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Gender Differences in High School Students’ Perceptions of Math and Science Identity, Self-Efficacy, and Utility

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Gender Differences in High School Students' Perceptions of Math and Science Identity, Self-Efficacy, and Utility

by

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Abstract

This quantitative dissertation examined the differences between young men and women's perceptions of mathematics and science identity, self-efficacy, and utility. There are gender norms and stereotypes that impact identity, self-efficacy, and perceived utility of mathematics and science. The secondary data analyzed were drawn from the follow-up High School Longitudinal Survey (HSLS:09). The survey was administered to 20,594 11th-grade students enrolled at 904 eligible public, charter, and private schools from all states and the District of Columbia. The study investigated whether there are gender-based statistically significant ($p < 0.05$) differences in 11th grade students' perceptions of mathematics and science identity, mathematics and science self-efficacy, and mathematics and science utility. The results of the study suggest that there are statistically significant differences between the genders in mathematics identity, science identity, mathematics self-efficacy, and science self-efficacy, but not statistically significant differences in mathematics utility and science utility. Continued research could prove useful to continue analyzing the gender gaps present.

Keywords: analytics, computer science, data science, gender, mathematics identity, mathematics self-efficacy, mathematics utility, STEM, science identity, science self-efficacy, science utility, technology industry

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Moreover, I would like to dedicate this research study to all the girls who have come into my pathway that needed someone to believe in them. My life-long dream is to find a way to enhance the world for girls without mentors.

Preface

I am writing this dissertation because of my passion for giving women independence. I was always the girl in the "boy" classes during my education, like advanced mathematics and science. My peers constantly reminded me that I was going against the grain and should be more feminine. The memories of other students chastising me for my passion for technical subjects are etched in my subconscious. Although it was a painful experience, I was strong enough to stay true to myself. Whenever someone told me I could not or should not, it drove me to work harder to pursue my goals.

This pattern continued from elementary school through my master's studies in data science. In my data science program, I was challenged and asked to over-explain my ideas because many of my male peers did not trust that my answers were valid. Although these environments were hostile and unwelcoming, I am thankful for the opportunity that I had to study actual technical academics. When I turned 26, I learned how immensely blessed I was to have had an excellent education that provided endless opportunities to care for myself. We live in a harsh world. My education was something that the world could never take from me, regardless of all the terrible things that I went through in my mid-20s. The technical content I had learned afforded me the ability to live a life I loved, as an independent woman. Some women do not have those sorts of options, which drives the purpose of my study. Mathematical knowledge has allowed me to compete in our cold world. I hope to inspire girls to gain technical knowledge to empower their independence. My most cherished belief is that all humans (and animals) deserve to live a life free of abuse. Through lucrative career options, women have more opportunities to live their best life.

Throughout my time thus far in education, I have seen how girls think that they are only allowed to do certain things. I was stubborn and independent enough to push through the comments and perceptions. However, do all girls have that grit? Should we expect girls to know that going against the grain will lead to a better life? The rhetoric needs to change, and the time is now. I hope this study can be a starting point for a larger conversation regarding female independence through gaining technology skills.

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List of Abbreviations

STEM	science technology engineering math
HSLS	high school longitudinal study
M	male
F	female

List of Symbols

M	mean
n	number of cases
se	sample error

Chapter 1: Introduction

There are significant gender gaps in students who enroll in technology-related degree programs and pursue technology-related careers in the technology industry. In particular, STEM, computer science, and data science are fields where men dominate the job market (Berman & Bourne, 2015). The gap between men and women in STEM, data science, and computer science is often due to women's limited computer literacy, computer-related experiences, encounters with stereotypes, and lack of positive learning experiences in technology courses (Crombie et al., 2002). Other researchers have investigated the contributing factors associated with the gender gap in data science, computer science, or science, technology, engineering, or mathematics (STEM) fields, including women's lack of personal interest in pursuing the field (Coyle & Liben, 2020), women's self-perception that they cannot be successful in the area (Kang et al., 2019), and the lack of humanity in those fields (Emeagwali, 2016). To achieve goals related to increasing the number of women in STEM fields, it is also essential for girls to develop a sense of belonging, feel supported by teachers, and be confident in their ability to pursue technology education and career fields (ASCD, 2019), all of which might be more likely to be achieved in single-gender, all-girl courses (Crombie et al., 2002; Pearl et al., 1990).

This study investigated young girls' perspectives of science and mathematics. Much of the STEM, data analytics, and computer science fields, including education and curriculum, are masculinized, focusing on examples, metrics, and characteristics that males are socialized to enjoy (Spaulding et al., 2020). This study examined girls' opinions and sentiments regarding computer science, the data science industry, STEM careers, and technology-based positions. The researcher aimed to dismantle the masculine stereotypes associated with computer science, specifically in data analytics (a subset of computer science) and STEM careers.

