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Disproportionality of Women in STEM Careers

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by
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Abstract

Despite inclusion efforts for women to be equally represented across all disciplines and at all career levels in science, technology, engineering, and mathematics (STEM), there remains a significant gap between males and females within the job market. The purpose of this cross-sectional, quantitative study was to examine how gender differences in mathematics and science are related to identity and self-efficacy and students' comparison of STEM subject competency. The secondary focus was to investigate the influence that STEM self-efficacy and STEM identity have on enrolling in advanced STEM-related classes. This research used secondary data from the follow-up High School Longitudinal Study (HSLS:09) survey conducted by the U.S. Department of Education. Participants included 20,594 Grade 11 students from public, private, and charter schools from all over the United States. Results from this study demonstrated a statistically significant different between mathematics and science self-identity, self-efficacy, and gender ability perceptions and whether or not a student enrolled in an advanced STEM-related course. Findings from this study found that enrolling in an advanced STEM-related course had the greatest effect on a student's self-identity. Female students who were enrolled in an advanced mathematics course were more likely to perceive male students as better in mathematics than females. In science, females who were enrolled in an advanced course were more likely to say males and females had equal science ability. Based on these findings, further research is needed to examine the relationship between STEM self-identity and enrolling in an advanced mathematics or advanced science course. Future research should also explore the relationship between female high school STEM self-identity and self-efficacy scores prior to, during, and following the participation in an advanced STEM-related class.

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Chapter 1: Introduction

Introduction

Despite years of inclusion efforts for women to be equally represented across all disciplines and at all career levels in science, technology, engineering, and mathematics (STEM), there remains a significant gap between males and females within the job market (Byars-Winston, 2014; Wang & Degol, 2017). Participation in advanced learning experiences predict future STEM success and are prerequisites for STEM majors in preparation for future careers (Wang & Degol, 2017). Careers in STEM play an integral role in driving innovation, aiding national security, and fueling global economic competition (National Science Board, 2015; Noonan, 2017; Sparks, 2017). Current extrapolations by the Bureau of Labor Statistics (2019) predict STEM careers, which include life and physical sciences, computer science, mathematics, architecture, and post-secondary teaching, will increase faster than non-STEM jobs from 2018 to 2028 (Vilorio, 2014). Workers educated and trained in STEM fields report having higher salaries, more favorable working conditions, greater opportunities for job promotions, more attractive job locations, and heightened feelings of respect by employers than individuals in non-STEM careers (National Science Board, 2015; Noonan, 2017; Vilorio, 2014).

STEM-related career fields are not a new addition to the United States workforce, yet the demand, function, and skillset have evolved over time with new discoveries and innovations in science, technology, engineering, and mathematics (Byars-Winston, 2014). Manpower and hard labor marked the age of the First Industrial Revolution. Innovation and skills were highly necessary at the onset of the turn of the twentieth century for factory productivity and assembly lines. Modern advancements in technology led the way for the following Industrial Revolutions that generated automated solutions for many jobs, and thus modified how the STEM workforce need met the demand. As society enters into a new Industrial Revolution, customization and personalization are at the forefront of innovation and mass production, calling for a greater quantity of STEM professionals to fill the demand in the economy (Yao & Lin, 2016). Though the structure STEM developments over time have changed, the core attributes associated with STEM careers, such as procurement for solutions to challenges, problem solving, creativity, innovation, and continuous learning, have stayed constant with time (Vilorio, 2014).

Within the STEM workforce, there exists a vast array of opportunities, which demonstrate a promise of increasing over time (Sheu et al., 2018). These opportunities formulate a considerable portion of the United States workforce and are creating historically lower unemployment rates than other professions (Noonan, 2017). The Bureau of Labor Statistics (BLS, 2020), defines STEM careers as “computer and mathematical, architecture and engineering, and life and physical science occupations, as well as managerial and postsecondary teaching occupations related to these functional areas and sales occupations requiring scientific or technical knowledge at the postsecondary level” (para. 7). The BLS reported 8.6 million STEM jobs in 2015 (Bureau of Labor Statistics, 2019; Fayer, Lacey, & Watson, 2017). In 2018, that number increased to 9.7 million STEM jobs. The STEM job market is projected by the BLS to continue to increase, creating a labor force of 10.6 million by 2028.

The knowledge and skills involved in STEM careers are transferable to non-STEM careers within the current globalized workforce (Sparks, 2017). Workers educated in STEM fields find greater ease and flexibility in the workforce for training in STEM knowledge and skills, which lead to a greater range of career choices among STEM-related or non-STEM-related available jobs (National Science Board, 2015). Career statistics reveal that in 2010, about 16.5 million jobs in the academic and professional areas of STEM required at least a bachelor’s degree in the areas of science and engineering yet were not officially classified as STEM careers (National Science Board, 2015). Sub-baccalaureate jobs, or positions where workers have the equivalent of either a high school degree or two-year technical training, make up a considerable portion of the workforce where STEM knowledge and skills are applied and are reported to be among the most stable, high paying jobs with one of the lowest averages in unemployment (Noonan, 2017). Occupations that are officially recognized as STEM careers, occupations requiring bachelor's degrees in STEM, and sub-baccalaureate jobs make up approximately 26 million U.S. jobs, equating 20% of the total U.S. workforce (National Science Board, 2015).

According to the U.S. Department of Commerce, STEM skillsets can bring individuals out of unemployment faster than non-STEM careers. This demonstrates the necessity of STEM-skilled workers from all education levels and within all career fields. Less than half of the STEM-degree college graduates reported working in a STEM or STEM-related careers (National Science Board, 2015). This suggests that STEM career paths are multidimensional for the knowledge and skills gained from undergraduate majors are transferable to other occupations (Sparks, 2017).

On average, workers in STEM careers report higher earnings than those in non-STEM careers (Xu, 2015). Workers holding a STEM degree and working in a STEM-related profession report earning 31% greater in salary than the individuals with a non-STEM degree working in a non-STEM career (Noonan, 2017). Workers who hold a high school diploma or less as their highest education level identify the greatest earning difference that can be seen between STEM and non-STEM workers. In 2017, STEM-related workers report averaging a $27.53 hourly wage whereas non-STEM workers earn $16.21, a 70% difference in hourly earnings. Professionals holding a STEM graduate degree earned an average hourly wage of $45.37, which was 29%

higher than an individual holding a non-STEM graduate degree who earned and hourly wage of $35.16 per hour.

Currently, STEM careers in computer science, mathematical occupations, engineering, life science, physical science, as well as science and engineering managers make up 5% of the U.S. labor force yet are projected to make up 50% of the future economic growth (Bautista, Diekman, & Fuesting, 2018; Sargent, Jr., 2017). Although the future is positive for job opportunities in STEM, there are not enough individuals to fulfill this demand (Bautista et al., 2018; Fealing, Lai, & Myers, 2015). The disparity of STEM laborers alludes to additional factors, such as a lack of interest and disparity of diversity within STEM vocations, as underlying causes preventing greater STEM career growth.

Statement of the Problem

In order to improve the STEM labor force deficit, the participation of women within STEM fields must increase (Byars-Winston, 2014; Van Veelen, Derks, & Endedijk, 2019). The disparity of women within the STEM workforce is proportional to females entering STEM educational programs, graduating with STEM majors, and choosing STEM-related careers (Van Veelen et al., 2019). The disproportionality of females in STEM in the United States has historical longevity (Cadaret, Hartung, Subich, & Weigold, 2017).

On October 4, 1957, Sputnik became the first artificial satellite to be launched into space by the Soviet Union (Byars-Winston, 2014). This monumental moment led to the formation of the United States National Aeronautics and Space Administration (NASA). Less than one year following Sputnik's history-making debut, the United States government passed the National Defense Education Act (NDEA) with the goal of strengthening K-12 education and post-graduate programs in science and technology fields (Byars-Winston, 2014; Jolly, 2009). The

NDEA provided individuals identified as having strong academic achievement in STEM subject areas with funding for university and graduate school programs (Jolly, 2009). For Americans, Sputnik was the catalyst that ignited an urgency to strengthen the country's collective efforts in science, technology, engineering, and mathematics (Byars-Winston, 2014). STEM was the nation's answer to becoming superior in innovation and expanding economic growth.

Six decades later, the United States is no longer competing against one rival, but is battling to be a leader in a high-stakes, global market (Jolly, 2009). In 2009, President Barack Obama launched the *Educate to Innovate* initiative, echoing the NDEA theme by drawing awareness to STEM education and careers (White House, n.d.). This rekindling of the nation's focus on STEM fields sought to enhance the United States' international STEM influence (Byars-Winston, 2014). While the NDEA Act sought to enhance the abilities of those considered advanced in STEM disciplines, the Obama administration sought to provide every student with the skillset and opportunities to have an equal chance of entering into the vastly growing STEM workforce. In collaboration with policy makers and stakeholders, new plans were established to prepare the next generation of STEM workers. In addressing equal access to STEM education and resources for all, the indigence of diversity within STEM fields was called out (Byars-Winston, 2014; National Science and Technology Council, 2013). The *Educate to Innovate* initiative shed light on the inequities in opportunities for underrepresented groups in STEM, such as those with low socio-economic status, minority groups, and women.

In order for the STEM workforce to expand, the participation of women in STEM careers must also grow (Byars-Winston, 2014). The underrepresentation of women in STEM careers has significant effects on fostering innovation in society by creating inequity in opportunity, income, and social advancement (Cadaret et al., 2017). Female contributions include underrepresented voices, unique perspectives, diverse backgrounds, cultural traditions, and creativity, all of which are linked to growing a diverse STEM workforce (Byars-Winston, 2014; Ong et al., 2011; Sparks, 2017; Stout, Grunberg, & Ito, 2016). Greater female participation in the STEM workforce allows for greater diversity in approaches to complex challenges, scientific discovery and innovation (Ong et al., 2011; Sparks, 2017). With the projections for STEM career opportunities on the rise, women, as an underrepresented group within society, should have a more equitable share of the opportunities within STEM (Byars-Winston, 2014).

More women than men are graduating with degrees at all levels (Cadaret et al., 2017; Snyder, de Brey, & Dillow, 2019; Tiedeu, Para-Mallam, & Nyambi, 2019). Females make up 57% of bachelor’s degrees, 50% of master’s degrees, and 53% of doctorate degrees. Women also represent 54% of biological and biomedical degrees and 48% of all medical degrees (Snyder et al., 2019). Although females have strong degree representation and presence within biological sciences and healthcare degrees, there persists a disparity of female representation in technological, engineering, and mathematics fields. Distributed by STEM doctoral domains, women earn 29% of the degrees in mathematics and statistics, 19% in computer and information sciences, 23% in engineering, and 34% in physical and technological sciences (Wang & Degol, 2017). Women make up only 14% of first year undergraduates in computer science (Cheryan, Ziegler, Montoya, & Jiang, 2017). Proportionally females are earning greater numbers of master’s degrees and doctoral degrees in computer science than bachelor’s degrees (Cheryan et al., 2017). This suggests that retainment efforts of females in computer science fields are working, yet there exists a need for programs to focus more energy on recruitment into the programs.

Although women are earning more than half of the degrees in higher education, females only represent 28% of the research community (Tiedeu et al., 2019). The U.S. Department of Commerce found that nearly half of all STEM or projected STEM careers are in computer science and mathematics (Noonan, 2017). Engineering follows, comprising 30% of the workforce, life sciences and physical sciences make up 12%, and 9% of STEM careers are in management. Within these STEM domains, women comprise 60% of biological or biomedical science domains, 43% in mathematics and statistics, 39% physical and technological sciences, 19% in computer and information sciences, and 18% in the field of engineering (Snyder et al., 2019; Wang & Degol, 2017). This demonstrates an uneven distribution of the women who are choosing STEM careers to fit the most needed STEM careers.

Barriers for women in STEM

Gender disparity can be viewed across STEM fields in the low numbers of women choosing to enter into STEM careers as well as the attrition of females out of STEM-related fields (Byars-Winston, 2014). Insufficient academic training, negative school experiences, lack of role models or mentors, work-family imbalance, and limited peer support are contributing factors to fewer women entering into STEM careers fields (Adams, Steiner, & Wiedinmyer, 2016; National Research Council, 2006). Females who choose to enter into the STEM workforce may experience a shorter career in STEM or may even leave the field sooner than men (Myers & Major, 2017). Once in the STEM workforce, women may experience environments that perpetuate gender roles and stereotypes that may result in discrimination, cultural isolation, self-doubt, and a low sense of belonging (Byars-Winston, 2014).

Improving work climate, removing gender bias, increasing females in senior level positions, and offering mentorship opportunities for all levels of women are a few methods that may increase female retention in STEM (Adams et al., 2016). Sparks (2017) shared the "assumption that those who leave the [STEM] pipeline leave by choice, not because of sexism, racism, and discrimination" (p. 167). Career barriers for women in the STEM workforce can affect the psychological well-being of women and over time influence the STEM identity and self-efficacy one has toward ability (Gnilka & Novakovic, 2017; Lin, Lee, & Snyder, 2018). Developing strong self-efficacy beliefs early on in education creates a greater resiliency toward future barriers (Bandura, 1993, 1997).

Stereotype threat. Implicit biases regarding women in STEM represent barriers that actively prevent interested, talented women from entering these fields (Dunlap & Barth, 2019). Stereotype threat is the awareness of negative stereotypes associated with gender and societal expectations of gender roles (Cadaret et al., 2017; Drake, Primeaux, & Thomas, 2018; Kelly, 2016). The stereotype that women do not perform as successfully as men in the fields of science, technology, engineering, and mathematics can create unwelcoming environments for women considering or pursuing STEM (Casad, Hale, & Wachs, 2017). The fear of living into a stereotype of underperformance may influence women to avoid entering into STEM-related careers (Kelly, 2016). Historically, men are associated with stereotypes of being dominant, forceful, and logical, while women are classified as being emotional, gentle, and sensitive (Drake et al., 2018). Stereotypes do not just affect those who are being underrepresented. In a study looking at physics majors, both men and women were surveyed to identify which gender held the greatest bias and found that men hold greater stereotypical attitudes than women. Traditionally, STEM fields, particularly computer science, engineering, and physics, have been stereotyped as male professions, and thus there are greater disparities of women within these STEM fields (Cheryan et al., 2017).

Stereotype threat causes women to question their own performance ability (Kelly, 2016). The entrance into a career requires much more than desire; an individual's career pursuit also considers one's self-evaluation of the success in that career. In a study of undergraduate physics majors, females almost always underestimated personal performance, whereas male students almost never underrated their ability (Kelly, 2016). This suggests that females place pressure on themselves to ensure that academic ability meets the expectations and demands in the STEM field. In a study targeting the disparity of women STEM researchers, Cidlinská (2019) found high levels of career attrition due to anxiety and uncertainty related to the academic environment, career development and advancement, as well as unrealistic performance expectations. Individuals within underrepresented backgrounds wrestle with balance between creating and living up to a professional sense of self with the desire to be true to one's identity (Flowers III & Banda, 2016; Poirier, Tanenbaum, Storey, Kirshstein, & Rodriguez, 2009). Women identify avoiding or abandoning STEM majors and vocations stereotypically considered masculine due to being widely male dominated in order to evade daily confrontation of negative stereotypes about women (Stout et al., 2016). Negative female stereotypes contribute to a female perception of lower ability, lower self-esteem, and beliefs that females are professionally incompetent, which lead to questioning personal qualifications for competing for higher level positions (Cidlinská, 2019).

Gender stereotypes are also reinforced by the culture to which someone belongs where there may exist pressure to live into gender norms of society (Ceci, Williams, & Barnett, 2009; Sachdev, 2018). Beliefs about gender norms are communicated to children beginning at a young age and shape beliefs about gender (Wang & Degol, 2017). The cultural beliefs about gender and gender roles an individual is born into negatively contribute to a woman's desire to enter into

STEM career fields and compound with societal and career obstacles (Sachdev, 2018; Wang & Degol, 2017). The perceptions of gender stereotypes within cultures add another barrier for females and influence the attitudes of women seeking to enter into male dominated professions. International studies identify a smaller gender gap in more developed countries than in underdeveloped countries (Williams & Best, 1990; Sachdev, 2018). Females have greater gender stereotype obstacles when pursuing male-dominated STEM careers in a male dominant culture and they must evaluate the cost associated with confronting societal gender norms (Sachdev, 2018).

Work and family conflict. Various surveys indicate women dedicate more time to caregiving over careers while men devote more time developing careers over caring for a family (Ceci et al., 2009). The expectation for women to both raise a family and have a career may affect a female's decision to enter into the STEM workforce (Myers & Major, 2017). The conflict between work and family have a greater influence on females' STEM career decision than males. Many women who have left the STEM workforce indicate the pressure to balance both family and work as a leading factor in attrition (Parson & Ozaki, 2018). In order to reach senior levels in STEM occupations, there is a great commitment to career development required in order to gain the expertise needed to be competitive (Wang & Degol, 2017). This dedication of time may present difficulties for women to take maternity or family leave and yet still remain competitive in their field.

In the area of academia and research, females may experience career or publication delays due to work-family conflict and childcare (Cidlinská, 2019). This interruption in a career may make it difficult for females to stay current within academia and thus hinder career advancement. Without career advancement, women may not be able to financially support a family (Buffington, Cerf, Jones, & Weinberg, 2016; Kmec, Huffman, & Penner, 2014; Xu, 2015). Dependents are identified as having a strongly negative financial effect on women. Contrary to women, men report dependents having a positive influence on earnings. For women, high career demands while balancing family life could cause women to leave the workforce altogether (Main & Schimpf, 2017). In society, and specifically the STEM community, "women bear more of the burden for childbearing and family-caring responsibilities, therefore, it is unrealistic and unreasonable to expect women to remain committed to work in the absence of needed support" (Xu, 2015, p. 517). The professional work environment has yet to adapt to allow for women to be devoted, flexible, and successful in both work and family life.

Wage inequality. The disparity women experience in STEM careers can be seen in the wages they receive. Variables contributing to male and female wages include: marital status, number of dependents, working part time or fulltime, degree major, level of degree earned, work history, and tenure (Buffington et al., 2016; Byars-Winston, 2014; Stout et al., 2016; Xu, 2015). Xu (2015) found that gender discrepancy in wages has only increased over time. In 1994, on average, men earned 22.5% more than women holding comparable positions, work history, education, marital status, and dependents, as compared to 20.1% in non-STEM careers. This wage gap increased to 28% in 1997, and jumped to 59% in 2003 (Buffington et al., 2016). Males graduating from selective university STEM programs reported earning significantly more pay than women graduating from the same programs and institutions (Xu, 2015).

Reaching gender pay parity is greater than solely viewing skills, efforts, and responsibilities equally. Although socioeconomic status and geographic location contribute to wages, the greatest factor contributing to salary is whether an individual is working part-time or full time for both men and women in STEM (James & Singer, 2016; Xu, 2015). Following employment status, holding higher levels of degrees and the duration of a STEM career are the greatest contributors for women earning higher wages (Xu, 2015). The greatest financial disadvantages for women are being married and having dependents (Buffington et al., 2016; Xu, 2015). The duration of employment within a STEM field is the most significant variable for men to receive higher earnings. Salary is contingent on the STEM career, yet even when conditions are controlled for, men earn more than women. The STEM fields that have the highest concentration of females in the STEM labor force are in the least lucrative careers such as in biological and environmental sciences, and women hold very few senior positions within the STEM labor force (Buffington et al., 2016; Wang, Degol & Ye, 2015).

Many women in STEM reach their pay class ceiling 10 years after graduating with a STEM degree (Xu, 2015). The STEM workforce holds some of the most lucrative careers in the economy, yet the majority of females in the STEM labor force hold positions in behavior sciences, which are on the low end of the STEM pay scale (Stout et al., 2016). If there is to be a greater presence of women being represented within all types and levels of the STEM workforce, women should also be receiving an equal share of the earnings of this labor force instead of being disadvantaged and deprived (Byars-Winston, 2014; Xu, 2015).

