reference group in statistical analyses. Socioeconomic status was originally included as a continuous variable, but quartiles were developed to assess the influence of income on college success. Quartile four, the highest socioeconomic status of the four, was used as the reference group for socioeconomic status.

As indicated in Table 3.2, the percentage of participants who identified as Asian, Hawaiian/Pacific Islander, non-Hispanic was 21.8%; with a total of 182, the Black or African American, non-Hispanic was 7.1%; with a total of 59, the Hispanic was10.0%; with a total of 84, Multiple race was 6.9; with a total of 58 and White, non-Hispanic was 4.2%; with a total of 453. The socioeconomic status of each quartile is approximately 235 participants in each category.

The organizational habitus relates to the secondary school and community environment, which is the second layer of Perna's (2006) conceptual model. This layer considers the impact of social structures on the facilitation or limitation of the college-going culture. The school and community involvement layer considered the type of secondary school defined as "public or private secondary school", location of secondary school defined as "school urbanicity", geographic region defined as "the geographic region of the school". The reference groups for the community involvement were public secondary school, suburb and southern region. In addition to these school variables, there were two types of GPAs that were included in this study. The "GPA in high school STEM courses" and "overall high school GPA" were used as continuous variables. Prior to conducting the SPSS logistic regression, mean imputation was used to supply missing values for continuous variables such as GPA for STEM courses and overall GPA. Mean imputation was used to supply missing values for nominal variables prior to statistical analyses.

As indicated in Table 3.2, there was a total of 231 participants who attended Catholic or other private secondary school with 605 participants attending public school. The location of secondary school was grouped together in three categories that included: city with 282 participants, suburb 327 participants, town/rural 227 participants. The geographic region included the United States with Northeast region with 164 participants, Midwest with 243 participants, South with 315 participants, and West with 114 participants. The GPA for STEM courses had a mean value of 3.38; standard deviation value of .58; and maximum and minimum values of 4.00 and .50. The overall GPA had a mean value of 3.57; standard deviation of .44; and maximum and minimum value of 4.00 and 1.00.

The third layer of Perna's (2006) conceptual model was the context of higher education. This layer recognized the influence of higher education on the student's college choice. The selection of the institution they choose to apply to and attend was based on the institutional characteristics such as location, cost, and selectivity for admission. This also included the marketing and recruitment efforts of the institutions to attract particular populations to submit applications. The marketing and recruitment efforts of particular populations to submit applications began with preparatory camps for students in middle and high school. The participation in secondary school experiences hosted by institutions was observed for the third layer. Participation in experiences such as pre-college camps, research with faculty member, and community-based project were observed in this layer. There were three variables that were selected for this study in this context. The college preparation camp variable included data about "participation in a college preparation camp outside of secondary school activities". The "research project with a faculty member" was gathered at the end of the last attended institution to report the participation in research at college. The community-based project assessed "participation in community-based project as part of a course in college". The first institution sector, the first type of institution that is attended, was the last variable observed for context of higher education. It was defined as the "type of post-secondary institution".

As indicated in Table 3.2, the percentage of participants in college preparation camp was 11.0%, with a total of 92, and non-participants 89.0%, with a total of 744. The percentage of participants who researched in college with a faculty member was 33.7%, with a total of 282, and non-participants was 66.3%, with a total of 554. The percentage of participants who completed community-based project in college was 34.4%, with a total of 288, and non-participants was 65.6%, with a total of 548. The percentage of participants who first attended a four-year public institution was 67.1%; with a total of 561, and private four-year institutions was 32.9%, with a total of 275.

Analytical Methods

Statistical Model

Different types of regression procedures are often used in educational research. Which types of regression should be used as primary depends on how your outcome variable is measured. Ordinary least square regression is the most widely used regression appropriate for use with continuous outcomes. Another type of regression procedure, logistic regression is appropriate for use with non-continuous or categorical variables (Pampel, 2000). The use of a dichotomous dependent variable is used for prediction of the probability of the occurrence of the dependent variable in logistic regression. Some outcomes in educational research are dichotomous, such as enrolled or didn’t enroll, graduate or didn’t graduate, persist or didn’t persist. The logistic regression estimates the likelihood to enroll, graduate or persist. Given that not all students have the same likelihood of enrolling, graduating or persisting, the logistic regression observes the strongest effect on the dichotomous variable.