Statement of the Problem

The STEM, data science, and computer science industries provide cutting-edge opportunities, job security, high wages, and numerous opportunities for growth and advancement (Welsch & Winden, 2019). Women are underrepresented and structurally excluded in STEM, data analytics, and computer science, limiting their technological influence. Researchers expect the computing gap to grow between young men and young women (Guyen, 2016). Although women constituted 50.75% of the overall population in the U.S. and 56.5% of all undergraduates enrolled in higher education institutions in 2018, only 22.67% of full-time students in science and engineering degree programs were women. Only 19.9% of graduates in computer science programs were women in the same year (National Center for Education Statistics, 2020). The pipeline continues to narrow for women in computer science master's degree programs: 21.6% of doctoral degrees in computer science went to women in 2018—a total of only 426 women (National Center for Education Statistics, 2020).

Furthermore, only 23.9% of computer scientists employed in 2019 were women (National Center for Education Statistics, 2020). There are also disparities in income earned by men and women in computer science occupations: in 2019, the median salary of women in computer science occupations was $90,000 compared to $105,000 for men (National Center for Education Statistics, 2020). The economic potential is great for women if there is an upswing in their computer science career participation. If women hypothetically entered the field at a rate approaching 40%, the cumulative earnings for women would increase by $299 billion (Guyen, 2016).

Messages about pursuing STEM careers are communicated very early in life, specifically in gifts and toys (e.g., ©Legos versus ©Barbies) or the types of activities in which young men and young women are engaged. According to the American Association of University Women (AAUW, 2015), only 20% of students taking the AP Computer Science exam were women in recent years. As early as high school, schools steer girls to make choices that prevent them from computer science and data analytics. There are few role models for women employed in STEM fields, thus psychologically communicating to young girls that women can only work in specific career fields (Khan & Rodrigues, 2017). Suppose educators could market and administer programs that inspire young girls through rigorous academia and socialized topics for girls in our society. In that case, it may be possible to open up the world of computer science to a more significant number of women.

Researchers commonly have found that early socialization experiences, lack of mentorship or role models in STEM, data science, and computer science careers, and a chilly "climate" for women in computer science and data science contribute to disparities in women's decisions to pursue tech degrees (Stoeger et al., 2019; Walker & Dalmage, 2016; Young et al., 2019). Many scholars have focused on female-only classes to promote identity, togetherness, and a stronger STEM identity. Saujani (2017) collaborated with research institutes on a homogeneous grouping to encourage a more positive STEM identity for girls. The positive identity component is the most common theme in the computing gap. According to Kang et al. (2019), girls' self-perception was the strongest indicator of STEM education and career pursuits. Harmful stereotypes that label women in American society can significantly influence young girls' opinions of STEM fields (Michell et al., 2017). Some researchers believe that there are gender elements at play in terms of the disparities present for girls in data science and computer science coursework (Dare, 2015). The gender and cultural viewpoints have generated exciting research studies, but knowledge about factors that can encourage women to pursue STEM, data science, and computer science education and careers are still missing.

Purpose of the Study

This study explored whether there are significant gender differences between 11th grade students' perceptions of their science and math identity, their science and math self-efficacy, and their science and math utility. Math identity is a student's perception and views of others' perceptions of their identity in mathematics. Science identity is students' perfection and views of others' perceptions of his or her identity in science. Math self-efficacy is a scale of students' mathematics self-efficacy, with higher values representing higher self-efficacy. Science self-efficacy is a scale of science self-efficacy, with higher values representing higher self-efficacy. Math utility is a scale of the sample member's perception of the utility of mathematics. Science utility is a scale of the sample member's perception of the utility of science. There have not been similar studies related to this topic conducted previously.

Research Question

The research questions guiding this study are:

1. Is there a significant difference in math identity between males and females?
2. Is there a significant difference in science identity between males and females?
3. Is there a significant difference in math self-efficacy between males and females?

4. Is there a significant difference in science self-efficacy between males and females?
5. Is there a significant difference in math utility between males and females?
6. Is there a significant difference in science utility between males and females?

Hypotheses:

H1aa: There is a statistically significant difference between male and female students and their mathematics identity.

H1ao: There is no statistically significant difference between male and female students and their mathematics identity.

H1ba: There is a statistically significant difference between male and female students and their mathematics self-efficacy.

H1bo: There is no statistically significant difference between male and female students and their mathematics self-efficacy.

H1ca: There is a statistically significant difference between male and female students and their mathematics utility.

H1co: There is no statistically significant difference between male and female students and their mathematics utility.

H2aa: There is a statistically significant difference between male and female students and their science identity.

H2ao: There is no statistically significant difference between male and female students and their science identity.

H2ba: There is a statistically significant difference between male and female students and their science self-efficacy.

H2bo: There is no statistically significant difference between male and female students and their science self-efficacy.

H2ca: There is a statistically significant difference between male and female students and their science utility.

H2co: There is no statistically significant difference between male and female students and their science utility.