Purpose of the Study

Sheu et al. (2018) called for more indicators to explain why women continue to be underrepresented in STEM careers despite previous efforts to close the STEM gender gap. This study was to focus on how the course decisions of high school students influence the drive or avoidance into STEM majors and careers. The purpose of this cross-sectional, quantitative study was to examine how gender differences in mathematics and science are related to identity and self-efficacy and students' comparison of STEM subject competency. The secondary focus was to investigate the influence that STEM self-efficacy and STEM identity have on enrolling in advanced STEM-related classes.

Research Questions

The following research questions were explored in this study:

1) What difference, if any, exists between male and female students in their mathematics identity, mathematics self-efficacy, or perception of how males and females perform in mathematics?
2) Is there a statistically significant difference between students' mathematics identity, mathematics self-efficacy, or comparison of mathematics subject performance based on whether or not they enrolled in an advanced mathematics class?
3) What difference, if any, exists between male and female students in their science identity, science self-efficacy, or perception of how males and females perform in science?
4) Is there a statistically significant difference between students' science identity, science self-efficacy, or comparison of science subject performance based on whether or not they enrolled in an advanced science class?

Significance of This Study

The STEM workforce is growing at a rapid rate and that growth is tied to the diversity of those participating in STEM careers (Byars-Winston, 2014; Cadaret et al., 2017). There is a great need for women to possess a greater share of the STEM workforce (Xu, 2018). A greater presence of women in one of the fastest growing career fields would increase labor supply, attract more qualified workers, and increase competition (Xu, 2018). Empowering this underrepresented group within society to dismantle gender stereotypes and bias will inspire women to enter and stay in STEM fields (Cadaret et al., 2017; Xu, 2017, 2018). This empowerment would then affect the education and professional decision making of females in the future (Xu, 2018).

STEM career intention for an individual begins with gaining successful performance experiences resulting in the increase of one's belief in one's ability (Bandura, 1993, 1997; Hushman & Marley, 2015; Resnick, 2008; Sheu et al., 2018; Taylor & Betz, 1983). Mastery experiences in STEM create a belief, or self-efficacy, within an individual that they can be successful in STEM courses and thus STEM careers (Sheu et al., 2018). Students who lack self-efficacy in STEM will engage in fewer STEM experiences resulting in lower academic performance in STEM subject areas (Hong & Lin, 2013; Sheu et al., 2018). Lower achievement in STEM courses may prevent students from enrolling in more challenging classes that are prerequisites for STEM majors (Wang, 2013). For women, STEM career intention is supported by enrolling in advanced STEM courses in high school (Wang & Degol, 2017).

The aim of this study was to examine the influence that enrolling in an advanced STEM-related class has on the self-efficacy and self-identify of high school female students in STEM subject areas. Studies have focused on student self-efficacy and self-identity related to STEM interests, courses, and careers, yet no studies have looked at the effects of advanced STEM course enrollment on Grade 11 female students on self-efficacy and self-identify in a large scale, nationwide, longitudinal study. Therefore, the importance of this study was to identify influences on women's participation in STEM courses and STEM-related career choices.

The findings from this study will have implications for advancing research literature on STEM self-efficacy and taking advanced STEM courses in high school. Although many solutions have been implemented, there remains a gender gap within the STEM labor force (Byars-Winston, 2014; Wang & Degol, 2017). Aside from state mandated courses, the choices students make about the courses they enroll in are chosen with regard to the positive self-efficacy beliefs that a student holds (Bandura, 1993; Falco & Summers, 2019). If a student is enrolling in advanced STEM courses, that student will then be more prepared to enter into STEM majors (Institute of Educational Sciences, 2019; Lauff & Ingels, 2014; United States Department of Education, 2010).

Definition of Terms

The following terms are defined to delineate use for this study:

STEM: An acronym for the disciplines of science, technology, engineering, and mathematics (National Science Board, 2015, 2018). STEM includes policies, programs, practices, majors, and careers that include one or more of the disciplines, and may include innovation of new ideas or technologies and research and development (Byars-Winston, 2014; Bybee, 2010; Noonan, 2017; Vilorio, 2014). Although STEM is defined as science, technology, engineering, and mathematics, there remains no clear distinction as to which careers are included or excluded in the STEM umbrella of occupations. This has led different institutions and organizations to create and use different definitions of STEM and STEM careers (Granovskiy, 2018). Without a clear definition of STEM and STEM occupations, STEM research may not be consistent among institutions and may cause confusion over the findings.

According to the Department of Commerce, STEM is narrowly defined as “professional and technical support occupations in the fields of computer science and mathematics, engineering, and life and physical sciences” (Langdon, McKittrick, Beede, Khan, & Doms, 2011, p. 2). The National Science Foundation (NSF) define STEM as the academic and professional areas of STEM including psychology, economics, chemistry, physics, and biology (The America COMPETES Act of 2010). The definition of STEM occupations that most aligns with this study is the definition used by the ACT standardized testing organization which includes science, computer science, mathematics, engineering, technology, as well as medical and health (ACT, 2014b).

Self-efficacy: Self-efficacy is associated with the beliefs and judgments an individual has about one's capabilities or abilities to perform particular academic or career tasks (Bandura, 1997; Hushman & Marley, 2015; Resnick, 2008; Sheu et al., 2018). Self-efficacy is created and strengthened through experiences of successful performance and mastery, vicarious learning, anxiety management, and encouragement (Bandura, 1993; Falco & Summers, 2019; Taylor & Betz, 1983).

Self-identity: Self-identity is the understanding of personal abilities and values that attribute to one's own identity formation (Matsushima & Ozaki, 2015). Motivation and academic success depend heavily on an individual's self-identity. A student with a strong sense of STEM self-identity is able to visualize himself or herself in a STEM-related career.

Advanced mathematics: Advanced mathematics courses include International Baccalaureate (IB), Advanced Placement (AP), or are classes taken in high school following Algebra I, Algebra II, and Geometry, such as Algebra III, Pre-calculus, Calculus, or Trigonometry (Institute of Educational Sciences, 2019; Lauff & Ingels, 2014; U.S. Department of Education, 2018).

Advanced science: Advanced science courses include any computer science or programing course as well as second year science courses such as Biology II, Chemistry II, and Physics II. Advanced courses also include International Baccalaureate (IB), Advanced placement (AP), or any other higher level science course (Institute of Educational Sciences, 2019; Lauff & Ingels, 2014; National Science Board, 2018).

Organization of the Remainder of the Study

Chapter One provides the introduction to the study and identifies the impact that conducting this study will have on the current state of education. Chapter Two will look at empirical research on self-efficacy and self-identity specifically relating to gender disparity in STEM education and STEM career fields. Chapter Three will describe the research design, theoretical framework, data collection procedures, and data analysis for the study. Chapter Four will present the findings and demonstrate if the findings reject or support the hypotheses. Chapter Five will close the study by providing a discussion of the implications the results will have on the current state of education as well as identify the recommendations for future research.

Chapter 2: Literature Review

Introduction

For years the United States has been a lead global contender in scientific advancement and innovation, however, with increased funding and a stronger emphasis on STEM education, international nations and corporations are gaining traction in the areas of science, technology, engineering, and mathematics (National Science Board, 2020; Ong, Wright, Espinosa & Orfield, 2011). Natural sciences and engineering fields hold some of the greatest growth potential, yet the U.S. only has 16% undergraduate participation in these majors as compared to 48% of undergraduate representation in China, followed by South Korea holding 38%, and France at 27% (Ong et al., 2011). Comparably, by some definitions of STEM, computer science and mathematics comprise half of all STEM jobs, yet these only account for 22% of U.S. undergraduate majors (Noonan, 2017). Improving and investing in female participation in STEM majors may aid in rectifying U.S. STEM workforce shortcomings by increasing the quantity and quality of top performers to meet the increasing demand for STEM workers, thus increasing U.S. economic competitiveness (Granovskiy, 2018).

STEM Undergraduate Majors

Students who enter into STEM undergraduate programs have a greater chance (40%) than non-STEM majors (28%) of being accepted into more selective universities (Xu, 2015). Earning a degree from a more prestigious university can provide greater opportunities for internships, jobs, the potential for a significantly higher salary, and an increased probability of staying in the same career field as one's undergraduate major (Noonan, 2017; Xu, 2015). Females hold a greater likelihood to work in the career of their major, which provides the individual with the foundational training, skills, and knowledge in the content area, in addition to the greatest return on the investment of education (Xu, 2015).

STEM majors report a greater gender disparity as compared to other undergraduate majors (Xu, 2017). Females comprise only 28% of employed college graduates working in a science, technology, engineering, or mathematics related profession (Cheryan et al., 2017; National Science Board, 2015). In areas such as computer science, women remain greatly underrepresented (Epstein & Fischer, 2017). Fields such as electrical and mechanical engineering show significantly lower female interest, remaining at or below 1% representation over the last 30 years (Iskander, Gore, Furse, & Bergerson, 2013). Although women hold greater representation than men in some branches of science, such as biological sciences and chemistry, these careers only account for 38% of STEM careers available (Noonan, 2017; Stout et al., 2016).

The University of Utah's engineering department mirrors national growth by reporting a 70% increase of undergraduate participation in biomedical and mechanical engineering since 2006 (Iskander et al., 2013). Although more undergraduate students are showing interest in obtaining engineering degrees, the University of Utah reported in 2009, only 12 of its 129 mechanical engineering graduates were women. The lack of female engineering students reflects the greater gender imbalance that is prominent across many STEM fields and the possible benefits that could result from participating in such majors (Noonan, 2017).

Career intention, or the drive toward pursuing a particular career, is required in order for females to enter a STEM career, yet women are frequently subjected to competing against high costs of education and family intentions (Epstein & Fischer, 2017). The disparity of women in male-dominated fields creates an added level of pressure to demonstrate high performance at all times to combat gender stereotypes (Makarova, Aeschlimann & Herzog, 2016). In order to create equity in STEM, there should be equity among all levels of STEM higher education (Xu, 2018). Depending on the institution, women faculty comprise on average of 15-30% of the STEM faculty (Adams et al., 2016). If the U.S. seeks to be a global competitor, there must be efforts to “increase participation of the woman scientist in order to promote diversity and enhance innovative power which impacts the education and career development of future generations” (Xu, 2018, p. 620).

Female STEM degree obstacles. Women report facing numerous obstacles in male-dominated STEM professions which are equally apparent at the university level. Although women constitute half of the workforce holding a college degree, about half of declared STEM majors later change majors (Bautista et al., 2018; McFarland & Hussar, 2019). In male dominated undergraduate spheres, females may experience marginalization from peers and an absence of support from professors (Johnson, 2011). In a study looking at computer science majors, 18 out of 23 universities found females have greater undergraduate attrition over male students (Main & Schimpf, 2017). Environments with high female attrition rates, such as computer science, attributed isolation and lack of support as the leading causes. Female students who remain in isolating majors identify possessing strong traits in agency, resilience, and self-efficacy (Jenson, Petri, Day, Truman & Duffy, 2011; Johnson, 2011; Main & Schimpf, 2017).

Classroom practices. Parson and Ozaki (2018) suggested the existence of an unspoken definition of the ideal undergraduate student which rewards masculine stereotyped traits. This definition was influenced by male dominated labor forces and provides advantages to those who conform to this stereotypical masculine ideal. It also automatically overemphasizes feminine stereotyped characteristics, calling attention to the extent of which females do or do not conform to the masculine definition of the ideal student. Identified practices which support masculine education preferences include the manner in which classes are taught and new content is introduced, formative and summative exam structures, as well as grading practices (Parson & Ozaki, 2018). Participating in university majors created by and tailored to support males may deter women from attaining a STEM degree for fear of taking on another challenge of being part of a minority group (Johnson, 2007; Parson & Ozaki, 2018).

University STEM faculty deny the presence of the influence of gender within the classroom expressing there is no need for gender interventions (Blair, Miller, Ong, & Zastavker, 2017). The obstacles that may be experienced by undergraduate female students have been attributed by professors as a lack of ability or lower skills instead of an absence of diversity, a lack of supportive environment, classrooms run on individualized learning instead of collaboration, and competitive coursework structure (Johnson, 2007; Makarova et al., 2016; Ong et al., 2011). Without the acceptance that gender influences a classroom environment, instructors are not motivated to change current structures and practices. Many professors identify gender as an obsolete factor in instruction (Blair et al., 2017; Lawson, Kooiman & Kuchta, 2018). Some professors expressed that the presence of gender stereotypes in the classroom create opportunities for women to demonstrate a high level of commitment and passion to STEM careers so that women are not perceived as lacking interest or confidence (Blair, et al., 2017).

Lack of female faculty. In order to circumvent the obstacles experienced by women, feeling a sense of comfort and belonging within a STEM environment is significant for females to gain interest in the field and view themselves as a contributor to that environment (Main & Schimpf, 2017). In addition, participating in courses taught by female faculty decreases female

STEM major attrition (Main & Schimpf, 2017). At the undergraduate level, female professors make up 12% of tenured professors and 30% of assistant professors (Adams et al., 2016). The disparity of females in STEM increases with each level of higher education. When the diversity within a university's faculty does not match the population of the students, especially in underrepresented groups such as women, there is a greater rate of turnover by those underrepresented groups (Xu, 2018). When students are learning about STEM fields, it is significant for women represented in an equal fashion (Sparks, 2017). When there is a lack of representation by underrepresented groups when promoting workforce careers, a sense of invisibility and discrimination is created (Sparks, 2017).

Stress. With a lack of support comes the extended internal pressure for females to overachieve in STEM courses to demonstrate performance qualifications to overcome gender stereotype beliefs (Makarova et al., 2016). Female students reported experiencing higher feelings of anxiety about failing physics than male students (Kelly, 2016). When students experience high stress derived from the pressure to achieve high performance, knowledge recall becomes difficult and it may be difficult to perform the necessary skills for that content area (Jenson et al., 2011). In order to minimize stress, student subject area self-efficacy must be strengthened to create environments that allow students to feel safe and willing to fail (Jenson et al., 2011; Kelly, 2016; Parson & Ozaki, 2018).

Self-efficacy

Self-efficacy includes the beliefs surrounding an individual's capabilities and the control an individual has over these capabilities (Bandura, 1993). Self-efficacy has a direct relationship to academic achievement and can be used as a predictor of an individual's future career aspirations (Bandura, 1993; Epstein & Fischer, 2017). When boys and girls at the primary level are surveyed in regard to differences in STEM self-efficacy, both genders showed comparable outcomes (Brown, Concannon, Marx, Donaldson & Black, 2016). Yet as students develop into adolescents, a noticeable difference in STEM self-efficacy can be noted between genders where it once was parallel. Female students who demonstrate a lower interest in STEM-related degrees and career fields also report a lower level of interest and confidence in STEM content areas, both of which are needed for a strong sense of self-efficacy (Falk, Rottinghaus, Casanova, Borgen, & Betz, 2017). Providing continual or increased opportunities to succeed in a subject area increases the possibility that a person will likely engage with that subject area again (Hushman & Marley, 2015). The stronger a student's self-efficacy in STEM-related fields, the greater the student's STEM career interest will be (Epstein & Fischer, 2017).

Self-efficacy and learning experiences. Self-efficacy is a product of the sum of experiences an individual has over time (Charleston & Leon, 2016). The attitudes students have toward STEM are influenced by previous encounters with STEM content (Hushman & Marley, 2015). These experiences influence whether an individual lives out or rejects gender stereotypes pertaining to STEM content ability (Tellhed, Bäckström, & Björklund, 2017). The type and frequency of learning experiences males and females encounter influence interest, motivation, and self-identity in STEM (Bandura, 1997; Hushman & Marley, 2015). Learning experiences vary at different stages of a child's development in STEM (Hushman & Marley, 2015). For example, in computer science the progression may begin with interacting with computers, followed by being exposed to the computer science career field, and then engaging with different degrees and specializations within the field. Bandura (1993) identified that ability is not fixed but rather it can develop and evolve over time and self-efficacy is what helps to develop ability.

It is critical to future career ideation that strong self-efficacy is built within every stage of learning.

Subject self-efficacy grows and is sustained through successful performance accomplishments (Bandura, 1993; Taylor & Betz, 1983). Students with a higher sense of self-efficacy have a stronger drive in science, find greater enjoyment in science, and exude greater feelings of control over academic achievement and thus career opportunities (Hushman & Marley, 2015). Vicarious learning experiences, verbal persuasion, encouragement, and joy brought by successful accomplishments have been shown to be significant in influencing a person's STEM self-efficacy (Charleston & Leon, 2016). Mastery experiences in science and mathematics are significant for developing self-efficacy in the field (Charleston & Leon, 2016; Grigg, Perera, McIlveen & Svetleff, 2018). The greater the frequency of mastery experiences, the greater the increase in self-efficacy (Hong & Lin, 2013). This demonstrates the weight that providing regular mastery experiences can have on underrepresented groups such as females, and mastery experiences are necessary in order to increase female participation in STEM courses throughout their education.

STEM, academic achievement, and motivation. The career an individual pursues in STEM is the cumulation of STEM subject achievement and motivation in STEM (Wang & Degol, 2017). In one study including 400 students, 275 females and 125 males, from Grade 6 to Grade 10 attending two different non-public schools enrolled in required mathematics classes, the researchers sought to examine the relationship between self-efficacy, mathematics achievement, interests, and future career intentions (Grigg et al., 2018). The study found that mathematics self-efficacy was a greater predictor of academic achievement, even over initial levels of achievement or grade point average (GPA) (Grigg et al., 2018). The results showed that previous student achievement was related to current mathematics self-efficacy; it was not able to predict changes in future mathematics self-efficacy.

When students' mastery experiences result in an increase in STEM self-efficacy, subject area performance also increased. In a study of over 250 introductory biology undergraduate students from a Midwest university, researchers compared the science self-efficacy of underrepresented groups following active mastery learning experiences to the traditional lecture style learning (Ballen, Wieman, Salehi, Searle & Zamudio, 2017). The mastery student experiences increased student subject self-efficacy and also increased academic achievement. This gain was most evident in underrepresented student populations and was able to eliminate a performance gap.

Although strong academic achievement does not ensure STEM career success, without a strong foundation in STEM content areas, the path into STEM careers becomes more difficult (Dennehy & Dasgupta, 2017). When a STEM foundation is lacking, self-efficacy, beliefs about STEM capability, and STEM interests must be exceptionally high to compensate for such deficiencies. In addition to foundational skills, a candidate must be capable, interested, and motivated in order to pursue a STEM career (Wang & Degol, 2017). Self-efficacy is significant because it can forecast future interests and goals for individuals and aid in persistence toward those goals (Cadaret et al., 2017).

STEM self-efficacy is one of the greatest predictors of STEM career success, however, student interest is of the greatest motivators leading women to peruse a STEM major and career field (Brown et al., 2016). Although students may hold a strong self-efficacy in mathematics, they still might not choose to pursue mathematics careers (Grigg et al., 2018). Strong confidence and performance in mathematics is significant, yet still depends on interest in order to pursues a mathematics career path. Low career self-efficacy is also attributed to increased career aversion or indecision (Stărică, 2012).

Self-efficacy and STEM majors. Studies show that high self-efficacy in STEM is needed for women to show interest in a pursuing a STEM career (Tellhed et al., 2017). One study that included a random sample of 1,327 Grade 12 students enrolled in a college preparatory program, sought to understand student career interests. The results showed male students with higher interest in pursuing STEM careers. Female students who displayed interest in STEM careers, identified high social belongingness and self-efficacy. Having a strong self-concept is necessary in order to demonstrate success in a STEM field, but optimal performance will be reached when a strong self-concept accompanies motivation (Wang et al., 2015). Female retention within mathematics and science majors rely on females having strong self-efficacy early on in their academic experience in order to drive motivation to pursue a STEM career (Dennehy & Dasgupta, 2017; Larson et al., 2015).