Logistic regression is a more appropriate choice with use of dichotomous and non-continuous probability of variables. Given the nature of the dependent variable in this study was dichotomous, this study employed logistic regression with block entry to explore the relationship between variables within three layers of individual habitus, organizational habitus and higher education context. Each one of the layers included variables that were used to explore its relationship between women persisting in STEM fields. Typically, logistic regression is expressed as follows:

$$\ln\left(\frac{\text{P}}{\text{1-P}}\right) = \text{a} + b_1x_1 + b_2x_2 + b_nx_n$$

In this equation P indicates the probability of dropping out of a STEM major. 1-P indicates the probability of persisting in a STEM major (Pampel, 2000). Comparing two odds is referred to as odds ratio. In this study, this allows the comparison of dropping out or persisting in STEM major.

Block Entry with Variables in Logistic Regression

This study employed the block entry procedure in logistic regression, which included a set of independent variables to explore the effects specific to each one of Perna's layers on persistence of women in STEM fields. The first block entry was individual habitus. This block included variables such as race and socioeconomic status. The next block entry was school and community involvement. Type of secondary school, location of secondary school, geographic region of secondary school, GPA for STEM courses and cumulative were variables explored in the second block. The third block was the final entry including the following: participation in college preparation camp, research project with faculty, community-based project and first institution sector.

Block 1/ Individual habitus: race and socioeconomic status

Block 2/ School and community involvement: type of secondary school, geographic region, high school GPA cumulative, high school GPA STEM

Block 3/ Context of Higher Education: participation in college preparation camp, research project with faculty, community-based project and first institution sector

Each block yielded a pseudo R-Square to estimate explanatory power. There are a number of R-Squares offered in SPSS such as Cox and Snell R square and Nagelkerke R square to understand the effects of specific blocks on retaining or not retaining in STEM fields. The results of this study reported regression coefficient, standard error, odds ratio, relative risk, and statistical significance, as well as a pseudo R-squares values.

Data Integrity Procedures

Preliminary analyses must be performed to ensure data integrity before administrating logistic regression. The Statistical Package for the Social Sciences (SPSS) was used to store and analyze the data used for this study. Logistic regression modeling statistics have data assumptions such as multicollinearity and outliers (Alin, 2020; Pampel, 2000). Multicollinearity is the linear relationship existing between one independent variable and combination of other independent variables. It may cause spurious estimates when independent variables are highly correlated with each other. (Alin, 2010). In this study, Variance Inflation Factor (VIF) was used to determine the level of multicollinearity. This number estimates the extent of which the variance of a coefficient is inflated. VIF demonstrated how strongly independent variables are correlated with each other. A value of five or greater provided by SPSS indicates multicollinearity exists. Any variables exhibiting high multicollinearity have been removed from this statistical analysis.

Logistic regression models for binary outcomes are to be tested for fit to model assumptions, Hosmer-Lemeshow Goodness-of-Fit is used to test this assumption (Fagerland & Hosmer, 2019). It tests to ensure that data do not conflict the model's assumptions. The Hosmer-Lemeshow Goodness-of-Fit counts the number of observed and expected cells to determine whether the model produces acceptable accuracy.

Limitations

There are a number of limitations of using the HSLS 2009 dataset. The dataset did not include post-secondary graduation data. Moreover, for the purpose of this study, the last recorded major is used to access persistence in the major. This last recorded major isn't necessarily the major at the time of graduation. This major is used to evaluate persistence in STEM. Once graduation data is available in the future, then another data analysis should be completed using this variable. Another limitation of this study is the deletion of missing values. There are a total of 241 missing values which represent 20.8% of the original dataset. The deletion of the missing value did decrease the total number of participants in the study, which decreases the generalizability of the findings. We also don't know the enrollment impact of institutions that offer summer camp programs because the data set did not indicate the name of the institution that offered the summer camp and the institution first attended.