Significance

This study was critical because of the dire need for more computer science and data science professionals in the economy. The lack of women in computer science and data science hurts companies due to the lack of diverse perspectives and ideas (Nwankwo & Pisa, 2021). Company leaders hope to attract and retain more women in computer science to create a diverse workforce (Pearl et al., 1990). Data scientists and coders use their values to drive projects and analyses. Therefore, the current disparities are detrimental to our world's future discoveries because women are not being given equal representation in many decisions. Furthermore, gender disparities in computer science and data science can potentially lead to harmful policies for women (Nwankwo & Pisa, 2021). The problem of gender disparities in STEM careers have been ongoing; however, technological advances are beginning to overtake women-dominated positions like clerks and assistants (Nwankwo & Pisa, 2021). There exists a dire need to change the math, STEM, computer science, and data science skills gap. If women are not equipped with the necessary skills to compete in the computing workforce, they may lose their current roles and not have many options to make money.

Given the current wage gaps across all occupational areas (Nwankwo & Pisa, 2021), providing women with lucrative options to ensure independence and economic security has been shown to be essential. Women are more likely to be the heads of their households, thus increasing the importance of earning livable wages (National Center for Education Statistics, 2020). From an economic perspective, engaging more young women in computer science would level the wage gap when women and men choose various careers (Welsch & Winden, 2019).

This study provided insights for teachers and administrators who wish to use data science and computer science pedagogy to increase young women's recruitment and retention into data science classes, degree programs, and careers. An infusion of feminized thought into computer science and data science could prompt more girls to enter the lucrative market of the technology industry. Feminism can be a way to combat traditional gender and societal roles (Yenor, 2021). There has been substantial research regarding engaging more women in computer science and data science careers (Berman & Bourne, 2015). Despite many studies about creating interest for girls and women, researchers have not found any significant positive impact related to decreasing the gender gap in computing (Vitores & Gil-Juárez, 2016).

A specific curriculum can be fruitful in increasing young girls' computer science identity. Some research suggests that curricula can be more engaging to encourage women to pursue the field (Quesenberry, 2019). Not only does engagement matter, but so do persistence and grit in completing STEM tasks (Elective Staff, 2021). Self-efficacy, tied with determination, can positively impact girls' completion of STEM classes. Women are typically disadvantaged in technology careers because young women are less likely than young men to pursue computer science coursework in high school (Elective Staff, 2021). Setting goals involving computer science material was crucial in girls' desire to pursue data science degrees and career pathways (Wang & Degal, 2017).

Definition of Terms

Analytics. According to Oracle (2018), analytics involves processing data to interpret and analyze it. Analytics provides businesses with insights from collected data to make better business decisions.

Computer science: According to the Department of Computer Science at the University of Maryland (n.d.), computer science studies computers. There are many applications of computer science in various fields. The field requires adaptability, coding knowledge, and integration of many skills.

Data science: According to Oracle (2018), data science combines many skill sets into one position, including statistics, artificial intelligence, and coding. Data science involvessifting data from a database, cleansing it. aggregating it, and analyzing the meaning within the data.

Gender: According to the World Health Organization (n.d.), gender is a social construct that determines the actions of young men and young women. The construct of gender can vary depending on societal norms and culture. The constructs define how people act in social situations, relationships, and day-to-day life.

Mathematics identity: Math identity is a student's perception and views of others' perceptions of their identity in mathematics. The items related were statements such as "You see yourself as a math person" and "Others see me as a math person" (National Center for Education Statistics, 2016, p. 136).

Mathematics self-efficacy: Math self-efficacy is a scale of a student's mathematics self-efficacy, with higher values representing higher self-efficacy. An example of this variable is "You are certain that you can understand the most difficult material presented in the textbook used in this course" (National Center for Education Statistics, 2016, p. 136).

Mathematics utility: This variable is a scale of the sample member's perception of the utility of mathematics; higher values represent perceptions of more excellent mathematics utility. A sample item for this variable is "Do you see your math class as useful for a future career?" (National Center for Education Statistics, 2016, p. 136).

Science, technology, engineering, and mathematics (STEM): STEM fields use the acronym STEM. According to UC Berkeley (n.d.), STEM provides the United States with much intellectual prowess.

Science identity: Science identity is a student's perfection and views of others' perceptions of his or her identity in science. A sample item for this variable is "Others see me as a science person" (National Center for Education Statistics, 2016, p. 138).

Science self-efficacy: Science self-efficacy is a scale of science self-efficacy, with higher values representing higher self-efficacy. A sample item for this variable is "You are certain that you can understand the most difficult material presented in the textbook used in this course" (National Center for Educational Statistics, 2016, p. 138).

Science utility: This variable is a scale of the sample member's perception of the utility of science; higher values represent perceptions of more excellent science utility. A sample item for this variable is “Do you see your science class as useful for a future career?” (National Center for Education Statistics, 2016, p. 136).

Technology (tech) industry: According to Team Prosple (2020), the technology industry is the broad sector of business that deals with technology. The definition makes it quite clear that coding skill is not required.