There is a strong relationship between science self-efficacy and choice of scientific major (Ong et al., 2011). One study that surveyed the mathematics and science self-efficacy of first semester undergraduate students enrolled in introductory science courses found that STEM self-efficacy, more so than prior academic achievement or aptitude, strongly predicted graduation rates 4 to 8 years later (Larson et al., 2015). In a study of engineer majors, women had lower self-efficacy than male students and identified as having lower interests in academics and science activities (Wang & Degol, 2017). Comparably, looking at computer science graduate students, females identified a direct relationship between confidence in computer science and motivation and academic success (Charleston & Leon, 2016).

Self-efficacy is also positively associated with university entrance exams, creative thinking, and general intelligence (Day, Hanson, Maltby, Proctor & Wood, 2010). In a three year longitudinal study of 129 undergraduate students (52 males, 77 females) from two cohorts, researchers used data from three time points in an undergraduate student's experience: pre-university data included standardized test scores and high school transcripts, undergraduate first year which included a hope scale, personality test, intelligence test, and semester grades; and at the time of graduation including final undergraduate grades. The results of the study showed an individual's hope, defined by an individual's determination and goal setting toward academic achievement, displayed a significant positive correlation to degree attainment. First year STEM majors with high self-concept traits were able to visualize desired grades for the end of the semester and were more likely to see these grades come into fruition than students with low self-concept.

Self-efficacy and STEM careers. Self-efficacy is significant in predicting an individual's confidence toward STEM careers (Myers & Major, 2017). Those with high STEM career self-efficacy are able to execute STEM tasks with greater confidence and are able to see desired outcomes (Myers & Major, 2017). Individuals with high self-efficacy are able to visualize and prepare themselves in a greater number and variety of careers, and have greater job retention (Bandura, 1993; Epstein & Fischer, 2017). High self-efficacy allows the individual to envision themselves in situations where they are successful, can formulate goals to achieve success, and are able to stay dedicated to these paths regardless of outside pressures and obstacles (Bandura, 1993). The careers women choose to pursue are strongly dependent upon the amount of career self-efficacy (Tellhed et al., 2017). When negative self-efficacy is strong, students display an aversion to entering into STEM majors.

Self-identity

Partaking in STEM-related careers transpires from identity formation and self-efficacy (Kim, Sinatra, & Seyranian, 2018). Identity formation includes understanding a sense of one's own abilities and values, which aid in the production of an individual's self-esteem. Motivation and academic success depend heavily on a student's degree of their self-identity (Wang & Degol, 2017).

STEM identity is the combination of what you believe about yourself in STEM subjects as well as what others see in you (Sparks, 2017). Students with a strong sense of self-identity in STEM subject areas are able to visualize themselves graduating with a degree in a STEM field and ascertain a STEM career (Matsushima & Ozaki, 2015). In one study using data from the Aspire2 project, a 10-year longitudinal study of 13,421 students ranging in ages from 15-16 years old, surveys were collected to understand the students' science and career intentions (Archer, Moote, Francis, DeWitt & Yeomans, 2017). When high school students reported science and mathematics subject performance and subject identity, students who had strong subject performance reported strong identity in that same subject (Archer, Moote, Francis, DeWitt & Yeomans, 2017). When males reported low STEM subject performance, such as in physics, they reported only a slight decrease in subject identity as compared to females who reported a much greater decrease in subject identity.

In a study that used data from the Trends in International Mathematics and Science Study (TIMSS) of Grade 8 student assessments from 53 countries, a logistic regression analysis was used to compare student future career aspirations in science and mathematics as compared to student subject interest and assessment test score (Riegle-Crumb, Moore & Ramos-Wada, 2011). The results found that female students were 50% less likely than male students to show interest in pursuing a mathematics career. In science, although males and females rated themselves as having a similar degree of enjoyment in the subject area, females identified themselves as less likely to aspire a science career. This gender disparity of self-identity in adolescence is mirrored within undergraduate degrees and the STEM workforce.

In order to establish a sense of self-identity in STEM an individual must understand where his or her current abilities reside, have a commitment to personal beliefs and goals, have confidence in STEM ability, engage in experiences that provide academic success, as well as stay true to target goals (Matsushima & Ozaki, 2015). Positive self-identity in STEM provides a sense of purpose for future careers, and provides individuals motivation towards reaching STEM career ambitions (Flowers III & Banda, 2016; Matsushima & Ozaki, 2015). In addition to motivation, self-identity influences how students view their level of control over situations and environments (Matsushima & Ozaki, 2015).

High self-identity allows individuals to view themselves as having control over career outcomes, which then influences the courses students elect to take and their sense of control they have about their academic achievement (Matsushima & Ozaki, 2015). Students with low STEM self-identity view STEM task completion as tedious and hold a lack of responsibility or accountability to the field. Students with high STEM self-identity are able to envision a future career path and make choices that contribute to that future goal (Flowers III & Banda, 2016; Matsushima & Ozaki, 2015; Sparks, 2017). Subject area self-identity contributes to an individual's core identity beliefs (Sparks, 2017). A student's STEM identity is strengthened by developing a student's STEM literacy skills which then sparks a sense of belonging within the STEM culture, thus fostering a strengthened core identity. STEM identity is critical for underrepresented groups to gain more representation within STEM career fields (Flowers III & Banda, 2016).

Education

The female STEM career gap identifies the need to appeal to the female STEM professional (Xu, 2018). Over 20% of all U.S. careers require the knowledge and understanding of at least one STEM subject area (Tanenbaum, 2016). STEM success goes beyond understanding STEM fields, but rather is the synthesis and application of STEM content knowledge (U.S. Department of Education, 2010). In addition to content knowledge, STEM fields foster supplementary skills such as: resilience, flexibility, collaboration, problem solving, and systems thinking (Bybee, 2010; Tanenbaum, 2016). In order to prepare future STEM professionals for the workforce, students must have vast and numerous experiences with these skills.

According to Parson and Ozaki (2018) the ideal STEM student has a connection to school with a strong academic background, possesses high problem solving skills, is resilient to adversity, and is persistent in the face of failure. Participating in advanced learning experiences contribute to the beliefs an individual holds about personal ability and contributes to future STEM accomplishments (Wang & Degol, 2017). Interdisciplinary and transdisciplinary methods of STEM instruction provide appropriate learning experiences for students to gain STEM skills and content literacy (McDonald, 2016). The understanding of STEM concepts and skills needed to solve daily problems and sustain a global economy can be supported through quality STEM education (Bybee, 2010).

There are varying definitions of STEM education. Some researchers define STEM education as the integration of two or more of the STEM disciplines, while others insist all content areas need to be present in order to be defined as STEM (Brown, 2012; National Science Teaching Association, 2020). Regardless of the definition used, the goal of STEM education is to create connections for students in science, technology, engineering, and mathematics through interdisciplinary learning methods (McDonald, 2016; National Science Teaching Association, 2020). In order for STEM education to be successful it must be able to evolve over time to meet the needs of society (Brown, 2012). The current gender gap in STEM can be reduced through utilizing engaging STEM interdisciplinary approaches while monitoring student achievement and interests in K-12 education (Brown, 2012).

Elementary education. The beliefs and stereotypes women hold about STEM ability begin early in education (Wang & Degol, 2017). At the elementary level, both boys and girls demonstrate equal levels of enjoyment, interest, and self-efficacy in STEM content areas (Brown et al., 2016). The learning experiences students engage in influence the attitudes and beliefs an individual holds about personal ability and contributes to future STEM accomplishments (Hushman & Marley, 2015; Wang & Degol, 2017).

Threats of gender stereotypes in STEM careers begin at a young age, when girls are starting to explore and form interests about future career interests (Wang & Degol, 2017). How adults, including teachers and parents, treat boys and girls in relations to academic fields and careers persuade children toward or away from different professions. How adults treat failure is seen differently in boys and girls. When girls do not have high performance in mathematics or science they are treated as the low performance is a lack of ability, whereas low performance from boys is seen as a lack of effort (Tenenbaum, 2009). Student interest is not fixed and through the implementation of appropriate interventions, self-efficacy can be molded and increased (Master, Cheryan, Moscatelli, & Meltzoff, 2017).

Self-efficacy is not a fixed construct, and with appropriate interventions self-efficacy can be positively influenced. In one robot computer programing study, 96 six-year-old boys (48) and girls (48) were randomly assigned to one of three groups: an experimental robot group, a control group that used a no technology equivalent lesson, or a "no activity" group (Master et al., 2017). For students who were beginning to learn how to program robots, boys reported to have higher interest in programing than girls at the beginning of the study. In addition, girls initially identified boys as having greater programming ability than girls. The students in the experimental robot group were provided with one-on-one, intentional, mastery computer science experiences that were controlled for the instructor gender. The results reported that girls identified at the end of the study that both boys and girls had equal ability in programing robots. In addition, girls also reported an equal interest level in programming as boys. This study demonstrates the significance mastery experiences have on students' motivation and confidence toward programming, especially at the younger age levels.

When classrooms have a positive culture around making mistakes and provide mastery learning experiences, girls strengthen their STEM self-efficacy (Epstein & Fischer, 2017; Parson & Ozaki, 2018). Negative learning environments and learning experiences demonstrate long-term damaging effects to female STEM self-efficacy (Britner & Pajares, 2006; Jenson et al., 2011; Main & Schimpf, 2017; Tellhed et al., 2017). Main and Schimpf (2017) stated that "external cues signifying belonging in an environment are critical in determining student interest in a given field" (p. 4).

These negative experiences may create high levels of stress and anxiety, reinforce gender stereotypes, and question personal performance ability in STEM content areas (Casad et al., 2017; Cheryan et al., 2017; Epstein & Fischer, 2017; Jenson et al., 2011; Main & Schimpf, 2017). Too many negative experiences with STEM may cause girls to avoid STEM content areas and courses altogether (Kelly, 2016).

When surveying students ranging from Grades 4-8, female students demonstrated less interest than male students toward entering into STEM careers although boys and girls identified equal levels of STEM enjoyment (Riegle-Crumb et al., 2011). Both boys and girls in Grade 4 indicated equal levels of enjoyment in science, yet students in Grade 8 showed an overall decrease in enjoyment from Grade 4. The decrease in enjoyment was much greater for girls than it is for boys. Enjoyment is not a direct result of poor performance because girls, with the exception of elementary school, outperform boys academically in both science as well as overall GPA, yet boys report having higher science self-efficacy than girls (Hong & Lin, 2013; Riegle-Crumb et al., 2011).

Secondary education. A student's high school STEM preparation is significant to STEM career retention. Secondary education provides variety and choice in class offerings such as advanced, accelerated, IB, or AP courses (Vilorio, 2014; Wang & Degol, 2017). High school also provides students with internships, volunteer experiences, and research opportunities that put STEM content knowledge into practice in addition to increasing STEM career interest (Vilorio, 2014). Increased positive experiences, content knowledge, and STEM interest increase student confidence in difficult STEM material resulting in greater STEM field retention (Nix, Perez-Felkner & Thomas, 2015).

High academic achievement in STEM courses increase the probability that an individual will enter into a STEM major and career (Riegle-Crumb et al., 2011; Wang et al., 2015; Xu, 2017). In a study of Grade 8 students from 232 international schools, researchers reported a significant positive correlation between students' test scores and their desirability to pursue science-related careers (Riegle-Crumb et al., 2011). Individuals who demonstrate high abilities may have a wider range of choices when selecting a career (Wang & Degol, 2017). Supporting high mathematics and science achievement for females should also then support an increase in female representation in STEM careers.

Science academic performance and science self-efficacy decline greatly in girls from primary school to middle school (Hong & Lin, 2013). Although both males and females see a decline in grade point average (GPA) possibly due to exposure to new and more challenging content, females experience a greater decline. There is another decline in female STEM interest in the transition from middle school to high school (Kier, Blanchard, & Albert, 2014). Stereotype bias, inequitable treatment, isolation, greater coursework time commitments, STEM classes with more challenging content and high levels of rigor are identified as some of the contributing factors to the decline of high school STEM interest (Kier et al., 2014; Mau & Li, 2018). When content begins to get more challenging, students may experience STEM confusion (Ocumpaugh, San Pedro, Lai, Baker & Borgen, 2016).

One study of high school juniors from an urban New England school investigated STEM vocational self-efficacy and STEM interest (Ocumpaugh, et. al, 2016). Of the 284 eligible students, 76 students participated in a survey that measured seven indicators of STEM student engagement and three indicators of mathematics performance. The results of the survey found that STEM content confusion negatively affects STEM self-efficacy and STEM career interests. STEM confusion occurs for students when they struggle with STEM content and they are not able to resolve the confusion. STEM confusion negatively affects student perception of subject knowledge and results in a loss of confidence in STEM (Ocumpaugh et al., 2016). If this confusion persists over time, students are at a greater risk for decreased STEM career interest resulting in dropping out of STEM classes and majors.

High mathematics and science abilities correlate with high STEM career success. According to the National Assessment of Educational Progress (NAEP) results, higher percentages of both boys and girls are scoring at or above proficiency levels in science and mathematics achievement tests over the last 10 years (Tanenbaum, 2016). These standardized tests also identify that females are closing the STEM achievement gap. Even with rising female STEM academic achievement, there continues to remain a gender gap in STEM career fields. Increasing mathematics and science performance in females may seem like the solution to eliminating the gender gap in STEM careers, yet achievement alone does not increase participation of women in STEM careers (Wang et al., 2015). Studies show that although student standardized test scores have a positive correlation to science career interests, self-efficacy, motivation, and interests in STEM have the greatest apparent influence on STEM career attainment (Riegle-Crumb et al., 2011; Wang et al., 2015).

One study using data from the Longitudinal Study of American Youth that followed 5,945 students from 50 public schools from across the United States, through middle school, high school, and post-high school sought to identify gender differences in pursuing a STEM career (Wang et al., 2015). The students completed a mathematics assessment and STEM attitude survey every year of school through Grade 12. When the students were between the ages of 33 to 37, the study followed up with the participants to inquire about their career history. The results demonstrated that females had lower interests and motivation toward mathematics careers. Lower interest is related to lower achievement. Females demonstrated lower mathematics achievement than males, and high mathematics achievement was associated with obtaining a STEM career.

Women must feel enjoyment and a sense of belonging toward STEM careers, which in unison with achievement, fuels motivation. Students who hold high levels of STEM self-efficacy in high school demonstrate greater interest and aspirations toward pursing STEM careers (Mau & Li, 2018). Mau and Li used data from the High School Longitudinal Study of 2003-2014 (HSLS:09) to understand how educational and social experiences influence the development of career plans of 21,444 Grade 9 students. They found there is a significant gender discrepancy in students in Grades 9 in mathematics and science self-efficacy and the career path they pursue. In addition, the results showed that although female students who demonstrated an interest in a STEM career had higher STEM self-efficacy, their interest in mathematics and science was lower than those students who declared non-STEM-related career interests.

In a descriptive research study of the past 30 years of research across fields of psychology, sociology, economics and education, Wang and Degol (2017) sought to find connections about female disparity in STEM fields that are concentrated in mathematics. Females, more often than males, demonstrate lower interest in mathematics and science courses and viewed STEM careers with lower enthusiasm for future goal attainment. The motivational factors behind these decisions begin at a young age and are reinforced through adolescence. The repercussions of lower female interest can be viewed in fields such as engineering where women make up only 18% of the labor force (Snyder et al., 2019; Wang & Degol, 2017; Xu, 2017).

In one study using data from the Aspire2 project, a 10-year longitudinal study of 13,421 students ranging in ages from 15-16 years old, surveys were collected to understand the students' science and career intentions (Archer et al., 2017). In addition, 70 participants were chosen to be interviewed. In regard to preferred subject areas, the researchers found that 61.1% of boys chose physics as their best subject while only 38.9% of girls viewed physics as their best subject. Results are similar to engineering where 75.7% of males identify interest in pursuing engineering as a career compared to 24.3% of females. Contrary to physics and engineering interest, 58.9% of females saw biology as their strongest subject as compared to 41.1% of males. When female students were questioned about the discrepancy between physics and biology, the most common response was that physics and engineering were viewed as masculine career fields. Females tended to agree more with than not regarding statements like: "Physics is masculine," (Archer et al., 2017, p.12) "Physics is hard," (p. 12) and "boys are better at hard subjects like Physics" (p. 12). Themes from the research were that females who did enjoy physics felt alienated from the subject and invisible as a female in the subject. Out of the 70 students interviewed, only six female students were identified by the researchers as holding a strong physics identity, physics self-efficacy, with strong physics careers intentions.

Students who perceive mathematics or science as a strength will be more likely to choose a STEM career than those who view verbal ability as a high strength (Wang & Degol, 2017). In a longitudinal study, Wang and Degol identified that when an individual had strong mathematics cognitive aptitude, the individual was more likely to choose mathematics, science, or technology careers over having a strong verbal domain. This study found that woman more commonly identified higher strengths and interests in verbal cognitive abilities and careers than mathematics abilities and careers. It is more common for women who have high mathematics ability to choose a non-STEM career than it is for men with high mathematics ability (Ceci et al., 2009; Wang & Degol, 2017). Women who demonstrate proficiency in both verbal and mathematics domains have higher levels of mathematics self-efficacy and show a greater likelihood for developing interest in STEM fields. When career strengths are not identified or do not correspond to career values, an individual then may experience career indecision. This demonstrates the need to support both of these domains in high school to increase female STEM self-efficacy and career interests (Wang & Degol, 2017).

A study that examined ACT scores over a span of 30 years found that although students may show interest in STEM-related disciplines, they may not have an understanding regarding the skills and preparation involved in many STEM-related career fields (Iskander et al., 2013). For example, students who are interested in computer science may not show interest in mathematics, a required course for graduation in computer science, thus creating a gap in preparation for this major (Archer et al., 2017). Historical ACT data shows that 75% of female students who report interest in a STEM career are poorly to moderately prepared to enter these undergraduate majors (ACT, 2018; Iskander et al., 2013). This lack of preparation is partly due to a lack in understanding about prerequisites and achievement level needed in order to be successful in a STEM-related career (Iskander et al., 2013). With increased STEM college and career knowledge, students may be more interested and invested in the classes high school courses that are requirements to enter into STEM fields (Snyder et al., 2019; Wang & Degol, 2017; Xu, 2017). A clearer comprehension of STEM-related disciplines would result in high school course loads that encompass the specific needs of a discipline (Archer et al., 2017).

Encouraging female students to enroll in advanced, accelerated, IB, or AP courses look more favorable on a high school transcript while they also prepare students for the more rigorous and challenging courses in a STEM major (Vilorio, 2014; Wang & Degol, 2017). Students who are engaged in advanced or enrichment STEM courses increase the likelihood of student ambitions and accomplishments in STEM (Nix et al., 2015). In addition, advanced courses are prerequisites for many STEM undergraduate majors (Wang & Degol, 2017). Advanced STEM courses prepare students for the rigor and challenges of STEM majors and careers (Wang & Degol, 2017). More challenging classes may require more abstract content and thinking which may discourage high school students from enrolling in these courses (Jenson et al., 2011). Abstract content can be a challenge for students and many high school students report preferring hands-on and applied learning (Jenson et al., 2011).

This disparity of women in STEM careers corresponds to the lack of interest displayed by girls in high school when enrolling in advanced STEM courses. When examining Grade 10 students, strong perceived ability in mathematics and science indicated a 30% greater chance for the student to enroll into the most advanced mathematics and science courses (Nix et al., 2015). According to the Organization for Economic Cooperation and Development (OECD), the largest international educational survey of students ranging from ages 15 to 16, female high school students outperform male students in all science test strands, yet males identify a stronger science self-efficacy over females (Stoet & Geary, 2018). This gap contributes to females being 24% less likely to take advanced sciences classes such as Chemistry II or Physics II (Nix et al., 2015). Females are also 86% less likely to enroll in advanced engineering or mathematics courses. High STEM self-efficacy and STEM self-identity greatly influence female high school students into participating in advanced high school science courses (Young, Ero-Tolliver, Young & Ford, 2017). Career aspirations of students begin far before reaching high school but become solidified during these years.