Summary

This chapter has reaffirmed the purpose of the study, research questions, introduction to the data source and explanation of data analysis used. High School Longitudinal Survey of 2009 (HSLS:09) was used to retrieve both input and output variables for this research study. Chapter IV will offer the results of this data analysis.

CHAPTER IV

RESULTS

This chapter is organized into three sections. First, the results of data integrity are addressed. The second section of this chapter outlines research questions to be addressed. the variables used for each of the block entries for the logistic regression and the results of each of the block entries. The three block categories used for this study were individual habitus, school and community environment and context of higher education. The third section of the chapter explores the findings pertaining to the relationship between each of the blocks and persistence for women majoring in STEM.

Data Integrity Procedures

Multicollinearity is the linear relationship existing between one independent variable and combination of other independent variables. It may cause spurious estimates when independent variables are highly correlated with each other (Alin, 2010). In this study, Variance Inflation Factor (VIF) was used to determine the level of multicollinearity. This number estimates the extent of which the variance of a coefficient is inflated. VIF demonstrated how strongly independent variables are correlated with each other. A value of five or greater indicates multicollinearity exists (Alin, 2010). Tests of the study variables for multicollinearity revealed that the maximum VIF value found was 4.801 for overall GPA with the minimum value of 1.067 for participation in community-based project. The average VIF value was 2.053 This value was achieved after the removal of reference groups used in logistic regression. Because this value is below 5, this indicated that none of the study variables showed disturbing signs of multicollinearity.

Logistic regression models for binary outcomes are to be tested for fit to model assumptions, Hosmer-Lemeshow Goodness-of-Fit is used to test this assumption (Fagerland & Hosmer, 2019). It tests to ensure that data do not conflict the model's assumptions. The Hosmer-Lemeshow Goodness-of-Fit counts the number of observed and expected cells to determine whether the model produces acceptable accuracy. The Hosmer-Lemeshow Goodness-of-Fit was 0.528 for the third block of this study. Because the p-value is greater than .05, Goodness of Fit is acceptable. There is no significant difference between the predicted and observed data.

Research Questions

The results of the research study are presented in this chapter. The purpose of this study was to explore the relationship of various pre-college and college factors with persistence of women in STEM majors. Each block in logistic regression analyses address the following research questions guided the study:

RQ1. Is there a relationship between race, and socioeconomic status and persistence for women majoring in STEM?

RQ2. Is there a relationship between high school GPA, science interest indicators, high school locale and type and persistence for women majoring in STEM?

RQ3. Is there a relationship between participation in summer camp, research and community-based projects and persistence for women majoring in STEM?

Logistic Regression Results

I used a block entry logistic regression analysis to explore the relationship of the persistence of women in STEM fields. The variables used for this study are grouped together in blocks based on Perna's conceptual framework. Each research question represents a different block. The first block entry was individual habitus. This block included variables such as race and socioeconomic status. The next block entry was school and community involvement. Type of secondary school, location of secondary school, geographic region of secondary school, GPA for STEM courses and cumulative were variables explored in the second block. The third block is the final entry including the following: participation in college preparation camp, research project with faculty, community-based project and first institution sector.

Block 1: race and socioeconomic status (RQ1)

Block 2: type of secondary school, geographic region, high school GPA cumulative, high school GPA STEM (RQ2)

Block 3: participation in college preparation camp, research project with faculty, community-based project and first institution sector (RQ3)

This study addressed research questions that explain the effect of each research question using r-squared. R-squared, the proportion of variance affecting the dependent variable. For the purpose of this study, I used the Nagelkerke R Square value. The Nagelkerke R Square values provide an indication of the amount of variation in the dependent variable explained by the model with values from 0 to 1. Logistic regression was the statistical method used to analyze the data for both questions. The statistical results related to each research question are organized by three block entries discussed later in this chapter.

Logistic regression outcomes are typically explained using an odds ratio, which is an exponential form of logistic regression coefficients. A positive odds ratio indicates a positive effect of the variable in probability, whereas a negative odds ratio implies a negative effect on the outcome. For instance, a odds ratio for Asians was 1.416. This is interpreted as Asian students are about 1.4 times more likely than Caucasian students to persist. When odds ratios are less than 1.00, they indicate negative effects on persistence. In such cases, an odds ratio – 1.00 is applied to illustrate the magnitude of effect, which is often referred to as a relative risk (DeMaris, 1995).