Organization of the Study

Chapter 2 reviews the literature relevant to the research study thematically. In the literature review, the themes are societal gender bias in STEM fields, personal and family economics, resiliency, and strategies to support women in STEM. Chapter three contains the research methods and design, research questions, researcher positionality, sampling design, research setting, instrumentation and protocols, interviews, data collection, data analysis, and ethical considerations. The study findings from the research exist in Chapter four. Chapter five will expound on the implications of the investigation and future research suggestions.

Chapter 2: Review of Literature

Gender disparities in computer science and data science degree completion and career engagement have occurred for over four decades (Vitores & Gil Juárez, 2016). The biggest question in the research focuses on why the gender gap persists in STEM fields, including computer science and data analytics careers. Despite numerous attempts to develop expensive interventions and programs, girls' engagement in computer science and data science has remained the same or declined (Emeagwali, 2016; Payton & Berki, 2019). Over time, women have pursued post-secondary education, which contrasts with the percentage of computer science degrees awarded to women; these numbers declined from 27% in 1998 to 19.9% in 2018 (National Center for Education Statistics, 2020). In science and engineering, computer science is one of the lowest areas of female graduation (National Center for Education Statistics, 2020). Low graduation rates prompt a need for research and continued investigation regarding societal practices and norms perpetuating such a gap.

In science and engineering, women are significantly underrepresented (National Center for Education Statistics, 2020). Fewer women are pursuing STEM careers and attaining more college degrees in general, indicating that women are actively choosing to pursue interests outside of STEM, computer science, and data science. Underrepresentation in STEM, data science, and computer science leads to many long-term issues in companies. Over the last 20 years, fewer women have pursued mathematics and statistics degrees (National Center for Education Statistics, 2020). Lack of interest leads to assumptions regarding the gender disparities in the data analytics industry, such as mathematics and statistics, which are essential for this field. The literature review investigates the discrepancies within the STEM pipeline and proposes solutions to fill the gap.

Throughout the literature, common themes have surfaced to explain the computing gap. This literature review will focus on societal gender bias, isolation, barriers, gender roles, family economics, Title I schools, global poverty, and strategies to support women. The review will also focus on gender stereotypes, Title I funding inequities, and cultural barriers for women in STEM fields (Froelich et al., 2020; Hirn et al., 2018; Minnotte & Pederson, 2021). Economics can significantly impact girls' access to high-quality computer science and data science content (Guttman, 2021; Pan & Ye, 2017). Economics can be personal, familial, or school-based. Many families cannot afford to pay for additional STEM classes for their children (Walker & Dalmage, 2016). In addition, Title I schools often struggle with funding to provide adequate STEM education comparable to more affluent districts (Lin, 2008).

Gender bias can deter young girls from trying the cutting-edge computer science and data science fields. Due to social schemas regarding how genders should act and work, girls are frequently disinterested in the area because of the learned bias in social situations. Along with societal norms, personal attitudes can also contribute to how girls interact with data science and computer science content. Due to curriculum gaps and a lack of "girl-focused" tasks, STEM can disengage girls because of the lack of entry points. Additionally, this review will present gaps within the "leaky pipeline" model that future research studies can utilize.

Societal Gender Bias in STEM Fields

Societal views of gender roles have historically impacted young girls' willingness to participate in coding and data science activities (Kang et al., 2019; Stoeger et al., 2019;

Wei-Cheng Mau et al., 2020). The #MeToo Movement brought women's experiences forward in life and work, including the various inequities present to women (Matic & Jadhan, 2018). It has become more socially acceptable to discuss unfairness in the world to generate change openly. The exposure of gender bias instances has brought to light some potential reasons for a gender gap in the computing workforce (Berman & Bourne, 2015). Gender is utilized in society to normalize behaviors (Khan & Rodrigues, 2017). Pursuing coding and analytics education often appears impractical when girls do not consider computer science and data science as behavior within their reach.

How girls are discouraged or encouraged to seek computer science, and data science can significantly impact the likelihood of these girls entering the fields (Shein, 2018; Welsh & Winden, 2019). Many gender-specific discouragements begin early, even during children's natural acquisition of toys that include specific labels and packaging (Coyle & Liben, 2020). The socially constructed ideas regarding gender can cause girls to lack interest in STEM (La Paz, 2012). Many girls do not see women in social settings applauded or well-known for their STEM abilities, causing a bias regarding the attractiveness of a woman pursuing STEM as a career (Van Langen, 2015). Thus, socialization and cultural norms significantly impact girls' social identities.

Coding and data science environments have not welcomed women, which is a primary factor for women leaving the field altogether (Payton & Berki, 2019; Robnett & John, 2020; Shein, 2018). In the New Scientist Jobs STEM Industry Survey, 43% of women respondents revealed that they were victims of bias at work due to their gender (Li & Scientist, 2021). *New Scientist* (2020), companies, including small ones that would be typically inclusive, demonstrate gender bias. Bias is taught and learned through societal norms; female scientists face gender bias in grant reviews, and there is a significant funding gap in scientific research by gender (Matic & Jodhan, 2018). The relatively low number of female scientific researchers in higher education may be partly due to funding inequities or more profound problems.