Attempted Solutions

There are multiple barriers preventing the elimination of the gender gap in STEM careers and a variety of solutions have been implemented in attempts to narrow this gap. Women who overcome such obstacles and excel in STEM careers attribute achievements to a strong support system, a belief in personal responsibility for the actions that contribute to career success, and a strong belief in the ability be successful (Mozahem et al., 2019). The University of Washington found supportive peers and mentors significant to female success in addition to teachers, teaching assistants, and faculty that represent the underrepresented populations (Cheryan et al., 2017). The culture of the workplace is set and modeled by the leaders and it is customary for employees to also follow the example provided (Fogg-Rogers, Sardo, & Boushel, 2017). For this reason, it is crucial for leaders to set the example in creating inclusive environments for women in STEM, especially in providing mentorship for the next generation (Tiedeu et al., 2019).

Mentoring. Mentoring has the capability to increase STEM self-efficacy, confidence, and motivation thus increasing participation and retainment of females in STEM careers, such as engineering (Dennehy & Dasgupta, 2017). Mentees also report increased academic achievement, career advancements, higher salaries, higher self-confidence, increased work satisfaction, and a decrease in the STEM gender wage gap (Adams et al., 2016). Mentorship opportunities provide sustained positive impacts on students during high school and beyond for students including high school GPA, high school graduation, college graduation, employment longevity, and career earnings (Schwartz, Rhodes, Spencer, & Grossman, 2013). High school mentorship experiences influence significant positive gains in STEM GPA and STEM standardized test scores (Lyons, & McQuillan, 2019). Especially in science fields with lower percentages of female participation, near-peer mentors, such as undergraduate and graduate students, experience relatable connections that develop the skills of both the mentee and mentor that otherwise might not be achieved in mentorships with power imbalances (Tenenbaum, Anderson, Jett, & Yourick, 2014).

In the workplace, the primary goal of a mentor is to support the mentee to feel comfortable and a sense of belonging within a major or workplace (Adams et al., 2016). Underrepresented populations benefit greatly from mentoring to combat feelings of estrangement and isolation as a minority in work environments. Having a mentor with a shared identity allows for the greatest opportunity for connection and support for a mentee (Adams et al., 2016; Dennehy & Dasgupta, 2017). For women, having a female mentor offers the greatest benefits (Adams et al., 2016). Cross-gender mentoring can be effective, but precautions should be taken to remove any possibilities of stereotype biases (Adams et al., 2016). Mentoring has also been attributed to opportunities for career advancement; in male dominated careers, women can be highly excluded (Adams et al., 2016). Although, mentoring contributes greatly to success of women in STEM careers, there are not enough women available to take on the role of a mentor due to the disparity of women in STEM careers (Adams et al., 2016).

Mentoring is highly necessary during the most vulnerable times for women such as transitions from high school to university, university to graduate school, and beginning a career (Dennehy & Dasgupta, 2017). In engineering majors, Dennehy and Dasgupta (2017) found significant positive effects of peer mentoring on first year students. Within the STEM workforce, Fogg-Rogers, Lewis, and Edmonds (2017) found that mentorship for women is most successful when is provided by senior management or through peer networks. These channels of mentorship allow for women to connect and receive guidance in manners that foster confidence (Adams et al., 2016; Dennehy & Dasgupta, 2017; Fogg-Rogers, Lewis, et al., 2017).

Teaching. On international performance assessments in mathematics and science, the U.S. has made very little progress in the twenty-first century (Hushman & Marley, 2015). U.S. students partake in the TIMSS assessments in Grades 4 and Grade 8, as well as the Programme for International Student Assessments (PISA) for students 15 years of age (Averett, Ferraro, Tang, Erberber, & Stearns, 2018; Stoet & Geary, 2018). The most recent release of data from 2015 displayed no significant change in the PISA mathematics and science student scores (Stoet & Geary, 2018). The U.S. came in 38th place in mathematics out of 71 countries, and 24th place in science. The TIMSS assessment results have shown some improvement over time but the only significant change in 2015 came on the Grade 8 mathematics assessment, rising five points since 2011 (Averett et al., 2018). More importantly, these assessments exposed the widening of the gap between the highest and lowest performing U.S. students, calling on the improvement of instructional practices.

Goal development, early and repeated exposures to STEM content and skills, receiving encouragement from peers and teachers, as well as receiving mentorship opportunities from experts in the field are best practices to increase STEM competence and self-efficacy (Cadaret et al., 2017; Charleston & Leon, 2016). STEM-literate teachers create learning experiences for students that demonstrate the interdependency of STEM fields while supporting STEM content knowledge and skills (Bell, 2016). In order for STEM learning to create mastery experiences for students, teachers must have a depth of STEM knowledge and skills to effectively deliver instruction (Bell, 2016). In addition, teachers' attitudes towards academic achievement impact students' beliefs and feelings toward STEM subject areas (Wang & Degol, 2017). Student STEM self-efficacy is increased in classrooms where mastery is valued over grades. Mastery focused learning environments report higher student academic achievement, allowing for students to continuously create and evaluate personal STEM goals which contribute to future career goals (Wang & Degol, 2017).

Teacher aversion to teaching STEM content limits students interactions with STEM subject areas and career fields (Honey, Pearson, & Schweingruber, 2014). When teachers display strong levels of STEM teaching self-efficacy, teachers provide students with more learning experiences in STEM, which increase the teachers' confidence in teaching STEM as well as student STEM academic performance (Wendt, Isbell, Fidan, & Pittman, 2015). The greatest opportunities for increasing teacher self-efficacy is to provide multiple opportunities to put STEM pedagogy into practice which provides teachers with immediate STEM teaching feedback (Bozdoğan, 2018). Successful student learning experiences then increased STEM teaching self-efficacy creating increased desire for teachers to continue to provide quality STEM experiences (Velthuis, Fisser & Pieters, 2015).

When comparing impact of the different levels of teaching self-efficacy, teachers with the lowest and the highest confidence in teaching STEM show to be least effective at teaching STEM subject areas than those who hold neither high nor low teaching self-efficacy (Saka, Bayram & Kabapınar, 2016). Teachers with low teaching self-efficacy often provide minimal experiences for students in science, technology, and engineering or skip instruction in these content areas all together (Bell, 2016; Saka et al., 2016). Teachers with high confidence in teaching STEM show greater resistance toward learning new skills, and are less likely to self-evaluate where teaching growth needs to happen (Saka et al., 2016). When teachers exude average levels of self-efficacy in teaching STEM subject areas, teachers are both confident to provide regular and appropriate STEM instruction while being receptive to new methodologies of teaching, and providing differentiated methods of instruction.

Teachers gain confidence in teaching self-efficacy by learning from the modeling of both teacher experts as well as STEM field experts (Wendt et al., 2015). Modeling allows teachers to conceptualize how to appropriately implement STEM subject areas, such as engineering concepts, into practice, in addition to increasing teaching self-efficacy. Teacher goals, preparing and teaching lessons, collaboration with other teachers, and implementing small group lessons allow for teachers to gain confidence in teaching STEM curriculum (Velthuis et al., 2015). Administrator support in teaching and learning STEM content and skills also hold a role in increasing teacher STEM confidence. STEM teaching self-efficacy is negatively affected when support is reduced by administration.

Teachers should also be provided with access to experts in the STEM workforce, as well as STEM career options and deficits to be informed of needed STEM career skillsets (Knowles, Kelley & Holland, 2018). In a study aimed at increasing high school STEM career interest by providing STEM career knowledge to high school teachers, twenty-two teachers were provided with a ten-day intensive professional development training on STEM careers. The study found that when teachers have a narrow range knowledge about different STEM careers or STEM careers outside one's subject area, student STEM career knowledge also remains limited. When teachers included STEM field experts within the classroom, the study found that student knowledge of needs related to industry, research and development opportunities, and information technology competencies that utilize STEM skillsets was greatly increased.

Providing regular and continual experiences are key for growing the STEM labor forces. The ideal time to target STEM interventions with girls is when they are in middle school because this is the age when career decisions are being made, and this is before they miss out on the opportunity to enroll in advanced STEM classes (McDonald, 2016; Wang & Degol, 2017). Increasing interactions with STEM professionals during these adolescent years may influence interest and decisions for women about STEM careers. Programs such as Project Lead the Way, increase student interest, participations, and excitement toward STEM careers (Wang et al., 2015). Funding for these programs is not consistent which makes high quality programs under constant threat for closing (Tanenbaum, 2016). Underrepresented and disadvantaged students suffer the greatest without resources and experiences in STEM, thus contributing to their disparity in the STEM workforce.

Summary

Of employed college graduates in STEM fields, females only constitute 28% of the representation (Cheryan et al., 2017; National Science Board, 2015). High self-efficacy in STEM is needed for women to show interest toward pursuing a STEM career (Tellhed et al., 2017). Female students who demonstrate a strong sense of self-efficacy in STEM-related degrees and career fields also report having high levels of interest and confidence in STEM content areas (Falk et al., 2017). STEM subject self-efficacy grows and is sustained through successful performance accomplishments in addition to increasing cognitive aptitude (Bandura, 1993; Taylor & Betz, 1983; Wang & Degol, 2017). Students who are engaged in advanced or enrichment STEM courses, which are prerequisites for the enrollment into many STEM undergraduate majors, increase the likelihood of student ambitions and accomplishments in future STEM endeavors (Nix et al., 2015; Wang & Degol, 2017). Advanced STEM courses increase female academic achievement, STEM self-efficacy, and STEM self-identity while preparing students for the rigor and challenges of STEM majors and careers (Vilorio, 2014; Wang & Degol, 2017).

Chapter 3: Methodology

Purpose of the Study

The research questions for this study explored how enrolling in a STEM-related class affects student perceptions of gender performance in science and mathematics. The purpose of this study was to investigate the influence that STEM self-efficacy and STEM identity have on enrolling in an advanced STEM-related class. The perception data was additionally analyzed by gender. This study investigated if participation in STEM-related classes influences a student's belief about female ability in STEM-related courses. Participating in STEM-related courses at the high school level prepares learners for future education or work experience (Vilorio, 2014). Understanding the influence of STEM-related classes on student perceptions and stereotypes will inform school systems as to necessary improvements to order to increase female participation in STEM-related courses.

The rationale behind using secondary data is that this study's sample included more than 20,000 participants (National Center for Educational Statistics, 2016). The large scale of the sample size of the study reduces the presence of bias from the results. Without access to the HSLS:09 data, replication of the largescale research performed in this longitudinal study would require a large team of researchers and a vast amount of labor hours and resources to be able to produce similar results. Using a large scale dataset increases the reliability of results as well as the possibility for the results to be reproduced (Orcher, 2014; Patten 2014).

Theoretical Framework

This research used secondary data from a survey designed to gather cross-sectional, quantitative data from the follow-up year of the High School Longitudinal Study (2009-2013; HSLS:09) conducted by the U.S. Department of Education (National Center for Educational

Statistics, 2016). This research drew upon secondary survey data using a quantitative design. Quantitative research allows data to be quantified through numbers in order to provide an explanation of specific occurrences or events, such as attitudes or beliefs, through specifically designed instruments, such as surveys (Muijis, 2011). Research designs intended to expand or challenge theories put into place by previous research typically lie within the quantitative spectrum (Merriam & Tisdell, 2016).

The theory of self-efficacy provides a framework for this study. Self-efficacy has a direct relationship to students' academic achievement and can be used as a predictor of an individual's future career aspirations (Bandura, 1993; Epstein & Fischer, 2017). A student's attitude toward personal ability in STEM courses directly contributes to whether a high school graduate pursues a STEM major at a postsecondary institution (Ong et al., 2011). The stronger a student's self-efficacy in STEM-related fields, the greater the student's interest in a STEM career (Epstein & Fischer, 2017).

Providing continual or increased opportunities to experience a subject area increases the possibility that a person will engage with that subject area again (Hushman & Marley, 2015). This study aimed to measure the effect participating in a STEM-related class had on student perceptions of gender ability and future career aspirations. Given the importance that a student's STEM identity and STEM self-efficacy have on one's future career pursuit, understanding how participating in a STEM-related class influences perceptions of gender ability are vital for school districts to aid in closing the STEM gender gap (Flowers III & Banda, 2016; Vilorio, 2014).

Research Design

The United States Department of Education began the HSLS:09 study by surveying Grade 9 students in addition to their parents, administrators, mathematics and science teachers, and counselors in the 2009-2010 school year (National Center for Educational Statistics, 2016). The students sampled in the base year of the study were selected using a stratified sampling design. The dataset that was used in this study is secondary survey data from the follow-up HSLS:09 survey in 2012 of the same Grade 11 students.

Central research questions guiding the inauguration of the HSLS:09 study were to examine the transformation of individual plans to gravitate toward or retreat from careers in science, technology, engineering, and mathematics (Ingels et al., 2011). An additional goal to beginning the HSLS:09 study was to identify secondary education factors related to this retreat from or gravitation into STEM fields. Understanding the transition of high school students into postsecondary education will aid in identifying drivers for individuals choosing STEM careers (United States Department of Education, 2016).

Research Questions

The following research questions were explored in this study:

1) What difference, if any, exists between male and female students in their mathematics identity, mathematics self-efficacy, or perception of how males and females perform in mathematics?
2) Is there a statistically significant difference between students' mathematics identity, mathematics self-efficacy, or comparison of math subject performance based on whether or not they enrolled in an advanced mathematics class?
3) What difference, if any, exists between male and female students in their science identity, science self-efficacy, or perception of how males and females perform in science?
4) Is there a statistically significant difference between students' science identity, science

self-efficacy, or comparison of science subject performance based on whether or not they enrolled in an advanced science class?

Hypotheses

H_{1aa}: There is a statistically significant difference between male and female students and their mathematics identity.

H_{1ao}: There is no statistically significant difference between male and female students and their mathematics identity.

H_{1ba}: There is a statistically significant difference between male and female students and their mathematics self-efficacy.

H_{1bo}: There is no statistically significant difference between male and female students and their mathematics self-efficacy.

H_{1ca}: There is a statistically significant difference between male and female students and their perception of how males and females perform in mathematics.

H_{1co}: There is no statistically significant difference between male and female students and their perception of how males and females perform in mathematics.

H_{2aa}: There is a statistically significant difference between students' mathematics identity and whether or not they enrolled in an advanced mathematics class.

H_{2ao}: There is no statistically significant difference between students' mathematics identity and whether or not they enrolled in an advanced mathematics class.

H_{2ba}: There is a statistically significant difference between students' mathematics self-efficacy and whether or not they enrolled in an advanced mathematics class.

H_{2bo}: There is no statistically significant difference between students' mathematics self-efficacy and whether or not they enrolled in an advanced mathematics class.

H_{2ca}: There is a statistically significant difference between students' comparison of mathematics subject performance and whether or not they enrolled in an advanced mathematics class.

H_{2co}: There is no statistically significant difference between students' comparison of mathematics subject performance and whether or not they enrolled in an advanced mathematics class.

H_{3aa}: There is a statistically significant difference between male and female students and their science self-identity.

H_{3ao}: There is no statistically significant difference between male and female students and their science self-identity.

H_{3ba}: There is a statistically significant difference between male and female students and their science self-efficacy.

H_{3bo}: There is no statistically significant difference between male and female students and their science self-efficacy.

H_{3ca}: There is a statistically significant difference between male and female students and their perception of how males and females perform in science.

H_{3co}: There is no statistically significant difference between male and female students and their perception of how males and females perform in science.

H_{4aa}: There is a statistically significant difference between students' science self-identity and whether or not they enrolled in an advanced science related class.

H_{4ao}: There is no statistically significant difference between students' science self-identity and whether or not they enrolled in an advanced science related class.

H_{4ba}: There is a statistically significant difference between students' science self-efficacy and whether or not they enrolled in an advanced science related class.

H_{4bo}: There is no statistically significant difference between students' science self-efficacy and whether or not they enrolled in an advanced science related class.

H_{4ca}: There is a statistically significant difference between students' comparison of science subject performance and whether or not they enrolled in an advanced science related class.

H_{4co}: There is no statistically significant difference between students' comparison of science subject performance and whether or not they enrolled in an advanced science related class.

Variables

The independent variables for this study were as follows:

1) Gender
2) Participation in an advanced mathematics class including: Algebra III, Trigonometry, Statistics or Probability, or other advanced math course such as Pre-calculus or Calculus
3) Participation in an advanced science-related class including: Physics I, Chemistry I, Anatomy or Physiology; Advanced Biology such as Biology II, AP, or IB; Advanced Chemistry such as Chemistry II, AP, or IB; Advanced Physics such as Physics II, AP or IB

The dependent variables for this study were as follows:

1) Mathematics identity ("You see yourself as a math person." and/or "Others see me as a math person.")

2) Mathematics self-efficacy (composite of mathematics tests, assignments, skills, and mathematics confidence)
3) Student comparison of mathematics performance by gender
4) Science identity ("You see yourself as a science person." and/or "Others see me as a science person.")
5) Science self-efficacy (composite of science tests, assignments, skills, and science confidence)
6) Student comparison of science performance by gender

Instrumentation

The data that was used in this study is existing secondary survey data provided by Inter-university Consortium for Political and Social Research (ICPSR) at the University of Michigan. The HSLS:09 study was conducted by the nonprofit organization RTI International for the National Center for Educational Statistics (NCES) in response to the Education Sciences Reform Act of 2002 (20 U.S.C. 1221e). The study used follow-up questionnaires given to students, parents, administrators, and counselors. For this study, data used for analysis were taken from a student questionnaire taken in the spring of 2012 when the participants from the HSLS:09 were in Grade 11 (National Center for Educational Statistics, 2016).

The student questionnaire was administered via the internet. The student survey included questions pertaining to demographics, attendance, grades, future preparations, post-high school plans, influences on thinking, expectations, behavior, and courses taken with an emphasis on mathematics and/or science. The questions were designed so that any student included in the survey, including dropouts, transfers, and those qualifying for early graduation, would be able to answer the questions with the opportunity to complete the follow-up survey via web, phone, or in-person interview. There were 61% of students who were administered the survey in school, while 20% completed the survey outside of school (National Center for Educational Statistics, 2016).

To ensure standardization in the test administration process, 140 supervisors were hired to administer the tests. Supervisors had to participate in pre-training activities including a five-day in-person training; they had to successfully complete the assessment certification in order to receive the credentials needed to be able to train the onsite session survey administrators. Onsite survey administrators received $100 with the ability to earn an additional $50 based on school student participation. Students participating in the survey received $10 upon completion of the survey (National Center for Educational Statistics, 2016).

Measures

The following variable statements come from the High School Longitudinal Study, 2009-2013 codebook descriptions (National Center for Educational Statistics, 2016).

Mathematics identity. This item is related to a student's perception and their view of others' perceptions of his or her identity in mathematics. The items related were the statements "You see yourself as a math person." and/or "Others see me as a math person." (National Center for Educational Statistics, 2016, p. 136).

Mathematics self-efficacy. This variable is a scale of a student's mathematics self-efficacy. Higher values represent higher self-efficacy. The items comprising this variable included:

- "You [are/were] confident that you [can/could] do an excellent job on tests in this course. /You are confident that you can do an excellent job on math tests."

- “You are certain that you can understand the most difficult material presented in the textbook used in this course.”
- “You [are/were] certain that you [can/could] master the skills [being taught/that were taught] in this course./You are certain that you can master math skills.”
- “You [are/were] confident that you [can/could] do an excellent job on assignments in this course./You are confident that you can do an excellent job on math assignments.” (National Center for Educational Statistics, 2016, p. 137).

Mathematics advanced courses. The participant was taking a mathematics course during the spring of 2012 including at least one of the following:

- Algebra III
- Trigonometry
- Pre-calculus or Analysis and Functions
- Advanced Placement (AP) Calculus AB or BC
- Other Calculus
- Advanced Placement (AP) Statistics
- Other Statistics or Probability
- International Baccalaureate (IB) mathematics higher level (National Center for Educational Statistics, 2016).

Mathematics subject performance perception. This item asks the participant’s perception of male and female ability in mathematics. The item asks “In general, how would you compare males and females in each of the following subjects?” (National Center for Educational Statistics, 2016, p. 678).