RQ1: Individual Habitus

Table 4.1 exhibits the result for RQ1 which investigated the relationship between race, and socioeconomic status and persistence for women majoring in STEM. The Nagelkerke R Square value for block entry one is 0.011 which indicates 11% of the persistence variance can be explained by the block 1 independent variables. The results of block entry one indicates that there was no significant relationship between race and persistence for women majoring in STEM. The results of the socioeconomic status found that women in upper middle SES are 29.4% (0.706-1) less likely than upper SES to persist in majoring in STEM. This is the how much the persistence of STEM varies by race and socioeconomic status.

Table 4.1

Regression Analysis Result: Block Entry 1

Dependent Var= STEM Persistence

Variable	Label	Unstand. Coeff.	Std. Error	Odds Ratio	Sig.	Relative Risk
Constant		1.118			0.000	
Race	Asian	0.348	0.207	1.416	0.093	
	Black	-0.035	0.306	0.965	0.909	
	Hispanic	0.004	0.262	1.004	0.988	
Socioeconomic Status (SES)	Low SES	-0.139	0.235	0.870	0.555	
	Lower Middle SES	-0.249	0.222	0.780	0.262	
	Upper Middle SES	-0.348	0.214	0.706	0.103*	-0.294
Pseudo R-square		0.011				

*** = < 0.01; ** = < 0.05; * = < 0.10

Reference Group: White non-Hispanic, Upper SES

RQ2: School and Community Involvement

Research question two investigated the relationship between high school GPA, science interest indicators, high school locale and type and persistence for women majoring in STEM. The results of block entry two indicate The Nagelkerke R Square value for block entry two is 0.068 (6.8%). This is the how much the persistence of STEM varies by race, socioeconomic status, type of secondary school, location of secondary school, region of secondary school and GPA for STEM and overall. There is a significant relationship between type of secondary school, location of secondary school and GPA for STEM Courses for persistence of women majoring in STEM. In block entry two, race, SES and overall GPA were not significant. In regards to type of secondary school, women who attended a catholic or private high school were 23.6% (0.764-1) less likely to persist in a STEM major. The location of the secondary school was also significant. Women who attended secondary school in the suburbs are 55.9% (1.559-1) more likely to persist in a STEM major than those who attended school in the town/rural areas. The region of the secondary school was also significant. Women who attended a secondary school in the northeastern United States are 55.6% (1.556-1) more likely to persist in a STEM major than those who attended in the southern United States. STEM GPA was the greatest indicator of women persistence in STEM majors with every one-point increase in STEM GPA it increased the odds of persistence in STEM by 2.255 times. Table 4.2 shows the results of block entry two.

Table 4.2

Regression Analysis Result: Block Entry 2

Dependent Var= STEM Persistence

Variable	Label	Unstand. Coeff.	Std. Error	Odds Ratio	Sig.	Relative Risk
Constant		-1.000			.202	
Race	Asian	0.332	0.214	1.394	0.121	
	Black	0.200	0.321	1.221	0.533	
	Hispanic	0.052	0.271	1.054	0.846	
Socioeconomic Status (SES)	Q1	0.041	0.252	1.042	0.870	
	Q2	-0.174	0.235	0.841	0.459	
	Q3	-0.274	0.219	0.760	0.211	
Type of Secondary School	Catholic or other private	-0.269	0.188	0.764	0.153*	-0.236
Location of Secondary School	City	0.199	0.214	1.221	0.351	
	Suburb	0.444	0.208	1.559	0.033**	0.559
Region of School	Northeast	0.442	0.244	1.556	0.070*	0.556
	Midwest	-0.144	0.194	0.866	0.459	
	West	0.247	0.266	1.280	0.353	
GPA For STEM Courses	X3 GPA for STEM courses	0.813	0.289	2.255	0.005***	1.255
Overall GPA	X3 Overall GPA computed	-0.259	0.387	0.772	0.503	
Pseudo R-square		0.068				