Women find less favorable outcomes in patent processes than men (Matic & Jodhan, 2018). Again, in terms of novel discovery, women experience more stringent requirements throughout processes than their male counterparts. Although women typically outperform men in STEM studies, they underestimate their STEM abilities (Bloodhart et al., 2020), which explains the more stringent requirements for grant funding and patent acquisition. There is a significant pay inequality by gender in terms of STEM positions (Matic & Jadhan, 2018). The pay gap is quite substantial, and the reasons for the gap are not clear besides the allusion that gaps in employment due to family obligations lead to lower average wages for women over time.

Li and Scientist (2021) also noted the pay gap of 19% in current studies between men and women in STEM fields. All of these barriers could be deterrents for women in the STEM fields. According to Delaney (2018), the software demonstrates gender bias. The software bias indicates men's technological influence and women's lack of influence. Due to the bias in the field, experts have suggested that computer science and analysis courses should be all-female to increase girls' confidence in the area before entering the workforce (Crombie et al., 2002; Pearl et al., 1990; Saujani, 2019). In heterogeneous groups, women lack confidence in STEM fields when working with peers who do not support them. Due to the computing gap, some companies employ workforce initiatives to hire and promote more women. In workforce surveys, some men express frustration regarding these policies. When women are given opportunities due to a need for a more gender-balanced workplace, this can frustrate male employees (Crombie et al., 2002).

Thus, companies need a robust cultural shift to analyze bias and move towards a better collaborative environment (Berman & Bourne, 2015).

Frequently it is not girls' inability to understand STEM course materials that deters them from the field but rather a general lack of interest that stems from an absence of role models within the area (Coyle & Liben, 2020; Khan & Rodrigues, 2017; Pearl et al., 1990; Young et al., 2019). Girls' self-perception, or how they view themselves or the world around them, is the strongest indicator of STEM pursuit (Kang et al., 2019). According to the World Health Organization, gender constructs and societal norms create a person's view of themselves. The lack of humanity involved in STEM frequently drives women away due to the social constructs of being a woman (Emeagwali, 2016; Wei-Cheng Mau et al., 2020).

According to La Paz (2012), many girls and women state that a lack of interest in STEM comes from the missing component of helping others through the work involved in STEM. In many cultures, women are nurturers and exhibit kindness. In STEM fields, this is not a minor component of the curriculum taught in K-12 schools. In numerous research studies, researchers write that girls desire to be engaged in multi-disciplinary activities to serve others, but there is indeed a lack of curriculum for girls (La Paz, 2012; Phelan et al., 2017; Van Langen, 2015). The current curriculum disparities in schools pose STEM tasks that need to provide girls with the humanitarian aspects that stimulate their interests.

Harmful stereotypes that label women in American society can significantly influence girls' opinions of STEM fields (Michell et al., 2017). The culture of many engineering and science institutions is not female-friendly, thus decreasing female retention in both undergraduate programs and workplaces (Cohoon, 2001; Glass, 2017). Sexism and misogyny in the workplace drive women to quit (Li & Scientist, 2021). Frequently, women underestimate their abilities in STEM coursework despite outperforming their male counterparts (Blooheart et al., 2020). *New Scientist* (2020), children and family obligations are significant reasons women do not move up in STEM fields. Professional goals and personal values contribute to women's lack of interest in computing, and socialization for many women is a vital driving force behind a career choice (Spaulding et al., 2020; Wang & Degal, 2017). According to Bloodheart et al. (2020), peer-to-peer interactions can deter women from desiring to pursue STEM careers. Negative interactions among classmates can lead to women leaving the degree path. Environment and support are two vital components for women to feel that STEM careers can work for them.

Gender appropriateness is another element of societal bias that researchers investigated (Selimbegović et al., 2019). The division of household labor, career selection, and discrimination may explain why girls do not pursue STEM careers (Traylor et al., 2020). Due to how girls see themselves fitting into society, there are elements of bias that arise, which can potentially deter girls from pursuing STEM careers. According to Niese et al. (2019), people experience more job satisfaction when they do things they enjoy or find interesting. Although girls may see STEM content as attractive, expectations for success in STEM can influence effort and performance in STEM tasks (Selimbegović et al., 2019). Pre-existing beliefs can reconstruct memories, manipulating girls' ideas about fulfillment and happiness (Niese et al., 2019). Stereotypes regarding male and female interests may contribute to girls' lack of STEM engagement (Selimbegović et al., 2019)).

People typically use past domain knowledge to decide how to engage with life in the future (Niese et al., 2019). Thus, the mismatch of female gender identities and STEM interests may be causing the struggle for girls to identify with technical content (Selimbegović et al., 2019). Self-beliefs about a person's practical identity can be a form of bias that can alter memories and decrease motivation in certain areas (Niese et al., 2019). There should be interventions in place to target stereotypes that exist. Since much of this concept comes from societal norms of gender identities, there is a dire need for more concrete study in this area (Selimbegović et al., 2019). The construct of being a girl should not determine conformity to the stereotype that STEM is only for men (Selimbegović et al., 2019). This prevalent and pervasive idea will take time and effort to dismantle.