Science identity. This item is related to a student's perceptions and their view of others' perceptions of his or her identity in science. The items related were the statements "You see yourself as a science person" and/or "Others see me as a science person" (National Center for Educational Statistics, 2016, p. 138).

Science self-efficacy. This variable is a scale of student's science self-efficacy. Higher values represent higher self-efficacy. The items comprising this variable included:

- "You [are/were] confident that you [can/could] do an excellent job on tests in this course. /You are confident that you can do an excellent job on science tests."
- "You are certain that you can understand the most difficult material presented in the textbook used in this course."
- "You [are/were] certain that you [can/could] master the skills [being taught/that were taught] in this course./You are certain that you can master science skills."
- "You [are/were] confident that you [can/could] do an excellent job on assignments in this course./You are confident that you can do an excellent job on science assignments." (National Center for Educational Statistics, 2016, p. 138).

Science advanced courses. The participant was taking a science course during the spring of 2012 including at least one of the following:

- International Baccalaureate (IB) Biology
- Anatomy or Physiology
- Other biological sciences such as botany, marine biology, or zoology
- Chemistry II
- Advanced Placement (AP) Chemistry
- International Baccalaureate (IB) Chemistry

- Advanced Placement (AP) Environmental Science
- International Baccalaureate (IB) Environmental Systems and Societies
- Other earth or environmental sciences such as ecology, geology, oceanography, or meteorology
- Physics II
- Advanced Placement (AP) Physics B or C
- International Baccalaureate (IB) Physics
- Principles of Technology
- Other physical sciences such as astronomy or electronics
- Computer Applications
- Computer Programming
- Advanced Placement (AP) Computer Science
- International Baccalaureate (IB) Design Technology
- Other computer or information science course
- An engineering course such as general engineering, robotics, aeronautical, mechanical or electrical engineering
- Other science, computer science, or engineering course (National Center for Educational Statistics, 2016, p. 144).

Science subject performance perception. This item asks the participant's perception of male and female ability in science. The item asks "In general, how would you compare males and females in each of the following subjects?" (National Center for Educational Statistics, 2016, p. 678).

Pilot Test

The development of the instrumentation and the revisions were based on the results of field tests. Twenty-four schools and over 500 students participated in the field test. Prior to the study being conducted, a non-response bias analysis was conducted. This field test was to examine the presence of any detectable nonresponse bias in the variables. For the student questionnaires, the field test analyzed item nonresponse, test-retest reliabilities, and scale reliabilities; an examination of correlations between theoretically related measures was included. The items that were chosen to be on the final questionnaire came from an Item Response Theory (IRT) technique (National Center for Educational Statistics, 2016).

Sampling Design

The base year of the High School Longitudinal Study, 2009-2013, used a stratified, two-stage random sample design for the first stage (National Center for Educational Statistics, 2016). This study targeted high school Grade 9 students who attended public, charter, and private high school in the United States. The student population were then chosen from random sampling for the second stage. For the follow-up year, only schools and students that participated in the base-year were eligible for the follow-up year survey.

Data Collection Procedures

The population for this study included students who participated in the base year of the High School Longitudinal Study, 2009-2013 (National Center for Educational Statistics, 2016). The dataset that was used comes from existing data on a follow-up HSLS:09 survey. Of 939 eligible public, charter, and private schools from all states and the District of Columbia within the United States of America, 904 of the schools participated. Of the 25,184 students who were identified as enrolled in Grade 9 and eligible to take the student survey, only 20,594 Grade 11 students participated. The students were allotted 90 minutes to take the survey and 98% of students took the student survey during school hours.

The data that was used for this study was found in the Inter-university Consortium for Political and Social Research (ICPSR) data base. The ICPSR is an organization at the University of Michigan that assembled a warehouse for data to provide the public with rich data and research to be used in education, research, policy making, and grant-funding. According to the U.S. Department of Education NCES, the data provided by the HSLS:09 longitudinal study is open to the public to use and no credit needs to be given to ICPSR (National Center for Educational Statistics, 2016). Since the research and data is open to the public, permissions are not necessary in order to use the data for personal data analysis. Considerations did need to be made to protect the privacy of the research subjects and at no time shall the researcher intend to uncover the identity of the subjects. The researcher was authorized to use the data and the purpose must be for educational or research purposes. The Bethel University Institutional Review Board (IRB) provided authorization that the study met educational and research requirements. Finally, all credit must go to the original authors of the research and data.

Criteria for STEM. For this study, students that are considered STEM students are those students who are participating in advanced mathematics and science courses. Advanced mathematics courses are considered the classes following Algebra I, Algebra II, and Geometry such as Algebra III, Pre-calculus, Calculus or Trigonometry (Institute of Educational Sciences, 2019; Lauff & Ingels, 2014; U.S. Department of Education, 2018). Courses considered advanced science courses include any computer science or programing course as well as second year science courses such as Biology II, Chemistry II, Physics II (Institute of Educational Sciences, 2019; Lauff & Ingels, 2014; National Science Board, 2018). Advanced courses also include International Baccalaureate (IB), Advanced placement (AP), or any other higher-level mathematics or science course.

For Research Question 1 comparing the variable of gender on mathematics identity, mathematics self-efficacy, and mathematics subject performance perception, the dependent variables include mathematics identity, mathematics self-efficacy, and mathematics gender perception. The independent variable is gender (male, female). The analysis used for hypotheses 1_a and 1_b was a factorial ANOVA. A Chi-Square analysis was used for hypothesis 1_c.

For Research Question 2 investigating if the variables of gender, mathematics identity, mathematics self-efficacy, and mathematics advanced class enrollment are related, the dependent variables are mathematics identity, mathematics self-efficacy, and comparison of mathematics subject performance. The independent variables are gender (male, female) and if student is taking an advanced mathematics course. The analysis used for hypotheses 2_a and 2_b was a factorial ANOVA. A Chi-Square analysis was used to analyze hypothesis 2_c.

For Research Question 3 investigating if the variables of gender on science identity, science self-efficacy, and science subject performance perception, the dependent variables are science identity, science self-efficacy, and science gender perception. The independent variable is gender (male, female). The analysis used for hypotheses 3_a and 3_b was a factorial ANOVA. A Chi-Square analysis was used to analyze hypothesis 3_c.

For Research Question 4 investigating if the variables of gender, science identity, science self-efficacy, and science advanced class enrollment are related, the dependent variables are science identity, science self-efficacy and comparison of science subject performance. The independent variables are gender (male, female) and student enrollment in an advanced science course. The analysis used for hypotheses 4_a and 4_b was a factorial ANOVA. A Chi-Square analysis was used to analyze hypothesis 4_c.

Reliability, Validity, and Trustworthiness

The ideal measures for a study are for results to be both reliable and valid. Reliability refers to the consistency of the results, whereas validity indicates the degree to which instrumentation is able to accurately measure what is desired to be measured (Orcher, 2014; Patten, 2014). Researchers aim to use methods and measures that are both reliable and valid, however, it is more common for research instrumentation to achieve reliability over validity. Using trial and error, pilot testing, field testing, controlling for more variables, decreasing research bias, and cross referencing with other data sets all help to increase research validity (Patten, 2014).

The HSLS:09 follow-up year survey compiled multiple data points to create a construct of student beliefs of mathematics identity, science identity, mathematics self-efficacy, and science self-efficacy. The study used 13 scales to examine the reliability of the constructs. Cronbach alpha scores were 0.883 for mathematics identity, 0.893 for science identity, 0.910 mathematics self-efficacy, and 0.928 for science self-efficacy (National Center for Educational Statistics, 2016).

Limitations of the Study

A quantitative survey design is not without limitations. In a quantitative survey, a researcher predetermines a set number of selections from numerous response possibilities from which the sampled population can choose. This data collection design quantifies the diverse opinions and beliefs of the sampled population into numeric values creating inferences from the results. If the survey does not include options that accurately match a participant's beliefs or feelings, then the results become more of a generalization rather than an explanation of a phenomenon (Creswell, 2014).

Although the HSLS:09 study collected responses from schools over the 50 United States, this study and the experiences of the participants only reflect that of one country in the world. In addition, the HSLS:09 study only collected data from one generation of students, on one occasion. This method does not consider students who were ill or not having a good testing day to provide opportunities for the students to respond to identify the validity of the answers over time. When students take the survey one time in a year, students may be less invested to provide the most thoughtful and accurate answers.

In the student questionnaire when referencing mathematics courses, the student survey did not provide an option for advanced integrated mathematics courses as an option. Excluding the option for advanced integrated mathematics could have caused a participant to not report their participation in a mathematics course or to false choose an option the participant thought was the most related to the integrated course. Another limitation includes the analysis was limited by the date in which data were collected and future researchers should consider implementing the same design strategy to a more current population of students. Finally, the researcher using the HSLS:09 data does not have any input or control over the questions because these were predesigned questions.

ACT Inc. (2019), producers of the ACT college entrance exam, is an institution which acknowledges the significance of preparing a workforce for STEM careers and has been reporting STEM scores since 2015. In mathematics, the 2014 male national average ACT score was 21.4 where the female average score was 20.5, which shows a mean difference of 0.9. In 2018, the average male score in mathematics was 20.9 and females averaged 20.2, equaling a difference in the mean average of 0.7. In science, the male 2014 national average ACT score was 21.2 and the female average science score was 20.5, with a mean difference of 0.7. The male 2018 average ACT score was 20.9 and females scored an average of 20.6, which shows a mean difference of 0.3. As seen in the mean ACT scores, the gender gap decreased slightly in mathematics and slightly greater in science from 2014 to 2018. Although this decrease in the STEM gender gap would appear to be a limitation to this study, it is only a slight limitation for the overall mean ACT scores for both mathematics and science decreased between the genders from 2014 to 2018.

Ethical Considerations

When conducting empirical research, strict ethical considerations must be followed. The Belmont Report (1979) established the tenets by which ethical research studies should be performed in the United States. These basic tenants include: respect for persons, beneficence, and justice. The study should seek to identify positive outcomes for those involved, and the methodology should reflect this while protecting participants from harm (Creswell, 2014). All participants involved must be able to comprehend the information provided to them in regards to the proposed study. This clause of the Belmont Report especially protects those who are adolescents, therefore, guardians for underage participants should sign a consent form to state they understand and freely agree to participation (Creswell, 2014; Merriam & Tisdell, 2016; Patten, 2014).

The dataset disclosed by the NCES for public viewing was altered slightly from the original versions in order to prevent any identifiable individual or school information from being revealed. Participants, in addition to their parents or legal guardians, provided consent to partaking in surveys. In addition, all data collection procedures were implemented to protect the identity and anonymity of all participants. Anonymity is significant to the students engaging in the survey so they could feel comfortable being honest about their true feelings, also aiding in the accuracy of the results (Merriam & Tisdell, 2016).

In this study, the researcher took the appropriate precautions to not share any personal identifying characteristics of the sampled population. In addition, the researcher was the only person who had access to the data and the data will be stored on a password protected computer. The information and results will also be stored as a backup in a secure cloud account.

Summary

The underrepresentation of women in STEM careers is a deficit that has plagued developed nations for decades, and efforts have been taken to close the gaps that exist (Reilly, Neumann, & Andrews, 2019). Such efforts include providing exposure to STEM subject areas through interdisciplinary curriculum (Doerschuk et al., 2016; Perez-Felkner, 2018; Wang & Degol, 2017), utilizing instructional practices grounded in fostering interest and drive for exceptional STEM performance (Krämer et al., 2016; Perez-Felkner, 2018), increasing interest by connecting content to STEM professions (Han, 2016; Wang & Degol, 2017), developing peer and professional mentorships (Cheryan et al., 2017; Doerschuk et al., 2016; Han, 2016), and encouraging more females to teach in undergraduate and graduate STEM programs (Perez-Felkner, 2018). With such interventions in place, professionals, including universities, are seeking evidence that such efforts are yielding results in closing the gender STEM gap. The data collected in this study will aid in understanding the role that enrolling in a STEM-related class has on gender perceptions of mathematics and science self-efficacy and self-identity.

Chapter Four will provide the results of the statistical analysis related to the study research questions. The results of the study will determine if the researcher will reject or not reject the null hypothesis. Chapter Five will include an interpretation of the results as well as discuss the implications the results have on future research in relation to STEM.

Chapter 4: Results

Introduction

The purpose of this study was to examine how gender differences in mathematics and science are related to student identity, self-efficacy, and STEM subject competency. The secondary focus was to investigate the influence that STEM self-efficacy and STEM identity have on enrolling in advanced STEM-related classes. The secondary data of a sample size of 20,594 Grade 11 students were analyzed utilizing the Statistical Package for Social Sciences (SPSS) Software. This chapter is organized around the statistical analysis of each hypothesis for the research questions. The independent variables included gender and participation in an advanced STEM-related class. The dependent variables included self-identity, self-efficacy, and comparison of STEM performance.

Significant differences in analysis is the probability that a result was not due to chance. For the purposes of this study, the observed value is significant if the probability value (p) is equal to or less than 0.05. A null hypothesis is rejected if the result is statistically significant.

Mathematics Results

For both the mathematics identity and self-efficacy scales, two (sex of student) by two (whether or not student taking advanced mathematics course) factorial ANOVAs were used to analyze the data. These analyses address hypotheses 1_a, 1_b, 2_a, and 2_b. Note that each student's score for the identity and self-efficacy scales was transformed to a z-score. Therefore, the mean of the distribution is 0 and the standard deviation is 1. A negative group mean score indicates that it is below the distribution mean. The corrected model is the sum of the squares of the mean of the dependent variable. For this study the significance of the corrected model is 0.000.

Hypothesis 1_a sought to identify if there was a difference between male and female students and their mathematics identity. For mathematics identity scale there was a significant main effect for the sex of the student. Male students ($M = 0.18$, $SD = 1.01$) had significantly higher mathematics identity compared to female students ($M = -0.01$, $SD = 1.02$), $F(1, 17109) = 192.70$, $p < .001$, $\eta^2 = .011$. Hypothesis 2_a asked if there was a statistically significant difference between students' mathematics identity and whether or not they enrolled in an advanced mathematics class. There was also a significant main effect for whether or not the student was taking an advanced mathematics course. Students taking advanced mathematics ($M = 0.40$, $SD = 1.00$) had significantly higher mathematics identity than students who were not taking an advanced mathematics course ($M = -0.15$, $SD = 0.97$), $F(1, 17109) = 1312.66$, $p < .001$, $\eta^2 = .071$ (see Table 1 for descriptive statistics). Finally, there was also a significant, albeit weak, interaction between the independent variables, $F(1, 17109) = 11.23$, $p = .001$, $\eta^2 = .001$. As can be seen in Figure 1, when comparing students in advanced mathematics versus no advanced mathematics, the gap between mathematics identity was a little larger for males than it was for females.

Table 1

Descriptive Statistics for Mathematics Identity Scale by Gender and Advanced Mathematics Courses

Dependent Variable: Scale of student's mathematics identity

Student's sex	Taking Advanced Mathematics	Mean	Std. Deviation	N
Male	No advanced Mathematics	-.0717	.96487	5038
	Advanced Mathematics	.5286	.95784	3549
	Total	.1764	1.00632	8587
Female	No advanced Mathematics	-.2300	.97360	4813
	Advanced Mathematics	.2666	1.02171	3713
	Total	-.0137	1.02480	8526
Total	No advanced Mathematics	-.1490	.97232	9851
	Advanced Mathematics	.3946	.99956	7262
	Total	.0817	1.01998	17113

Table 2

Factorial ANOVA Table for Mathematics Identity Scale by Sex and Advanced Mathematics Courses

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1421.885[a]	3	473.962	495.035	.000
SEX	184.498	1	184.498	192.701	.000
AdvMath	1256.777	1	1256.777	1312.655	.000
SEX * AdvMath	11.233	1	11.233	11.732	.001
Error	16380.693	17109	.957		
Total	17802.578	17112			

a. R Squared = .08 (Adjusted R Squared = .08)

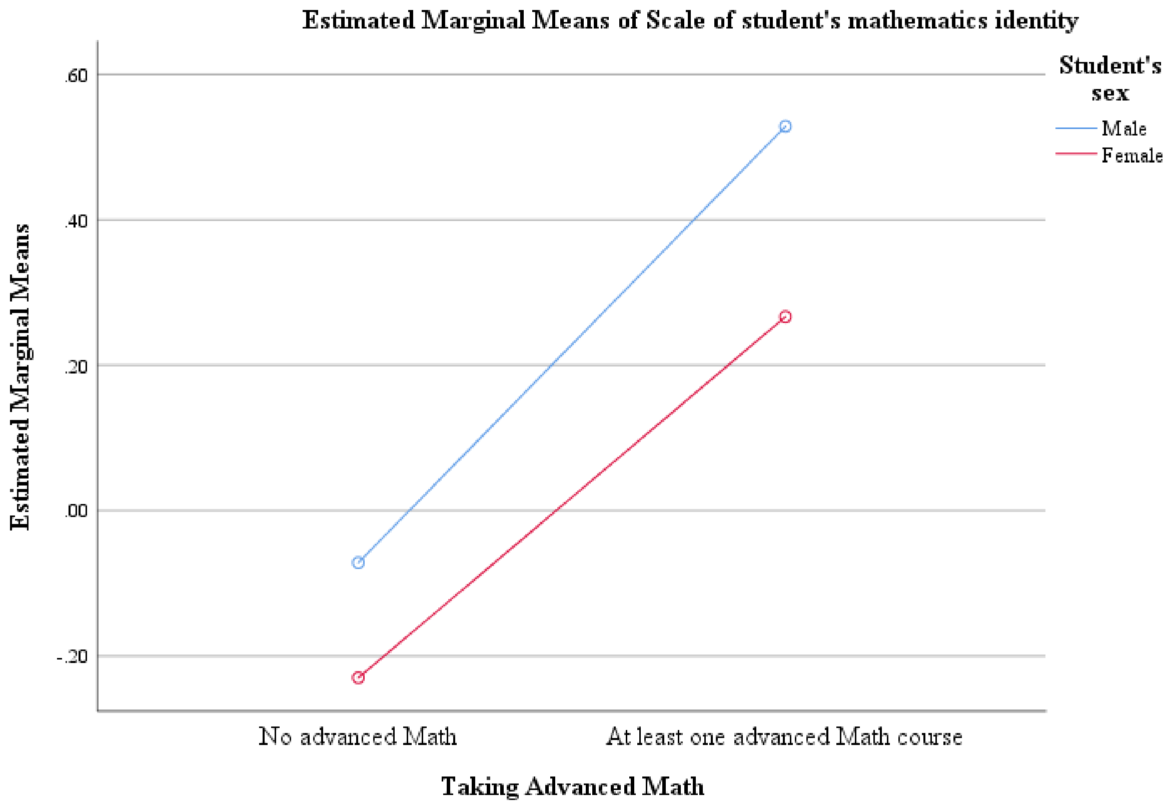

Figure 1

Estimated Marginal Means for Student's Mathematics Identity

Hypothesis 1_b sought to identify if there was a statistically significant difference between male and female students and their mathematics self-efficacy. For the mathematics self-efficacy scale there was a significant main effect for the sex of the student. Male students (M = 0.19, SD = 0.97) had significantly higher mathematics self-efficacy compared to female students (M = -0.03, SD = 0.99), $F(1,16926) = 250.40$, $p < .001$, $\eta^2 = .015$. Hypothesis 2_b asked if there was a statistically significant difference between students' mathematics self-efficacy and whether or not they enrolled in an advanced mathematics class. There was also a significant main effect for whether or not the student was taking an advanced mathematics course. Students taking advanced mathematics (M = 0.21, SD = 0.98) had significantly higher mathematics self-efficacy than students who were not taking an advanced mathematics course (M = -0.16, SD = 0.99),

$F(1,16926) = 227.67$, $p < .001$, $\eta^2 = .013$ (see Table 3 for descriptive statistics). Finally, there was also a significant, but weak, interaction between the independent variables, $F(1,16926) = 17.03$, $p < .001$, $\eta^2 = .001$ (see Table 4 for complete ANOVA information). Similar to the interaction for the mathematics self-identity scale, when comparing students in advanced mathematics versus no advanced mathematics, the gap between mathematics self-efficacy was a little larger for males than it was for females (see Figure 2).