*** = < 0.01; ** = < 0.05; * = < 0.10

Reference Group: White non-Hispanic, Upper SES, Public, Town/Rural, South

RQ3: Higher Education Context

Research question three investigated the relationship between participation in summer camp, research and community-based projects and persistence for women majoring in STEM. Table 4.3 shows the results of RQ 3. The Nagelkerke R Square value for block entry three is 0.121 (12.1%). This block has the greatest magnitude of the correlation between the between the predicted and actual values. This is the how much the persistence of STEM varies by all independent variables. The results of block entry three indicate there is a significant relationship between location of secondary school, region of secondary school, GPA for STEM courses, participation in research project with faculty and participation in community-based project with a course for persistence of women majoring in STEM. In block entry three, race, SES, type of secondary school and overall GPA were not significant. The location of secondary school was significant. Women who attended secondary school in the suburbs are 56.3% (1.563-1) more likely to persist in a STEM major than those who attended school in the town/rural areas. The region of the secondary school was also significant. Women who attended a school in the northeastern United States were 53.2% (1.532-1) more likely to persist in a STEM major than those who attended school in the southern United States. STEM GPA was significant for persistence of women majoring in STEM, with every one-point increase in STEM GPA it increased the odds of persistence in STEM by 2.134. There are two variables that were significant in the third layer of Perna's conceptual framework, which were participation in research with faculty member and participation in community project. Women who participated in research with faculty were 2.752 times more likely to persist in STEM than those who did not participate. Women who participated in a community-based project affiliated with a course were 36.3% (.637-1) less likely than those who did not participate to persist in STEM.

Table 4.3

Regression Analysis Result: Block Entry 3

Dependent Var= STEM Persistence

Variable	Label	Unstand. Coeff.	Std. Error	Odds Ratio	Sig.	Relative Risk
Constant		-0.793			0.315	
Race	Asian	0.318	0.221	1.374	0.150	
	Black	0.185	0.330	1.203	0.576	
	Hispanic	0.163	0.275	1.177	0.554	
Socioeconomic Status (SES)	Q1	0.181	0.257	1.198	0.482	
	Q2	-0.104	0.239	0.901	0.664	
	Q3	-0.241	0.224	0.786	0.282	
Type of Secondary School	Catholic or other private	-0.230	0.195	0.794	0.238	
Location of Secondary School	City	0.198	0.220	1.219	0.366	
	Suburb	0.446	0.212	1.563	0.035**	0.563
Region of School	Northeast	0.427	0.254	1.532	0.093*	0.532
	Midwest	-0.105	0.200	0.900	0.598	
	West	0.238	0.270	1.269	0.378	
GPA For STEM Courses	X3 GPA for STEM courses	0.758	0.294	2.134	0.010**	
Overall GPA	X3 Overall GPA computed	-0.345	0.392	0.708	0.379	
	Participated in College Preparation Camp	0.325	0.285	1.384	0.253	
	Participated in Research Project with faculty	1.012	0.202	2.752	0.000***	
	Participated in Community Based Project with Course	-0.451	0.177	0.637	0.011**	-0.363
Type of Institution	Private Institution	0.130	0.186	1.138	0.487	
Pseudo R-square		0.121				

*** = < 0.01; ** = < 0.05; * = < 0.10

Reference Group: White non-Hispanic, Upper SES, Public, Town/Rural, South, did not participate in preparation camp, research or project, Public Institution

Summary

This chapter presented the results of a block entry logistic regression design to answer three research questions. Results of the model to answer RQ1 determined that when entered with block one variables only race was not significant and SES was significant for persistence of women in STEM fields. As for Individual Habitus, SES was the only variable to support this particular context. In block entry two and three neither race nor SES were significant. Results of the model to answer RQ2 determined that when entered with block two variables there was a significant relationship between type of secondary school, location of secondary school and GPA for STEM Courses for persistence of women majoring in STEM. In block entry 2 overall GPA was not significant. As for School and Community Context, type of secondary school, location of secondary school and GPA for STEM courses were the only variables to support this particular context. In block entry three only location of secondary school and region of school were significant. Type of secondary school was no longer significant. In addition, overall GPA remained not significant. Results of the model to answer RQ3 determined that when entered with block entry three that higher education programs were significant and type of institution was not significant. As for Higher Education Context, location of secondary school, region of school, GPA for STEM courses, participation in research project with faculty are the variables that support this context.