Isolation and Barriers

The underrepresentation of women in STEM research environments is due to significant turnover (Minnotte & Pederse, 2021). Since the 19th century, technical disciplines like mathematics have been spaces for White men (Borum & Walker, 2012). Although more women are entering technical fields, there is a need for informal practices to be evaluated to improve women's day-to-day experiences (Wright, 2016). Torre (2014) stated that there are various reasons women exit male-dominated occupations. Some examples cited in the research are a lack of collegiality, isolation, and poor relationships with department members (Minnotte & Pedersen, 2021). There is a need to create positive STEM workplaces for women to be recruited, promoted, and enter tenure (Minnotte & Pedersen, 2021). Informal interactions at work that are disempowering are influential in pushing women away from STEM fields (Wright, 2016). Women encounter numerous obstacles in male-dominated occupations regarding integration and acceptance (Torre, 2014).

Isolation and perceived injustice are positively associated with turnover in STEM fields and STEM education (Minnotte & Pedersen, 2021). Women sometimes have little to no contact with other women in male-dominated fields, leading to feelings of isolation and distress (Wright, 2016). Researchers show that women drop out of mathematics graduate school due to a lack of support (Borum & Walker, 2012). Sometimes, departments struggle with the stigmatization of needing work flexibility to support their families (Minnotte & Pedersen, 2021). In addition, women leave gender-atypical positions more often than men (Torre, 2014). Department chairs can build staff relationships to decrease turnover and promote supportive departments and workplaces (Minnotte & Pedersen, 2021). As Wright stated, organizations should address workplace processes that enable retaining female employees. Companies have increased role models to mentor new women as they come into various departments (Minnotte & Pedersen, 2021).

Gender Roles

Gender inequality is a worldwide issue where many women face low-wage, high-turnover labor as their only option to make a living (Folberg, 2020). Occupational gender stereotypes exist through unequal access to control over societal resources (Froehlich et al., 2020). Stereotypes impact women's career goals due to cultural attitudes and intentions (Von Hippel et al., 2011). Influential people perpetuate these stereotypes in organizations and societies (Vesvio et al., 2005). Psychology can impact gender equality and stereotypic attributions for "success" that fit gender stereotypes (Folberg, 2020). Values from individuals and societies can create the gender split seen in labor data worldwide (Froehlich et al., 2020). For example, women frequently are perceived as less preferred hires in male-dominated fields due to stereotypes and therefore are provided with fewer opportunities (Von Hippel et al., 2011). Stereotypes often prevail through influential members of society and have significant consequences for low-income people (Vescio et al., 2005).

It is critical to consider how men and women acquire ideas about gender roles from media outlets (Wehnhold & Hansen, 2021). Goal congruence theory can explain some of the differences in STEM careers by gender (Folberg, 2020). Media creates a continuation of bias to maintain social order. For example, the media can negatively display feminism and create a bias toward assertive women (Wenhold & Harrison, 2021). Powerful women who show more masculine qualities can be less hireable or appealing due to gender norms.

Self-promotional women receive labels within society (Folberg, 2020). In addition, bias communicated in media messages leads women to struggle with marriage, parenting, and careers unless they comply with the media's ideas regarding their place (Wenhold & Harrison, 2021). Gender differences are socially cultivated and frequently used to control populations to act in specific ways (Wenhold & Harrison, 2021). The perception of work values for women versus men are quite different, with women placing more importance on family time and men placing more value on pay (Sallop & Kirby, 2007). These values are taught early in life, with many young girls deciding to pursue more "feminine" careers like teaching because of the permeating idea that they need summers off to care for their children (Seong Won Han & Borgonovi, 2020). Internalized gender stereotypes can prompt people to select gender role career paths that society is comfortable with (Froehlich et al., 2005).

Family career balance is challenging in all fields and has impacted those with privilege the most (Lynn et al., 2018). The social cognitive theory provides context to examine gender norms in life and the media (Wenhold & Harrison, 2021). Stereotypes prevail regarding male and female skills, roles, and fair pay (Sallop & Kirby, 2007). These stereotypes, perpetuated in education as early as preschool, prevent young girls from feeling comfortable pursuing STEM as a female (Seong Won Han & Borgonovi, 2020). The family and career expectations for girls, established in childhood, lead fewer women to pursue STEM careers and scientific research. Women frequently give up opportunities and monetary gain for the group's betterment (Sallop & Kirby, 2007). In addition, women are more dependent on family support than men regarding career advancement and goals (Lynn et al., 2018).