Table 3

Descriptive Statistics for Mathematics Self-efficacy Scale by Gender and Advanced Mathematics Courses

Dependent Variable: Scale of student's mathematics self-efficacy

Student's sex	Taking Advanced Mathematics	Mean	Std. Deviation	N
Male	No advanced Mathematics	.0710	.97829	4981
	At least one advanced Mathematics course	.3631	.94366	3498
	Total	.1915	.97477	8479
Female	No advanced Mathematics	-.1069	.99875	4742
	At least one advanced Mathematics course	.0598	.98137	3709
	Total	-.0337	.99455	8451
Total	No advanced Mathematics	-.0158	.99226	9723
	At least one advanced Mathematics course	.2070	.97504	7207
	Total	.0791	.99108	16930

Table 4

Factorial ANOVA Table for Mathematics Self-efficacy Scale by Gender and Advanced Mathematics Courses

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	447.853	3	149.284	156.162	.000
SEX	239.371	1	239.371	250.400	.000
AdvMath	217.646	1	217.646	227.674	.000
SEX * AdvMath	16.277	1	16.277	17.027	.000
Error	16180.497	16926	.956		
Total	16628.350	16929			

a. R Squared = .027 (Adjusted R Squared = .027)

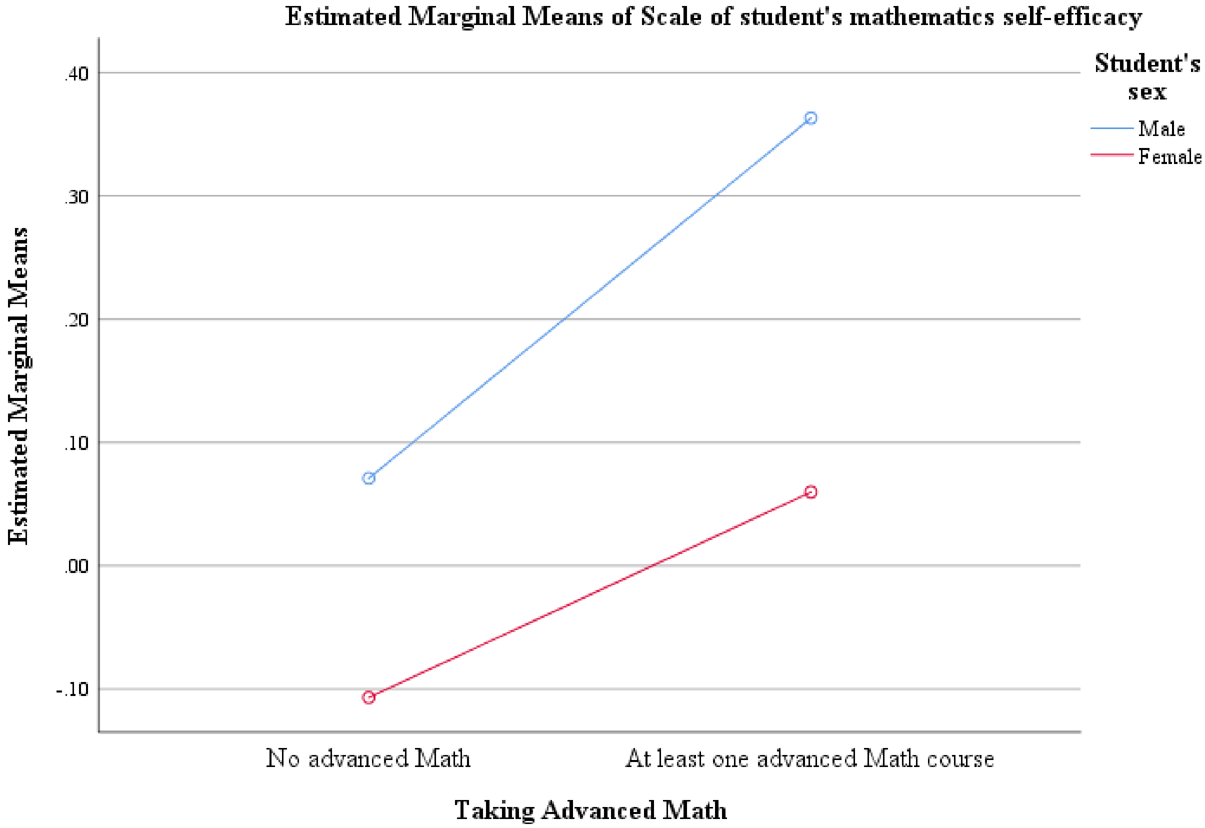

Figure 2

Estimated Marginal Means for Student's Mathematics Self-efficacy

Gender Differences in Mathematics Performance Perception

A Chi-Square was used to analyze the perceptions of gender on mathematics performance by the gender of the teen (hypothesis 1_c). There was a significant difference between females and males in their perceptions, χ^2 (4, N = 20013) = 199.12, p < .001. Female students (59.2%) were more likely to say that females and males were the same in mathematics performance compared to male students (53.5%). Male students (10.1%) were more likely to say that males were much better at mathematics performance compared to female students (5.2%). See Table 5 for detailed percentages.

Table 5

Crosstabs of Teens Comparisons of Males and Females in Mathematics by Gender of Student

			Student's sex		
			Male	Female	Total
How teen compares males and females in mathematics	Females are much better	Count	607	600	1207
		Expected Count	607.3	599.7	1207.0
		%	6.0%	6.0%	6.0%
	Females are somewhat better	Count	1106	937	2043
		Expected Count	1027.9	1015.1	2043.0
		%	11.0%	9.4%	10.2%
	Females and males are the same	Count	5386	5886	11272
		Expected Count	5671.2	5600.8	11272.0
		%	53.5%	59.2%	56.3%
	Males are somewhat better	Count	1957	2007	3964
		Expected Count	1994.4	1969.6	3964.0
		%	19.4%	20.2%	19.8%
	Males are much better	Count	1013	514	1527
		Expected Count	768.3	758.7	1527.0
		%	10.1%	5.2%	7.6%
Total		Count	10069	9944	20013
		Expected Count	10069.0	9944.0	20013.0
		%	100.0%	100.0%	100.0%

A Chi-Square analysis was used to analyze the perceptions of student mathematics performance and whether or not they are enrolled in an advanced mathematics class (hypothesis 2_c). First, female students' perceptions of gender and mathematics performance by whether or not they are in an advanced mathematics course were examined. There was a significant difference, χ^2 (4, N = 8530) = 27.31, p < .001. Compared to female students who were not taking an advanced mathematics course (19.2%), female students in advanced mathematics courses (22.5%) were more likely to say that males were somewhat better at mathematics than females. Additionally, compared to females who were taking an advanced mathematics course (5%), females who were not taking an advanced mathematics course (6.8%) were more likely to say that females are much better at mathematics than males. See Table 6 for detailed percentages.

Table 6

Crosstabs of How Female Teen Compare Males and Females in Mathematics by Taking Advanced Mathematics

			Taking Advanced Mathematics		
			No advanced Mathematics	At least one advanced Mathematics course	Total
How female teen compares males and females in mathematics	Females are much better	Count	325	186	511
		Expected Count	288.1	222.9	511.0
		%	6.8%	5.0%	6.0%
	Females are somewhat better	Count	452	339	791
		Expected Count	445.9	345.1	791.0
		%	9.4%	9.1%	9.3%
	Females and males are the same	Count	2840	2191	5031
		Expected Count	2836.4	2194.6	5031.0
		%	59.1%	58.9%	59.0%
	Males are somewhat better	Count	923	838	1761
		Expected Count	992.8	768.2	1761.0
		%	19.2%	22.5%	20.6%
	Males are much better	Count	269	167	436
		Expected Count	245.8	190.2	436.0
		%	5.6%	4.5%	5.1%
Total		Count	4809	3721	8530
		Expected Count	4809.0	3721.0	8530.0
		%	100.0%	100.0%	100.0%

Next male students' perceptions of gender and mathematics performance by whether or not they are in an advanced mathematics course were examined. There was a larger significant difference, χ^2 (4, N = 8563) = 237.75, $p < .001$. Male students in advanced mathematics courses (38.1%) were more likely to say that males were somewhat or much better at mathematics than females compared to male students who were not taking an advanced mathematics course (25.1%). See Table 7 for detailed percentages.

Table 7

Crosstabs of How Male Teens Compare Males and Females in Mathematics by Taking Advanced Mathematics

			Taking Advanced Mathematics		
			No advanced Mathematics	At least one advanced Mathematics course	Total
How male teen compares males and females in mathematics	Females are much better	Count	363	108	471
		Expected Count	276.0	195.0	471.0
		%	7.2%	3.0%	5.5%
	Females are somewhat better	Count	640	276	916
		Expected Count	536.7	379.3	916.0
		%	12.8%	7.8%	10.7%
	Females and males are the same	Count	2755	1812	4567
		Expected Count	2675.8	1891.2	4567.0
		%	54.9%	51.1%	53.3%
	Males are somewhat better	Count	814	915	1729
		Expected Count	1013.0	716.0	1729.0
		%	16.2%	25.8%	20.2%
	Males are much better	Count	445	435	880
		Expected Count	515.6	364.4	880.0
		%	8.9%	12.3%	10.3%
Total		Count	5017	3546	8563
		Expected Count	5017.0	3546.0	8563.0
		%	100.0%	100.0%	100.0%

Science Results

For both the science identity and self-efficacy scales, two (sex of student) by two (whether or not student taking advanced science course) factorial ANOVAs were used to analyze the data. These analyses address hypotheses 3_a, 3_b, 4_a, and 4_b. As with the science identity and self-efficacy scales, each student's score on these science scales was transformed to a z-score, with a distribution mean of 0 and a standard deviation of 1. The corrected model is the sum of the squares of the mean of the dependent variable. For this study the significance of the corrected model is 0.000.

The science identity scale in hypothesis 3_a sought to identify if there was a statistically significant difference between male and female students and their science self-identity. There was a significant main effect for the gender of the student. Male students ($M = 0.17$, $SD = 1.00$) had significantly higher science identity compared to female students ($M = 0.06$, $SD = 1.02$), $F(1,15750) = 32.96$, $p < .001$, $\eta^2 = .002$. Hypothesis 4_a investigated if there was a statistically significant difference between students' science self-identity and whether or not they enrolled in an advanced science related class. There was a significant main effect for whether or not the student was taking an advanced science course. Students taking advanced science ($M = 0.34$, $SD = 1.01$) had significantly higher science identity than students who were not taking an advanced science course ($M = -0.01$, $SD = 0.99$), $F(1,15750) = 436.92$, $p < .001$, $\eta^2 = .027$ (see Table 8 for descriptive statistics). Finally, there was no significant interaction between the independent variables, $F(1,15750) = 2.92$, $p = .087$ (see Table 9 for full ANOVA results).

Table 8

Descriptive Statistics for Science Identity Scale by Gender and Advanced Science Courses

Dependent Variable: Scale of student's science identity

Student's sex	Taking Advanced Science	Mean	Std. Deviation	N
Male	No advanced Science	.0497	.97270	4986
	Advanced Science	.3676	1.00737	2894
	Total	.1665	.99735	7880
Female	No advanced Science	-.0737	.99814	5133
	Advanced Science	.3008	1.02164	2741
	Total	.0567	1.02201	7874
Total	No advanced Science	-.0129	.98757	10119
	Advanced Science	.3351	1.01479	5635
	Total	.1116	1.01121	15754

Table 9

Factorial ANOVA Table for Science Identity Scale by Sex and Advanced Science Courses

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	483.010[a]	3	161.003	162.290	.000
SEX	32.701	1	32.701	32.963	.000
AdvSci	433.457	1	433.457	436.922	.000
SEX * AdvSci	2.901	1	2.901	2.924	.087
Error	15625.125	15750	.992		
Total	16108.135	15753			

a. R Squared = .030 (Adjusted R Squared = .030)

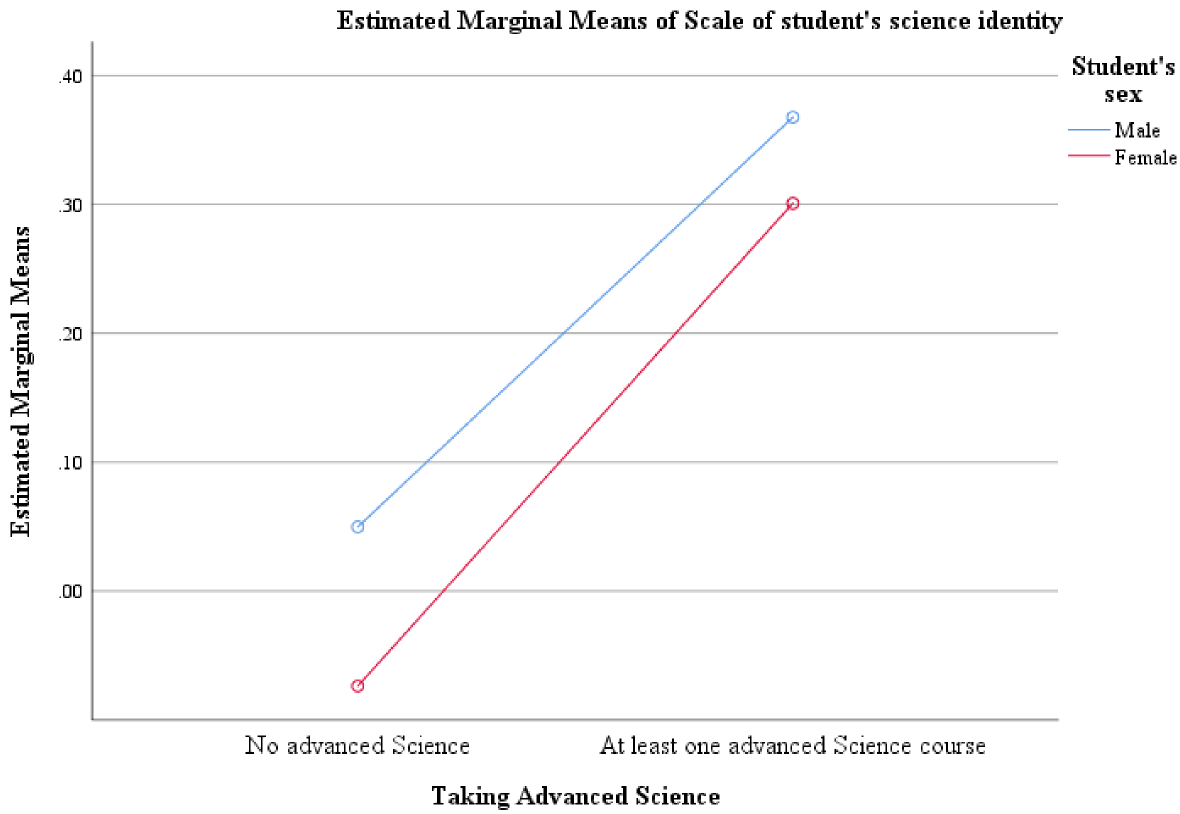

Figure 3

Estimated Marginal Means for Student's Science Identity

Hypothesis 3_b analyzed if there is a statistically significant difference between male and female students and their science self-efficacy. For the science self-efficacy scale there was a significant main effect for the gender of the student. Male students (M = 0.19, SD = 0.97) had significantly higher science self-efficacy compared to female students (M = -0.02, SD = 1.01), $F(1, 15500) = 149.94$, $p < .001$, $\eta^2 = .010$. There was also a significant main effect for whether or not the student was taking an advanced science course. Hypothesis 4_b examined if there was a statistically significant difference between students' science self-efficacy and whether or not they enrolled in an advanced science related class. Students taking advanced science (M = 0.23, SD = 1.00) had significantly higher science self-efficacy than students who were not taking an advanced science course (M = 0.005, SD = 0.97), $F(1, 15500) = 149.94$, $p < .001$, $\eta^2 = .011$ (see Table 10 for descriptive statistics). Finally, there was a significant, but weak, interaction between the independent variables, $F(1, 15500) = 17.03$, $p = .023$, $\eta^2 < .001$ (see Table 11 for complete ANOVA table). When comparing students in advanced science courses versus no advanced science, the gap between science self-efficacy was a little larger for females than it was for males (see Figure 4).

Table 10

Descriptive Statistics for Science Self-efficacy Scale by Gender and Advanced Science Courses

Dependent Variable: Scale of student's science self-efficacy

Student's sex	Taking Advanced Science	Mean	Std. Deviation	N
Male	No advanced Science	.1263	.97740	4893
	At least one advanced Science course	.3063	.95374	2833
	Total	.1923	.97260	7726
Female	No advanced Science	-.1130	1.01091	5066
	At least one advanced Science course	.1419	.97405	2712
	Total	-.0241	1.00551	7778
Total	No advanced Science	.0046	1.00171	9959
	At least one advanced Science course	.2259	.96714	5545
	Total	.0837	.99512	15504

Table 11

Factorial ANOVA Table for Science Self-efficacy Scale by Sex and Advanced Science Courses

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	354.485[a]	3	118.162	122.120	.000
SEX	145.081	1	145.081	149.941	.000
AdvSci	168.336	1	168.336	173.974	.000
SEX * AdvSci	5.002	1	5.002	5.170	.023
Error	14997.622	15500	.968		
Total	15352.107	15503			

a. R Squared = .023 (Adjusted R Squared = .023)

Figure 4

Estimated Marginal Means for Student's Science Self-efficacy

Gender Differences in Science Performance Perception

A Chi-Square was used to analyze if there was a significant difference between genders and student perception of male and female performance (hypothesis 3_c). There was a significant difference between females and males in their perceptions, χ^2 (4, N = 19983) = 348.25, p < .001. Compared to male students (60.8%), female students (67.9%) were more likely to say that females and males were the same in science performance. Male students (9.4%) were more likely to say that males were much better at science performance compared to female students (3.5%). See Table 12 for detailed percentages. These results are similar to the results on perception of gender and mathematics performance.

Table 12

Crosstabs of Teens Comparisons of Males and Females in Science by Gender of Student

			Student's sex		
			Male	Female	Total
How teen compares males and females in science	Females are much better	Count	393	484	877
		Expected Count	441.6	435.4	877.0
		%	3.9%	4.9%	4.4%
	Females are somewhat better	Count	698	757	1455
		Expected Count	732.7	722.3	1455.0
		%	6.9%	7.6%	7.3%
	Females and males are the same	Count	6116	6735	12851
		Expected Count	6471.5	6379.5	12851.0
		%	60.8%	67.9%	64.3%
	Males are somewhat better	Count	1906	1597	3503
		Expected Count	1764.0	1739.0	3503.0
		%	18.9%	16.1%	17.5%
	Males are much better	Count	950	347	1297
		Expected Count	653.1	643.9	1297.0
		%	9.4%	3.5%	6.5%
Total		Count	10063	9920	19983
		Expected Count	10063.0	9920.0	19983.0

A Chi-Square analysis was used to analyze if there was a significant difference between students' comparison of science subject performance and whether or not they enrolled in an advanced science related class (hypothesis 4_c). First, female students' perceptions of gender and science performance by whether or not they are in an advanced science course were examined. There was a significant difference, χ^2 (4, N = 7885) = 15.77, p = .003. Compared to females not taking an advanced science course (67.2%) females taking an advanced science course (70%) were more likely to say that males and females are the same at science. Additionally, females who were not taking an advanced science course (17.5%) were more likely to say that males are somewhat better at science compared to females who were taking an advanced science course (14.3%). See Table 13 for detailed percentages.