CHAPTER V

In the preceding chapter, the presentation and analysis of data have been reported. Chapter 5 consists of a summary of the study, summary of results, discussion of results, implications for practice, recommendations for future research and conclusions.

Summary of the Study

The purpose of the study was to explore the relationship between pre-college and college factors influencing the persistence of women in STEM majors. Factors influencing the persistence of women in STEM were explored in an effort to create a profile of students likely to persist to graduation in STEM fields of study. Specific to these intentions, this research study sought answers to the following research questions (RQ):

RQ1. Is there a relationship between race and socioeconomic status and persistence for women majoring in STEM?

RQ 2. Is there a relationship between high school GPA, science interest indicators, high school locale and type and persistence for women majoring in STEM?

IRQ3. Is there a relationship between participation in summer camp, research and community-based projects and persistence for women majoring in STEM?

To answer these questions, I used the HSLS 2009 national data set to identify the pre-college and college factors that were more likely to influence persistence of women majoring in STEM. The dependent variable was persistence in STEM. Independent variables were grouped using Perna's conceptual framework into three layers: individual habitus, organizational habitus and context of higher education. Given the dichotomous nature of the dependent variable, logistic regression was used to analyze the data. This study employed the block entry method to explore the effects specific to each one of Perna's layers on persistence of women in STEM fields. The first block entry was individual habitus. This block included variables such as race and socioeconomic status. The next block entry was school and community involvement. Type of secondary school, location of secondary school, geographic region of secondary school, GPA for STEM courses and cumulative were variables explored in the second block. The third block is the final entry including the following: participation in college preparation camp, research project with faculty, community-based project and first institution sector. A summary of the results is included in the next section.

Summary of Results

Research question one sought to identify a relationship between race, and socioeconomic status and persistence for women majoring in STEM. The results of block entry one indicated that socioeconomic status was significant and race was not significant for persistence in majoring in STEM.

Research question two sought to identify a relationship between high school GPA, science interest indicators, high school locale and type and persistence for women majoring in STEM. The results of block entry two indicated a significant relationship between type of secondary school, location of secondary school and GPA for STEM courses and persistence of women majoring in STEM. The results indicated that race, SES and overall GPA were not significant.

Research question three sought to identify a relationship between participation in summer camp, research and community-based projects and persistence for women majoring in STEM. After entering all the independent variables, the third block indicated there was a significant relationship between location of secondary school, region of secondary school, GPA for STEM courses, participation in research project with faculty and participation in community-based project with a course and persistence of women majoring in STEM. In this block that included all independent variables, race, SES, type of secondary school and overall GPA were not significant.

Discussion of Results

The results of the study are representative of a national data set. Despite the limitations of the study, it is reasonable to conclude the results are good predictors of persistence of women in STEM majors. The results add to the knowledge base about persistence of women majoring in STEM by contributing information about persistence to the existing literature. This study echoed the results of several other studies but also found results that were surprising.

The results of the study found that STEM GPA was a significant variable for predicting persistence in STEM for women. This finding is consistent with previous research findings that recognize that high school students who have demonstrated strong math and science achievement in high school are more likely to persist in STEM than those with lower math and science achievement (Shaw & Barbuti, 2010).

In addition, the STEM GPA finding that participation in research with a faculty member related to persistence in STEM was also consistent with previous research and an expected finding. This finding confirmed the existing research about the significance of faculty research on persistence of women in STEM (Espinosa, 2011). It also supported findings about the significance of academic socialization and persistence, doing research with a faculty member being one example (Astin, 1984).

The significance of women attending secondary schools in the northeastern United States as related to STEM persistence is a new idea. There is limited information about the impact of the location of the high school and performance in STEM majors. Further research is needed to confirm the significance of this variable.