Unequal pay in STEM fields perpetuates the gender role idea that STEM positions are only for men. The pay differences may be due to the different fields men and women pursue (Sallop & Kirby, 2007). Structural challenges can destroy the success of women across various STEM disciplines due to a lack of support structures which leads to lesser pay (Lynn et al., 2018). Laws ensure gender pay equity for jobs requiring similar skills and duties (Sallop & Kirby, 2007). The Equal Pay Act of 1963 made pay discrimination by gender illegal (Sallop & Kirby, 2007).

Nevertheless, women that enter career fields typically dominated by men continue to earn less than their male counterparts (Sallop & Kirby, 2007). Women in scientific and research environments have a much harder time with work-life balance than men, leading to less promotion and access to tenure (Lynn et al., 2018). The daunting task of maintaining a scientific career with family responsibilities is off-putting to many women due to the stress and lack of balance such a life would provide.

Gender stereotypes are similar globally since women and men tend to occupy similar roles despite cultural practices (Folberg, 2020). Nevertheless, in some religions, women are banned from paid work and have more restrictions on their lives in general (Froelich et al., 2020). Men usually earn more and are promoted faster than women across cultures (Von Hippel et al., 2011). Women are often concerned about being evaluated based on their gender in work settings seeking promotion or tenure (Von Hippel et al., 2011). Women across cultures are stereotyped as less qualified for male professions than men (Froehlich et al., 2020). The perceived lack of ability and fit leads to less promotion and compensation for women in male-dominated fields, specifically STEM careers (Froelich et al., 2020). This perception leads to lower performance of women due to stress (Von Hippel et al., 2011). Stereotyping processes operate in various ways to influence behaviors (Vescio et al., 2005). Power is a strong perpetrator of stereotypes to serve dominant social groups and maintain unjust systems that possess power over most people within a society (Vescio et al., 2005).

Personal/Family Economics

Parental education and involvement drive participation in technology classes; parental awareness also increases the perceived value of computer science and data science programming (Khan & Rodrigues, 2017; Walker & Dalmage, 2016). Title I school populations contain 40% or more impoverished students (U.S. Department of Education, 2018). In Title 1 schools, the lack of parental engagement due to language barriers and family economics significantly impacts girls' engagement with data science and analytics (Talaue, 2014). Cultural barriers and aversion to technology hinder young girls' ability to immerse themselves in the content (Van Langen, 2015). In many households, girls babysit, cook, and clean, so education is not a priority (Van Langren, 2015). Gender stereotypes and sociocultural ideas regarding women's roles often prevent families from understanding the importance of girls learning STEM content (Van Langen, 2015).

"Economic, educational capital," is a cyclical pattern in which citizens without knowledge of a field continuously miss out on the benefits (Stoeger et al., 2019, p. 78). Lack of parental exposure or understanding results in girls losing opportunities to gain skills in data science and computer science (Doerschuk et al., 2016). Due to lack of exposure, many parents and girls lack the engagement necessary within the field of computer science to recognize the economic potential in the area, which exacerbates economic divides in terms of technology skills. Family income also impacts girls' abilities to pursue data science and computer science in college. Significant opportunity gaps exist in equity and access between high and low socioeconomic status (Talaue, 2014).

Research studies show a correlation between exposure to the scientific process and increased interest in pursuing STEM higher education for at-risk youth (Doerschuk et al., 2016). Exposure to the scientific research process is a significant advantage that many young people are never provided due to access issues. Suppose parents do not recognize that this type of exposure is essential. In that case, there truly is no advocate communicating this necessity to teachers and schools, which leads to the blindness of what students need and requirements and a lack of accountability for schools to provide students with necessary classes for the 21st century. If parents do not have information on STEM education, the schools will not feel accountable for ensuring that the students receive a high-quality program.

Openly sharing success stories can promote parental openness to computer science and data science classes to raise awareness (Frieze & Quesenberry, 2019). If parents knew the value of the coursework and the growth potential for their children, they might better understand the importance of involvement in data science and coding. Summer camps are vital to engaging girls in various STEM areas. Courses can successfully transition young girls from being wary about STEM to feeling confident in their abilities to pursue it (Doerschuk et al., 2016). In addition, parents can learn about the tremendous economic potential for girls who enter the fields of data science and computer science. Yonghong Xu (2015) completed a study of earning differentials across ten years. The longitudinal study demonstrated a significant gap between men's and women's earnings after entering the workforce. If parents knew the long-term impact of women not entering the STEM field, they might be more open to supporting girls in pursuing STEM content.

The inequitable relative truth regarding computer science and data science engagement is that technical training requires increased funding for charter schools and after-school programming (Talaue, 2014). A high-quality STEM curriculum should be occurring at school to alleviate the family access burden. National policies are a way to ensure that equity and access for all children attending public schools are maintained (Talaue, 2014). In addition, federal policy should address the content-quality issue to ensure that all schools provide quality content inspiring to girls. If school funding is restricted and training is unavailable, there is less likelihood that girls will engage in computer science and data science at school.