Table 13

Crosstabs of How Female Teens Compares Males and Females in Science by Course

			Taking Advanced Science		Total
			No advanced Science	At least one advanced Science course	
How female teen compares males and females in science	Females are much better	Count	238	131	369
		Expected Count	240.3	128.7	369.0
		%	4.6%	4.8%	4.7%
	Females are somewhat better	Count	373	219	592
		Expected Count	385.5	206.5	592.0
		%	7.3%	8.0%	7.5%
	Females and males are the same	Count	3450	1927	5377
		Expected Count	3501.0	1876.0	5377.0
		%	67.2%	70.0%	68.2%
	Males are somewhat better	Count	900	394	1294
		Expected Count	842.5	451.5	1294.0
		%	17.5%	14.3%	16.4%
	Males are much better	Count	173	80	253
		Expected Count	164.7	88.3	253.0
		%	3.4%	2.9%	3.2%
Total		Count	5134	2751	7885
		Expected Count	5134.0	2751.0	7885.0
		%	100.0%	100.0%	100.0%

Next, male students' perceptions of gender and science performance by whether or not they are in an advanced science course were examined. There was a significant difference, χ^2 (4, N = 7897) = 17.85, p = .001. Male students who were not taking advanced science courses (10.6%) were a little more likely to say that females were somewhat or much better at science compared to male students who were taking an advanced science course (7.8%). Overall, the majority of male students (60.6%) said that females and males were the same in science. See Table 7 for detailed percentages.

Table 14

Crosstabs of How Male Teen Compare Males and Females in Science by Taking Advanced Science

			Taking Advanced Science		
			No advanced Science	At least one advanced Science course	Total
How male teen compares males and females in science	Females are much better	Count	174	65	239
		Expected Count	151.1	87.9	239.0
		%	3.5%	2.2%	3.0%
	Females are somewhat better	Count	356	162	518
		Expected Count	327.5	190.5	518.0
		%	7.1%	5.6%	6.6%
	Females and males are the same	Count	2998	1790	4788
		Expected Count	3027.3	1760.7	4788.0
		%	60.0%	61.6%	60.6%
	Males are somewhat better	Count	992	598	1590
		Expected Count	1005.3	584.7	1590.0
		%	19.9%	20.6%	20.1%
	Males are much better	Count	473	289	762
		Expected Count	481.8	280.2	762.0
		%	9.5%	10.0%	9.6%
Total		Count	4993	2904	7897
		Expected Count	4993.0	2904.0	7897.0
		%	100.0%	100.0%	100.0%

Gender Differences in Taking Advanced Courses

Female students (43.6%) were significantly more likely to be taking an advanced mathematics course compared to male students (41.2%), χ^2 (1, N =17.430) = 10.41, p = .001 (see Table 15 for percentages). Conversely, male students (36.7%) were significantly more likely to be taking an advanced science course compared to female students (34.8%), χ^2 (1, N =16,048) = 6.31, p = .012 (see Table 16 for percentages).

Table 15

Crosstabulation of Student's Sex with Taking Advanced Mathematics

			Student's sex		
			Male	Female	Total
Taking Advanced Mathematics	No advanced Mathematics	Count	5148	4896	10044
		Expected Count	5042.7	5001.3	10044.0
		% within Student's sex	58.8%	56.4%	57.6%
	At least one advanced Mathematics course	Count	3603	3783	7386
		Expected Count	3708.3	3677.7	7386.0
		% within Student's sex	41.2%	43.6%	42.4%
Total		Count	8751	8679	17430
		Expected Count	8751.0	8679.0	17430.0
		% within Student's sex	100.0%	100.0%	100.0%

Table 16

Crosstabulation of Student's Sex with Taking Advanced Science

			Student's sex		
			Male	Female	Total
Taking Advanced Science	No advanced Science	Count	5084	5225	10309
		Expected Count	5160.3	5148.7	10309.0
		% within Student's sex	63.3%	65.2%	64.2%
	At least one advanced Science course	Count	2949	2790	5739
		Expected Count	2872.7	2866.3	5739.0
		% within Student's sex	36.7%	34.8%	35.8%
Total		Count	8033	8015	16048
		Expected Count	8033.0	8015.0	16048.0
		% within Student's sex	100.0%	100.0%	100.0%

Summary of Findings

Mathematics. When reporting on mathematics identity, male students reported a significantly higher mathematics identity compared to female students. For student self-efficacy, male students had significantly higher mathematics self-efficacy compared to female students. Students taking advanced mathematics had significantly higher mathematics identity and mathematics self-efficacy than students who were not taking an advanced mathematics course. In both the mathematics identity scale and the mathematics self-efficacy scale, when comparing students in advanced mathematics versus no advanced mathematics, the gap was a little larger for males than it was for females.

Female students (59.2%) were more likely to say that females and males were the same in mathematics performance compared to male students (53.5%), yet male students (10.1%) were more likely to say that males were much better at mathematics performance compared to female students (5.2%). Female students in advanced mathematics courses (22.5%) were more likely to say that males were somewhat better at mathematics. Additionally, compared to females who were taking an advanced mathematics course (5%), females who were not taking an advanced mathematics course (6.8%) were more likely to say that females are much better at mathematics. Male students in advanced mathematics courses (38.1%) were more likely to say that males were somewhat or much better at mathematics than females compared to male students who were not taking an advanced mathematics course (25.1%). See Table 17 for summary results.

Science. Male students had significantly higher science identity and science self-efficacy compared to female students. Similarly, students taking advanced science had significantly higher science identity and science self-efficacy than students who were not taking an advanced science course. When comparing students in advanced science courses versus no advanced science, the gap between science self-efficacy was a little larger for females than it was for males.

There was a significant difference between females and males in their perceptions. Compared to male students (60.8%), female students (67.9%) were more likely to say that females and males were the same in science performance. Male students (9.4%) were more likely to say that males were much better at science performance compared to female students (3.5%). Compared to females not taking and advanced science course (67.2%) females taking an advanced science course (70%) were more likely to say that males and females are the same at science. Male students who were not taking advanced science courses (10.6%) were a little more likely to say that females were somewhat or much better at science compared to male students who were taking an advanced science course (7.8%). Overall, the majority of male students (60.6%) said that females and males were the same in science. See Table 17 for summary results.

Advanced mathematics and science enrollment. There is a significant gender difference in advanced STEM class enrollment. Females students (43.6%) were significantly more likely to be taking an advanced mathematics course compared to male students (41.2%). Conversely, male students (36.7%) were significantly more likely to be taking an advanced science course compared to female students (34.8%).

Table 17

Summary of Findings

Hypothesis	Hypothesis rejected or retained?	*p* value	See Table
H_{1ao}: There is no statistically significant difference between male and female students and their mathematics identity.	rejected	$p < .001$	Table 1
H_{1bo}: There is no statistically significant difference between male and female students and their mathematics self-efficacy.	rejected	$p < .001$	Table 3
H_{1co}: There is no statistically significant difference between male and female students and their perception of how males and females perform in mathematics.	rejected	$p < .001$	Table 5
H_{2ao}: There is no statistically significant difference between students' mathematics identity and whether or not they enrolled in an advanced mathematics class.	rejected	$p < .001$	Table 1
H_{2bo}: There is no statistically significant difference between students' mathematics self-efficacy and whether or not they enrolled in an advanced mathematics class.	rejected	$p < .001$	Table 3
H_{2co}: There is no statistically significant difference between students' comparison of mathematics subject performance and whether or not they enrolled in an advanced mathematics class.	rejected	$p < .001$	Table 6 Table 7
H_{3ao}: There is no statistically significant difference between male and female students and their science self-identity.	rejected	$p < .001$	Table 8

H_{3bo}: There is no statistically significant difference between male and female students and their science self-efficacy.	rejected	$p < .001$	Table 10
H_{3co}: There is no statistically significant difference between male and female students and their perception of how males and females perform in science.	rejected	$p = .001$	Table 12
H_{4ao}: There is no statistically significant difference between students' science self-identity and whether or not they enrolled in an advanced science related class.	rejected	$p < .001$	Table 8
H_{4bo}: There is no statistically significant difference between students' science self-efficacy and whether or not they enrolled in an advanced science related class.	rejected	$p < .001$	Table 10
H_{4co}: There is no statistically significant difference between students' comparison of science subject performance and whether or not they enrolled in an advanced science related class.	rejected	$p = .003$	Table 13

Chapter 5: Discussion

Overview of the Study

The purpose of this cross-sectional, quantitative study was to examine how gender differences in mathematics and science are related to identity, self-efficacy, and students' comparison of STEM subject competency. The secondary focus was to investigate the influence that STEM self-efficacy and STEM identity have on enrolling in advanced STEM-related classes. Despite years of previous efforts to close the STEM gender gap, women continue to be underrepresented in STEM careers (Sheu et al., 2018). STEM career intention for an individual begins with gaining successful performance experiences resulting in the increase of one's belief in one's ability (Bandura, 1993, 1997; Hushman & Marley, 2015; Resnick, 2008; Sheu et al., 2018; Taylor & Betz, 1983). For women, STEM career intention is supported by enrolling in advanced STEM courses in high school (Wang & Degol, 2017). Participation in advanced learning experiences predict future STEM success and are prerequisites for STEM majors in preparation for future careers (Wang & Degol, 2017).

The data that was used in this study were existing secondary survey data from the HSLS:09 longitudinal study. This HSLS:09 study's driving focus was on how the course decisions of high school students influence the drive or avoidance of STEM majors and careers. For this study, data used for analysis were harvested from a student questionnaire taken in the spring of 2012 when the participants from the HSLS:09 study were in Grade 11 (National Center for Educational Statistics, 2016).

Chapter Four analyzed the data and the hypotheses for this study. Factorial ANOVAs were used to analyze gender differences in mathematics and science self-identity, self-efficacy, and the relationship if the student is enrolled in an advance STEM-related class. Chi-square analyses were used to identify the gender differences student perception of student mathematics and science ability and the difference of being enrolled in an advanced STEM-related course. Chapter Five is a discussion of the results based on the data analysis in addition to the implications, recommendations for practitioners, and concluding comments.

Research Questions

The following research questions were explored in this study:

1) What difference, if any, exists between male and female students in their mathematics identity, mathematics self-efficacy, or perception of how males and females perform in mathematics?
2) Is there a statistically significant difference between students' mathematics identity, mathematics self-efficacy, or comparison of mathematics subject performance based on whether or not they enrolled in an advanced mathematics class?
3) What difference, if any, exists between male and female students in their science identity, science self-efficacy, or perception of how males and females perform in science?
4) Is there a statistically significant difference between students' science identity, science self-efficacy, or comparison of science subject performance based on whether or not they enrolled in an advanced science class?

Conclusions

Research question one. Research question one explored the difference between male and female mathematics identity, mathematics self-efficacy, and perceptions of student mathematics performance. Each dependent variable was divided into individual hypotheses and analyzed separately. The first hypothesis examined mathematics identity based on gender. A factorial ANOVA revealed that male students have a significantly higher mathematics identity than female students. Therefore, the null hypothesis was rejected. Current research demonstrated similar findings when analyzing male and female mathematics identity (Riegle-Crumb, Moore & Ramos-Wada, 2011). Findings from this study align with previous empirical research related to stereotype threat (Cadaret et al., 2017; Drake, Primeaux, & Thomas, 2018; Kelly, 2016). Both males and females are more likely to associate mathematics courses and mathematics professions with masculine identity traits (Cheryan et al., 2017). Biases regarding women in mathematics represent barriers that actively prevent interested, talented women from viewing themselves with strong mathematics identity (Dunlap & Barth, 2019).

The second hypothesis examined gender differences of mathematics self-efficacy. A factorial ANOVA showed a significantly higher mathematics self-efficacy in male students than female students. Therefore, the null hypothesis was rejected. Current research indicated similar findings. Females may have a heightened awareness of the stereotype beliefs around female performance, which may cause women to question their own performance ability resulting in lower mathematics self-efficacy (Cadaret et al., 2017; Kelly, 2016). Without a high level of confidence, females may not be able to combat negative stereotype barriers needed to display high levels of mathematics self-efficacy (Cadaret et al., 2017). In order to challenge personal beliefs surrounding STEM ability, an individual must engage in experiences that develop positive beliefs about mathematics ability (Charleston & Leon, 2016).

The third hypothesis explored the difference between male and female perceptions of student ability in mathematics. A Chi-Square analysis demonstrated a statistically significant difference between genders and mathematics perceived ability. Female students were more likely to state that females and males were the same in mathematics ability, whereas male students were more likely to state that males are much better at mathematics performance compared to females. Therefore, the null hypothesis was rejected. Current research demonstrated that male students report higher perceived mathematics ability (Nix et al., 2015). In addition, females report a lower mathematics confidence at the beginning of high school and a higher confidence in mathematics ability at the end of high school (Nix et al., 2015).

In summary, there is a statistically significant difference was found between male and female students in their mathematics identity, mathematics self-efficacy, and perception of how males and females perform in mathematics. Table 18 provides outcomes of the hypotheses for research question one.

Table 18

Research Question One Hypotheses Outcome

Hypothesis	Hypothesis Rejected or Retained?
H_{1ao}: There is no statistically significant difference between male and female students and their mathematics identity.	Rejected
H_{1bo}: There is no statistically significant difference between male and female students and their mathematics self-efficacy.	Rejected
H_{1co}: There is no statistically significant difference between male and female students and their perception of how males and females perform in mathematics.	Rejected

Research question two. Research question two examined the difference between mathematics identity, mathematics self-efficacy, and perceptions of student mathematics performance based on whether or not they enrolled in an advanced mathematics class. These variables were divided into individual hypotheses and analyzed separately. The first hypothesis examined male and female mathematics identity based on whether or not a student was enrolled in an advanced mathematics class. A factorial ANOVA revealed that students enrolled in an advanced mathematics course have a significantly higher mathematics identity than students who are not, and the gap was a little larger for males than it was for females. Therefore, the null hypothesis was rejected. Current research demonstrated similar findings. Females report feeling less competent in mathematics than male students, and it is these beliefs that greatly influence a student's identity, regardless of mathematics performance (Kalender, Marshman, Schunn, Nokes-Malach, & Singh, 2019). By enrolling in a challenging or advanced course, females report greater levels of mathematics confidence and increased feelings of mathematics identity (Kalender et al., 2019; Kim, Sinatra & Seyranian, 2018).

The second hypothesis examined gender differences of mathematics self-efficacy based on whether or not the student was enrolled in an advanced mathematics class. A factorial ANOVA showed a significantly higher mathematics self-efficacy in students who were enrolled in an advanced mathematics course. The gap between enrolling in an advanced course versus not enrolling in an advanced mathematics course was a little larger for male students than it was for female students. Therefore, the null hypothesis was rejected. Current research demonstrated that prior mathematics accomplishments contribute greatly to higher mathematics self-efficacy (Charleston & Leon, 2016). Successful accomplishments in mathematics contribute to students enrolling in an advanced mathematics course. A student who enrolls in a more challenging mathematics course also demonstrates a higher level of mathematics self-efficacy which is not mutually exclusive from mathematics interest (Grigg et al., 2018). High school students will be more inclined to enroll in an advanced mathematics course if that student has higher mathematics interest. Thus, there is a strong interplay between mathematics advanced course enrollment, mathematics self-efficacy, and mathematics interest. Overall, this study helps to add to the body of literature suggesting that gender is affected by enrolling in an advanced mathematics course.

The third hypothesis explored the difference between male and female perceptions of student ability in mathematics and enrollment in an advanced mathematics class. A Chi-Square analysis demonstrated a statistically significant difference between male and female mathematics perceived ability and whether or not they were enrolled in an advanced mathematics course. Female students in advanced mathematics courses were more likely to say that males are somewhat better at mathematics than females, where females who were not taking advanced mathematics courses were more likely to say females are much better at mathematics than males. Male students were more likely to say that males were somewhat or much better than females at mathematics compared to males who were not taking an advanced course. Therefore, the null hypothesis was rejected. Current research has found that for high school students taking challenging mathematics courses, females report equal ability between male and female students while male students reported male mathematics ability slightly higher than female ability (Cheryan et al., 2017; Nix et al., 2015). Nix et al. (2015) found that challenging mathematics courses had a greater effect on male mathematics growth mindset, or the belief that an individual can improve their mathematics performance. A stronger perception of male mathematics ability was identified in Grade 10 male students than in male students in Grade 12. This change over time was not demonstrated by female students over time. It is unknown if this decrease is due to factors such as the increase in opportunity to enroll and experience in more advanced mathematics courses over time, which might provide more encounters that challenge perception thinking over time (Cheryan et al., 2017). Given this research, this study would have expected to see a greater change in perception in student mathematics ability for female students. Further examination may prove beneficial in this area.

In conclusion, there is a statistically significant difference between students' mathematics identity, mathematics self-efficacy, and comparison of mathematics subject performance based on whether or not they enrolled in an advanced mathematics class. Table 19 provides a summary of the outcome of the hypotheses for research question two.

Table 19

Research Question Two Hypotheses Outcome

Hypothesis	Hypothesis Rejected or Retained?
H_{2ao}: There is no statistically significant difference between students' mathematics identity and whether or not they enrolled in an advanced mathematics class.	Rejected
H_{2bo}: There is no statistically significant difference between students' mathematics self-efficacy and whether or not they enrolled in an advanced mathematics class.	Rejected
H_{2co}: There is no statistically significant difference between students' comparison of mathematics subject performance and whether or not they enrolled in an advanced mathematics class.	Rejected

Research question three. Research question three explored the difference between science identity, science self-efficacy, and perceptions of student science performance which were divided into individual hypotheses and analyzed separately. The first hypothesis examined science identity based on gender. A factorial ANOVA revealed that male students have a statistically significantly higher science identity than female students. Therefore, the null hypothesis was rejected. Current research is aligned with this study. Traditionally, science has been stereotyped as a masculine content area and that males are more successful in science than females (Cadaret et al., 2017; Drake, Primeaux, & Thomas, 2018; Kelly, 2016). Gendered biases about science can negatively affect women and their beliefs about their own science identity (Kalender et al., 2019). Negative female stereotypes contribute to a female perception of lower ability, lower self-esteem, and beliefs that females are incompetent in science (Cidlinská, 2019; Patterson & Johnson, 2017). Flowers III and Banda (2016) stated that the risk for underrepresented populations who are not supported to challenge gendered science stereotypes is the cultivation of social persuasion for females to align science identity with gender stereotypes.

The second hypothesis examined gender differences of science self-efficacy. A factorial ANOVA showed a significantly higher science self-efficacy in male students than female students. Therefore, the null hypothesis was rejected. Current research has shown that high school females demonstrate significantly lower science self-efficacy than male high school students (Hong & Lin, 2013; Marshman, Kalender, Nokes-Malach, Schunn & Singh, 2018). This gender gap in self-efficacy is even noted when performance is controlled for when students are enrolled in introductory science classes (Marshman et al., 2018). This demonstrates a female bias about their own science ability, science competency, and beliefs about who is stereotyped to succeed.

The third hypothesis explored the difference between male and female perceptions of student ability in science. A Chi-Square analysis demonstrated a statistically significant difference between genders and science perceived ability. Female students were more likely to state that females and males were the same in science ability. Male students were more likely to report that males are much better at science performance compared to females. Therefore, the null hypothesis was rejected. Current research demonstrated that although there exists a stereotype bias that males are better at science than females, these beliefs can be challenged and changed through vicarious experiences thus increasing female science beliefs and participation (Master et al., 2017). Male students display higher self-efficacy than females even when male and female student achievement is similar (Marshman et al., 2018). In addition, negative social interactions negatively affect student STEM self-efficacy (Charleston & Leon, 2016). Female students report high social awareness around science class GPA, classroom environment, and the desire to maintain a perception of high STEM ability (Patterson & Johnson, 2017). When assessing personal ability with these comparison criteria, individuals may feel inferior to other students, especially if the students have a heightened science social awareness due to stereotype threat.

In summary, a statistically significant difference was found male and female students in their science identity, science self-efficacy, or perception of how males and females perform in science. Table 20 provides outcomes of the hypotheses for research question three.