Some variables were surprisingly significant or not significant in this study. Race was not significant for any of the blocks for persistence of women majoring in STEM. Previous studies have indicated that race is a predictor of persistence in STEM (Anderson & Kim, 2006; Fotlz, Gannon, & Kirschmann, 2014). In this study, however, race appeared in all three block entries as not significant after controlling for other variables. This finding was surprising. However, there was a small number of minority participants in this study. Indeed, some of the racial minority groups were deleted because the number of participants were too few for statistical inclusion. This small number effected the statistical analysis of the race variable. Perhaps this is why I did not find race to be a variable of significance in this study. Further research is needed to confirm or counter this finding.

If indeed race proves not to be a significant factor of success in further studies, one might speculate that other factors such as resiliency and grit might have a far greater impact than race as a predictor of success. The idea of resiliency and grit recognizes achievement is not solely based on the cognitive abilities of the learner. Resiliency and grit may account for other metrics of success that go beyond traditional measures of academic success such as high school GPA and standardized test scores. Maybe there are other variables not used in this study and/or not easily quantifiable that contribute to race not being a significant variable.

Socioeconomic status was significant for only block entry one. This variable was no longer significant after the addition of variables from school and community context and context of higher education. This finding contradicts the existing literature about the significance of SES on persistence in higher education. Traditionally, the literature has considered that students from low SES, are racially diverse, and have lower scores on standardized tests (Lee, 2002), are more likely to repeat a grade (Campbell, Hombo & Mazzeo, 2000) or to drop out of high school (Swanson, 2003), and are less likely to enroll in and graduate from college (Harvey & Anderson, 2005). The literature even shows that students from high SES families with similar test scores and class ranks as those from low SES families are more likely to attend four-year college (Kane, 2004). Nevertheless, the use of block entry logistic regression in this study led to the finding that SES was not significant when new variables were added. This study used logistic regression which is something that was not used in existing studies which may help to explain this unexpected finding, one which is contrary to what is suggested in the existing literature. My research findings suggest that other factors may make a greater contribution to persistence of women in STEM than SES.

The overall GPA proved not to be a significant predictor for persistence of women in STEM. This finding is contradictory to the existing literature. Prior research suggests that high school GPA and standardized test scores have a positive correlation with success in a STEM major (Espinosa, 2011; Maple & Stage, 1991). Researchers have argued that students' pre-college academic preparation is one of the strongest predictors of leaving STEM (Chen, 2013). In contract, this study found STEM GPA to be a predictor of persistence in STEM but overall GPA to not be a predictor. More research is needed to confirm or contradict my research findings.

It was also surprising to find that women who attended a catholic or private high school were less likely to persist than those who attended a public school. Schools with more funding tend to have more resources and to offer small class sizes and Advanced Placement courses; have higher and more credentialed teachers; and purchase newer technology, books, and other items to help prepare students for success (Wenglinsky, 1997)—all proven factors needed for success. I think this variable was not significant in this study due to the small number of participants in the study who attended catholic or private schools. Due to this small number, the participants were combined into one group for this study. There is limited research about the impact of school type on the persistence of women in STEM fields. More research is needed to understand the relation of school type with persistence of women in STEM majors and to see if the finding of this study about type of school is confirmed.

The most surprising result for me was finding that participation with a community-based project was negatively correlated with persistence in STEM. This finding contradicts the existing literature that encourages student involvement in such projects to increase academic success (Astin, 1984). Although participation is usually favorable for many students, perhaps this is different for women and/or STEM majors. Perhaps, the definition of this particular variable was too broad in this study to identify effective community-based projects. Since the details of this community-based project were unclear, further investigation is needed at an institutional level to assess the effectiveness of community-based projects.

Implications for Practice of Higher Education Institutions

Higher education institutions have received increased pressure from students, families, government and tax payers to be more accountable for student retention and employment. The results of this study provided several implications for practice for higher education institutions to support the persistence of women majoring in STEM. Higher education institutions could think more strategically about how to provide more personalized support for women majoring in STEM. Knowing such information may allow us to intentionally support women and go beyond the predicted profile (from upper SES, attended public secondary school in the northeastern

United States, secondary school in the suburbs, earned a high STEM GPA in secondary school, and participated in research with a faculty member while in college are more likely to persist in STEM).