Table 20

Research Question Three Hypotheses Outcome

Hypothesis	Hypothesis Rejected or Retained?
H_{3ao}: There is no statistically significant difference between male and female students and their science self-identity.	Rejected
H_{3bo}: There is no statistically significant difference between male and female students and their science self-efficacy.	Rejected
H_{3co}: There is no statistically significant difference between male and female students and their perception of how males and females perform in science.	Rejected

Research question four. Research question four explored the difference between science identity, science self-efficacy, and perceptions of student science performance based on whether or not they enrolled in an advanced science class. These variables were divided into individual hypotheses and analyzed separately. The first hypothesis examined male and female science identity based on whether or not a student was enrolled in an advanced science class. A factorial ANOVA revealed that although there was no significant interaction between males and females, students enrolled in an advanced science course have a significantly higher science identity than students who are not. Therefore, the null hypothesis was rejected. Current research demonstrated that when student expertise and science literacy are developed at higher levels, a greater sense science identity is created (Sparks, 2017). When a student's core identity parallels that of a high science identity, females are more likely to continue in science courses and have science career intention (Sparks, 2017).

The second hypothesis examined gender differences of science self-efficacy based on whether or not the student was enrolled in an advanced science class. A factorial ANOVA showed a significantly higher science self-efficacy in students who were enrolled in an advanced science class than those who were not enrolled. For females, the gap between science self-efficacy was a little larger than it was for males when comparing students in advanced science courses. Therefore, the null hypothesis was rejected. Current research stated that with more rigorous classes, female students display higher science self-efficacy than female students in more introductory science courses (Hong & Lin, 2013; Stoet & Geary, 2018). Students who were involved in advanced classes may also be engaged in more in mastery learning experiences (Bandura, 1993, 1997; Hong and Lin, 2013). When students are able to believe that they are successful in science, they are then more likely to believe that they belong to the social group, even if it is contrary to the social stigma (Patterson & Johnson, 2017; Wang et al., 2015).

The third hypothesis explored the difference between male and female perceptions of student ability in science and enrollment in an advanced science course. A Chi-Square analysis demonstrated a statistically significant difference between student perceived science ability and whether or not they were enrolled in an advanced science course. Females not enrolled in an advanced science course were more likely to say that females are much better at science than males. Female students in advanced science courses were more likely to say that males and females are the same at science. The majority of male students, whether enrolled in an advanced science course or not, were more likely to state that males and females have the same ability in science. Therefore, the null hypothesis was rejected. Current research showed a direct relationship between an individual's perceptions of ability directly related to a student's STEM experiences (Charleston & Leon, 2016). Students who are enrolling in advanced science courses identify a higher enjoyment of science and a greater sense of control over their own learning (Hushman & Marley, 2015). These students who were participating in more challenging science courses expressed greater changes in their beliefs about their science ability than those who were not enrolled in a challenging course.

In conclusion, there is a statistically significant difference between students' science identity, science self-efficacy, and comparison of science subject performance based on whether or not they enrolled in an advanced science class. Table 21 provides a summary of the outcome of the hypotheses for research question four.

Table 21

Research Question Four Hypotheses Outcome

Hypothesis	Hypothesis Rejected or Retained?
H_{4ao}: There is no statistically significant difference between students' science self-identity and whether or not they enrolled in an advanced science related class.	Rejected
H_{4bo}: There is no statistically significant difference between students' science self-efficacy and whether or not they enrolled in an advanced science related class.	Rejected
H_{4co}: There is no statistically significant difference between students' comparison of science subject performance and whether or not they enrolled in an advanced science related class.	Rejected

Implications for Practice

The conclusions from this study have implications for research and practice within schools. Results from this study demonstrate statistically significant differences between male and female STEM self-identity, self-efficacy, and perceptions of gender ability when enrolling in advanced STEM courses. Given the large sample size of this study, some results report a greater effect size in significance, demonstrating a higher explanation of the variance in the variables.

An area worth highlighting from the data in this study was the effect size of enrolling in an advanced mathematics course on mathematics identity ($\eta^2 = .071$). Students who are enrolled in an advanced mathematics course have a significantly higher self-identify to those who are not enrolled in an advanced mathematics course. It is unknown if the students enrolled in the advanced course because they had high self-identity or if their self-identity was high due to enrolling in an advanced course. Hübner et al. (2017) identified social comparisons and differences in achievement as contributors to this difference in advanced STEM-related classes and identity. Students tend to identify with the perceived achievement and the ability level of the social group. Having a significant difference in mathematics achievement between introductory high school courses and advanced courses, students tend to perceive themselves with a higher identity self-concept in advanced high school courses since that is the perceived social identity. Knowing this about advanced mathematics courses and self-identity, educators, counselors, and administrators would benefit from encouraging greater numbers of students to enroll in advanced mathematics courses.

High STEM self-identity and self-efficacy are the products of time and labor. Bandura (1993) identified that ability is not fixed but rather it can develop and evolve over time. The type and frequency of learning experiences males and females encounter influence interest, motivation, and self-identity in STEM (Bandura, 1997; Hushman & Marley, 2015). It is critical to future career ideation that strong self-efficacy is built within every stage of learning and that the type of learning experiences vary at different stages of a child's development (Hushman & Marley, 2015). Vicarious learning experiences, verbal persuasion, encouragement, and joy must begin and be repeated for a student from the beginning of their educational career and beyond, significantly influencing a person's STEM self-efficacy (Charleston & Leon, 2016). For students who have not engaged in mastery learning experiences, early interventions is necessary for students, especially for young girls, to increase engagement and self-efficacy which can impact a student's future educational trajectory (Falco & Summers, 2019).

One unexpected finding that came out as a result of this study was that females were more likely to enroll in an advanced mathematics course, whereas males are more likely to enroll in an advanced science course. Current research demonstrated females have lower participation in science related classes than male students in high school (Cheryan et al., 2017; Hong & Lin, 2013; Nix et al., 2015). Male students are 24% more likely to enroll into Chemistry II and Physics II over female students (Nix et al., 2015). The implications of enrolling in Chemistry II and Physics II increase the likelihood of students entering into a STEM undergraduate major over a non-STEM major. Completing any science course beyond introductory biology, chemistry, and physics increased the probability of a student entering into a STEM career by 85% (Nix et al., 2015). In addition, if female students are taking an advanced mathematics course, the skills and resilience built within these courses transfer to advanced science courses (Cheryan et al., 2017). Nix et al. (2015) found that increasing by only one percentage point in reported personal ability, students were 14% more likely to enroll in an advanced science course. In addition, once female students enter into advanced level STEM courses needed to enter into STEM majors, the attrition rate is very low (Cheryan et al., 2017).

One reason female students may enroll in an advanced STEM-related class is because the subject is a perceived strength (Wang & Degol, 2017). If students do not feel a sense of belonging in STEM, they may choose to pursue a different strength outside of STEM as a career

(Ong et al., 2011; Wang & Degol, 2017). It is for this reason school leaders and educators would benefit from continuing to improve in pedagogical practices that increase female interest and motivation in STEM-related careers (McDonald, 2016). Career aspirations in STEM emerge prior to entry into high school and it is in the hands of the educational system to assess current practices, strengthen curriculum and practices, and foster individual passions and strengths of females in STEM (National Science Board, 2015; Wang et al., 2015).

Creating a sense of belonging in STEM for females begins in the classroom (Tanenbaum, 2016). Optimal K-12 educational experiences should focus on creating formal and informal STEM experiences that are tailored to student interests and foster enjoyment and high levels of engagement (Tanenbaum, 2016; Wang et al., 2015). These experiences rely on highly qualified teachers that receive regular professional development and administrative support (McDonald, 2016). In addition, areas to support female students should include learning communities or support groups, enrichment groups, study skills courses, and mentoring, including peer mentoring (Blair, et al., 2017; Johnson, 2011; Sachdev, 2018). It would also be beneficial for district leaders to look at how current practices are implicitly supporting or objecting gender stereotypes and stigmas (Ong et al., 2011; Sachdev, 2018).

Supporting females with STEM career intentions also begin with strong advocacy from schools and families. Familial influences directly influence the educational and career aspirations of an individual (Mau & Li, 2018). The support and encouragement that parents provide to adolescents is significant for students when choosing to enter more challenging career fields, such as physics (Charleston & Leon, 2016; Kelly, 2016; Rozek et al., 2017). Students who are considered highly prepared for STEM careers commonly have parents with a STEM background, have been exposed to a variety of STEM experiences outside of school, and have been encouraged by an influential adult (Archer et al., 2017). Students with highly engaged parents are more likely to enroll in advanced courses in high school, in addition to scoring 12 percentile points higher on the mathematics and science ACT tests (Rozek, Svoboda, Harackiewicz, Hulleman & Hyde, 2017). Students and families who do not understand STEM majors and careers are at a disadvantage in preparedness for a future in STEM careers (Wang et al., 2015).

There is a gap within the school system in providing guidance for students and their families when deciding future undergraduate majors and career paths (Nikischer, Weis, & Dominguez, 2016). This can result in the school system failing to adequately set students up for STEM majors and careers. Schools could benefit from expanding the methods by which students and families access academic counseling, activities, discussion groups, internships, and mentorship opportunities regarding STEM careers and education and support regarding barriers, socio-cultural issues, and what is involved in STEM career decision making (Falco & Summers, 2019; National Science Board, 2015).

Recommendations for Academics

Results from this study indicate the opportunity for further research to advance knowledge in this field. This study demonstrated a statistically significant difference between males and females and their STEM self-identity, self-efficacy, and STEM gendered perceptions. Of the three variables, results indicated that enrolling in a STEM-related class has the greatest effect on self-identity (mathematics $\eta^2 = .071$, science $\eta^2 = .027$). What could be expanded upon in future quantitative, qualitative, and mixed methods research is to better understand the interplay between advanced STEM courses and self-identity. For example, it is unknown whether students in this survey enrolled in an advanced STEM course because they had strong self-identity, or if greater self-identity was the result of enrolling in an advanced STEM course.

Current research stated that female students who enroll in a challenging or advanced course report greater levels of STEM confidence (Kalender et al., 2019; Kim, Sinatra & Seyranian, 2018). Practitioners could focus on the relationship between female high school STEM self-identity and self-efficacy scores prior to, during, and following the participation in an advanced STEM-related class. The large sample size of this research ($N = 20{,}594$) demonstrated the results hold a smaller margin of error when representing the entire population. However, this research was limited to a scope of solely Grade 11 students and their courses from their spring semester. There is a need to expanding the current body of knowledge to understand in greater detail the specific factors that increase STEM self-identity in advanced courses for students over the duration of their educational experience.

Although this research focused on gender disparity in STEM careers, gender is not the only limiting factor or stereotype within STEM careers (Flowers & Banda, 2016; Wang et al., 2017). There also exists a disproportionality in STEM careers within race and socioeconomic contexts (Flowers & Banda, 2016; Wang et al., 2017). Wang et al. (2017) identified that a "double jeopardy" (p. 119) occurs when females belong to two or more underrepresented groups. Further research is needed to identify the correlations between enrolling in an advanced STEM-related course and not enrolling on more specific underrepresented female groups such as female students of color and female students of different socioeconomic levels.

Further research is also recommended on the effects of recruitment and retention efforts for females in advanced STEM-related courses. Research has shown that once female students enter into an advanced STEM-related course track, the attrition rate is very low (Cheryan et al., 2017). It could be beneficial to review different recruitment and retention strategies utilized by high schools and the relationship those strategies have on female STEM self-identity, self-efficacy, and gendered STEM perception of ability.

This study used secondary data from the High School Longitudinal Study of 2009 (HSLS:09) which viewed one cohort of students from their Grade 11 school experiences. Since the HSLS:09 study began, further developments in STEM education have launched, such as the implementation of the Next Generation Science Standards and school makerspaces, increasing student STEM motivation and interest (Caballero Garcia & Grau Fernandez, 2019). Given the amount that education changes over time, it is suggested that the HSLS:09 survey be repeated with a new cohort of students, and a follow up study be performed such as the one presented in this current study. This data would give a more current reality of STEM education.

Concluding Comments

Given the direct work to combat disproportionality of females in STEM careers, there still remains a gender gap. There remains a need for a transformation within the educational system to help attract more women in STEM and narrow the current gender gap (Xu, 2008). This study, which had a large sample size ($N = 20{,}594$), reflected results of similar studies with smaller sample sizes. The results of this study demonstrated that the primary variables of this study, mathematics and science self-identity and self-efficacy are not mutually exclusive for female students, and future STEM career motivation and interest rely heavily on the symbiosis of these attributes. Engaging in positive vicarious learning experiences, such as advanced courses as this study demonstrated, are critical for future career interest and motivation to pursue STEM-related careers (McDonald, 2016; Xu, 2018).

In addition, knowing the barriers and drivers within the education system and STEM career fields allows change leaders to work to identify strategies that leverage particular drivers and work for the removal of barriers for female students (Shadle et al., 2017). In order for sustainable change to occur, a culture shift is needed regarding the perception of how males and females view females in STEM. Studies such as this illustrate the significant role that engaging in advanced courses can have on student self-identity, self-efficacy, and perceptions of student STEM ability. More specifically, when all students are provided with the support, resources, and skills needed for STEM career success, females will be more prepared and empowered to step into any role or career of their choosing.

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Appendix A

IRB Approval

BETHEL UNIVERSITY

Institutional Review Board
3900 Bethel Drive
PO2322
St. Paul, MN 55112

February 28, 2021

Rachel Lanquist
Bethel University
St. Paul, MN 55112

Re: Project: *Disproportionality of Women in STEM Careers*

Dear Rachel,

On February 28, 2021, the Bethel University Level Two Institutional Review Board completed the review of your proposed study and approved the above referenced study.

Please note that this approval is limited to the project as described on the most recent Human Subjects Review Form documentation, including email correspondence. Please be reminded that it is the responsibility of the investigator(s) to bring to the attention of the IRB Committee any proposed changes in the project or activity plans, and to report to the IRB Committee any unanticipated problems that may affect the welfare of human subjects. The approval is valid until February 28, 2022.

Sincerely,

Craig Paulson

Craig Paulson, Ph.D.
Chairperson, Bethel University IRB Committee

Appendix B

Variable Survey Questions

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SECTION A: Student Background

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Next we are going to ask you a few questions about your background.

~~~~~~

What is your sex?

Male

Female

~~~~~~

SECTION C: Math Experiences

~~~~~~

Now we are going to ask you a few questions about your experiences with math.

~~~~~~

How much do you agree or disagree with the following statements?

You see yourself as a math person

Strongly agree

Agree

Disagree

Strongly disagree

Others see you as a math person

Strongly agree

Agree

Disagree

Strongly disagree

~~~~~~

When you are working on a math assignment, how often do you think you really understand the assignment?

Never

Rarely

Sometimes

Often

~~~~~~

Are you currently taking a math course this spring? [Were you taking a math course in the spring of 2012?]

Yes

No

~~~~~~ *

What math course(s) are you currently taking this fall? [What math course(s) were you taking in the spring (2012)?] (Check all that apply.)

Algebra I including IA and IB

Geometry

Algebra II

Trigonometry

Review or Remedial Math including Basic, Business, Consumer, Functional or General
~~~~~~

math

Integrated Math I

Statistics or Probability

Integrated Math II or above

Pre-algebra

Analytic Geometry

Other advanced math course such as pre-calculus or calculus

Other math course

~~~~~~ *

Why are you taking [spring 2012 math course]? [If you are no longer taking this course, think back to the spring when you answer this question and the questions that follow.] (Check all that apply.)

You really enjoy math

You like to be challenged

You had no choice, it is a school requirement

The school counselor suggested you take it

Your parent(s) encouraged you to take it

A teacher encouraged you to take it

There were no other math courses offered

You will need it to get into college

You will need it to succeed in college

You will need it for your career

It was assigned to you
~~~~~~

Some other reason

You don’t know why you are taking this course

~~~~~~ *

How much do you agree or disagree with the following statements about your [spring 2012 math course]?

You are enjoying this class very much

Strongly agree

Agree

Disagree

Strongly disagree

You think this class is a waste of your time

Strongly agree

Agree

Disagree

Strongly disagree

You think this class is boring

Strongly agree

Agree

Disagree

Strongly disagree

~~~~~~ *

How much do you agree or disagree with the following statements about the usefulness of your [spring 2012 math] course? What students learn in this course...

is useful for everyday life.

Strongly agree

Agree

Disagree

Strongly disagree

will be useful for college.

Strongly agree

Agree

Disagree

Strongly disagree

will be useful for a future career.

Strongly agree

Agree

Disagree

Strongly disagree

~~~~~~ *

How much do you agree or disagree with the following statements about your [spring 2012 math] course?

You are confident that you can do an excellent job on tests in this course

Strongly agree

Agree

Disagree
~~~~~~

Strongly disagree

You are certain that you can understand the most difficult material presented in the textbook used in this course

Strongly agree

Agree

Disagree

Strongly disagree

You are certain that you can master the skills being taught in this course

Strongly agree

Agree

Disagree

Strongly disagree

You are confident that you can do an excellent job on assignments in this course

Strongly agree

Agree

Disagree

Strongly disagree

~~~~~~

SECTION D: Science Experiences

~~~~~~

Now we are going to ask you a few questions about your experiences with science.

~~~~~~

How much do you agree or disagree with the following statements?
~~~~~~

You see yourself as a science person

Strongly agree

Agree

Disagree

Strongly disagree

Others see you as a science person

Strongly agree

Agree

Disagree

Strongly disagree

~~~~~~

Are you currently taking a science course this spring? [Were you taking a science course in the spring of 2012?

Yes

No

~~~~~~

*   What science course(s) are you currently taking this fall? [What science course(s) were you taking in the spring (2012)?] (Check all that apply.)

Biology I

Earth Science

Physical Science

Environmental Science

Physics I

Integrated Science I

Chemistry I

Integrated Science II or above

Anatomy or Physiology

Advanced Biology such as Biology II, AP, or IB

Advanced Chemistry such as Chemistry II, AP, or IB

General Science

Principles of Technology

Life Science

Advanced Physics such as Physics II, AP or IB

Other earth or environmental sciences such as ecology, geology, oceanography, or meteorology

Other biological sciences such as botany, marine biology, or zoology

Other physical sciences such as astronomy or electronics

Other science course

~~~~~~ *

Why are you taking [spring 2012 science course]? [If you are no longer taking this course, think back to the fall when you answer this question and the questions that follow.] (Check all that apply.)

You really enjoy science

You like to be challenged

You had no choice, it is a school requirement

The school counselor suggested you take it
~~~~~~

Your parent(s) encouraged you to take it

A teacher encouraged you to take it

There were no other science courses offered

You will need it to get into college

You will need it to succeed in college

You will need it for your career

It was assigned to you

Some other reason

You don't know why you are taking this course

~~~~~~ *

How much do you agree or disagree with the following statements about your [pring 2012 science] course?

You are enjoying this class very much

Strongly agree

Agree

Disagree

Strongly disagree

You think this class is a waste of your time

Strongly agree

Agree

Disagree

Strongly disagree

You think this class is boring
~~~~~~

Strongly agree

Agree

Disagree

Strongly disagree

~~~~~~ *

How much do you agree or disagree with the following statements about the usefulness of your [spring 2012 science] course? What students learn in this course...

is useful for everyday life.

Strongly agree

Agree

Disagree

Strongly disagree

will be useful for college.

Strongly agree

Agree

Disagree

Strongly disagree

will be useful for a future career.

Strongly agree

Agree

Disagree

Strongly disagree

~~~~~~ *

How much do you agree or disagree with the following statements about your [spring 2012 science] course?

You are confident that you can do an excellent job on tests in this course

Strongly agree

Agree

Disagree

Strongly disagree

You are certain you can understand the most difficult material presented in the textbook used in this course

Strongly agree

Agree

Disagree

Strongly disagree

You are certain you can master the skills being taught in this course

Strongly agree

Agree

Disagree

Strongly disagree

You are confident that you can do an excellent job on assignments in this course

Strongly agree

Agree

Disagree

Strongly disagree

~~~~~~

SECTION E: Home and School

~~~~~~

Now we are going to ask you a few questions about your experiences at home and in school.

~~~~~~

In general, how would you compare males and females in each of the following subjects?

Math

Females are much better

Females are somewhat better

Females and males are the same

Males are somewhat better 3

Males are much better

Science

Females are much better

Females are somewhat better

Females and males are the same

Males are somewhat better

Males are much better
~~~~~~