Instead of using race and SES to identify students who need additional support, perhaps institutions should focus on students with lower STEM GPAs for retention initiatives. The level of mathematical or academic competency of students entering college has been identified as one of the strongest predictors of retention to graduation in STEM (Maple & Stage, 1991; Morgan, Gelbsiger, & Weeden, 2013; Redmond-Sanogo, Angle, & Davis, 2016), with math skills having been found to be one of the strongest pre-college factors for success in STEM fields. Although limited information is known about the impact of STEM GPA on persistence, this study showed this variable to be significant for both blocks in which it was included.

Knowing that STEM GPA is significant for persistence of women in STEM will allow higher education institutions to provide intentional support for students based on their STEM GPA. Higher education institutions can support the success of students with lower STEM GPAs in a variety of ways. Study skills are needed for success in college and many students with lower STEM GPAs are not academically prepared. Offering study skills workshops, peer tutoring and supplemental instruction are a few ways higher education institutions can provide academic support. In addition, offering introductory STEM courses is another way to engage students early in the academic setting.

Introductory STEM courses provide early and frequent opportunities for students to engage with students, faculty and staff from their college and major. Oftentimes students do not take courses in their major until junior year. Offering introductory STEM courses freshman year, will allow students the opportunity to explore their major, career opportunities and become familiar with the curriculum. They also are more likely to get connected with resources needed for them to be successful such as tutoring and research opportunities.

Participation in a research project with a faculty member has been found to have a positive effect on persistence. Knowing the high-level significance of participating in research with a faculty member, each institution might pursue the way to cultivate student involvement in research in earlier years. Perhaps higher education institutions should invest more resources to offer such opportunities to more students. Given that faculty involvement through research projects impact student's intention to persist in this study and others, other programs designed to increase faculty interaction should be considered for implementation.

Recommendations for Future Research

Based on the findings and limitations of this study, additional research is recommended to explore persistence of women pursuing STEM majors. First, this study should be replicated to confirm or counter my findings that were not consistent with existing research. For example, another study to explore the relationship between race, SES, type of secondary school, and participation in community-based project and persistence of women majoring in STEM.

Second, further research is needed to know the details of the community-based project and research project with a faculty member. Since the details of this research project with a faculty member and community-based project were not clear in the dataset, further investigation is needed at an institutional level to assess the content of these projects. It would be helpful to know the details of each for further implementations.

Third, additional research should be conducted to explore the effects of other variables that weren't included in this study such as parental educational attainment, scholarship information, student involvement on campus activities. Additional research is also needed to learn more about variables (race, overall GPA and type of institution) that were significant in previous studies but not this present study. These variables could be significant for some students, even though the level of significance when including other variables proved to be insignificant in this study.

Fourth, the use of a national data set helps with generalizability of this study, but it would be helpful to learn anecdotal information from women who major in STEM. A qualitative study focusing on the variables of significance would be helpful to gain insight into the significance of the variables for persistence of women in STEM majors. The qualitive study could reveal anecdotal information that is helpful to create effective interventions needed to support student success.

Lastly, it would also be helpful to know the graduation and career results of this dataset. One of the limitations of this study was the use of the three-year progression data to assess persistence. Once graduation and career data are available, it would be helpful to know the results of the study using the same variables. This would give us an idea of any changes that may occur senior year or post-graduation in persistence in the STEM pipeline all the way to career choice.

Conclusion

This study sought to know more about the pre-college and college factors of women who persist as STEM majors. Factors influencing the persistence of women in STEM were explored in an effort to create a profile of students likely to persist in STEM majors. The profile of women majoring in STEM that emerged was: from upper SES, attended public secondary school in the northeastern United States, secondary school in the suburbs, earned a high STEM GPA in secondary school, and participated in research with a faculty member while in college are more likely to persist in STEM. Knowing such information may allow us to intentionally support women who do not fit this profile to persist in their major in an effort to diversify the STEM workforce with more women who will contribute to new discoveries.

If the findings from this study are found to be true in future research, then we can conclude that race and SES are not factors in persistence of women in STEM. We can then reimagine the profile of students who are less likely to persist in the existing literature. Perhaps we need to do a paradigm shift to focus on the STEM GPA at entry to college to provide additional support for student success.

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