The situation is even worse in schools with fewer economic resources. Title 1 school systems offer more irregular coding and data science programs due to the immense costs of operating elite technology camps (Crombie et al., 2002; Khan & Rodrigues, 2017). The population of Title 1 schools often sees data science and coding as an afterthought rather than as necessary as other school priorities. However, this results in girls losing exposure opportunities to the field. In addition, girls are more at risk of becoming economically dependent on others when they do not learn technical skills (Van Langen, 2015). To provide more economic returns on post-secondary education, girls can engage with STEM content to motivate their desire to work in the field.

Ideally, all students would have the same access to resources and opportunities to make the best decisions for the future (Talaue, 2014). In terms of schooling and pursuing STEM degrees, economics can be a significant factor for women, especially attending a prestigious college (Yonghong Xu, 2015). In technical content, company tenure and the university level earned can significantly impact salary and potential growth. Nations can enact better policies to focus on scholarship opportunities for girls who lack the economic capital to attend the college of their choice (Talaue, 2014).

Title I Schools and Funding

Poverty powerfully shapes how students live and interact with instruction (Hirn et al., 2018). Classroom teaching practices highly impact children's learning abilities (Hirn et al., 2018). Severe inequity occurs in state Title I funding allocation (Lin, 2008). For example, New York has a much higher spending per pupil nationally but spends $1,000-$2,000 less per pupil per child in poverty (Lin, 2008). Schools worldwide are seeing an increase in needy children and budget uncertainty (Lewis, 2006). Increases in poverty lead to immense challenges for educators and schools to provide children with what they need. Politicians debate over Title 1 funding and "portability" across districts (Ujifusa, 2015).

The Obama administration was against this idea of portability since it would take federal funds away from the highest poverty districts (Ujifusa, 2015). Since high-poverty districts already employ the least experienced teachers with the lowest levels of education and retention, Title 1 funding portability could be catastrophic for some of the poorest schools (Hirn et al., 2018). Poor children face many disadvantages regarding personal poverty and the community's poverty (Liu, 2008). Thus, funding away from poor children seems counterintuitive to the schools' needs in general.

In addition to Title I funding, states must provide improvement services to all schools needing improvement (Lewis, 2006). Cities like Chicago and Philadelphia feel the most impact from Title I funding inequities due to high poverty and competitive charter school options for families (Ujifusa, 2015). Title funding is around $3,000 per year (Ujifusa, 2015). Schools in poverty that lose this funding will face significant hardships. The government now requires schools to tutor children to close the achievement gap (Lewis, 2006). The effects of poverty are significant and challenging to overcome (Hirn et al., 2018). Concentrated poverty significantly impacts school results (Liu, 2008). With poverty increasing and funding stagnant, schools are challenging (Lewis, 2006). No Child Left Behind allowed students to transfer to high-performing schools from low-performing districts to provide families with better schooling options (Lewis, 2006). Despite various options to give children in poverty a better education, one of the most significant indicators of students' engagement with curriculum drives achievement (Hirn et al., 2018).

Global Poverty and Economic Dependence for Women and Girls

Across the globe, numerous girls are held back from education due to their gender (Pan & Ye, 2017). In Afghanistan, girls are not allowed to attend school due to the Taliban's rules (Guttman, 2001). In addition, girls account for 60% of the 113 million estimated out-of-school children (Guttman, 2001). In many countries, girls are encouraged to marry early as a safety tactic (Maclin et al., 2020). According to Human Rights Watch in South Africa, sexual violence and abuse significantly impact girls' access to quality education (Guttman, 2001). Girls living in poverty have a weakened educational unit due to their parents working significant hours to support the family (Pan & Ye, 2017). Many girls drop out of school due to parental poverty in locations where traditional cultural values are still strong (Guttman, 2001).

Women who try to move to urban environments with more opportunities face violence (Maclin et al., 2020). Despite the good intentions of education in general, it can sometimes be exploitative to serve the purpose of the economy at large (Pan & Ye, 2017). Globally, leaders recognize the need for all children to complete primary education (Guttman, 2001). According to Guttman (2001), waiving school fees still does not ensure that all girls will go to school since parents would lose out on the value of the girls' labor if they attend school. Significant work hours of parents contribute to little socialization of children (Pan & Ye, 2017). Also, violence and unstable, safe transportation methods pose barriers to girls' access to education. Parents and communities can have a voice in school improvement measures to provide more girls with educational opportunities worldwide (Guttman, 2001).

Many governments cannot protect women in cities where unsafe conditions exist (Maclin et al., 2020). Growing unemployment and increasing women's economic insecurity are problems (Angel, 2015). Violence has increased women's economic dependence (Basu & Famoye, 2004).

Women accept acts of violence to avoid future perpetration from attackers (Maclin et al., 2020). Economic peril significantly impacts girls' educational opportunities due to a lack of support from family (Pay & Ye, 2017). Socioeconomic inequalities create vulnerabilities for women to be abused and controlled (Antai et al., 2014). About 75% of women 18 and older have experienced sexual harassment (Traylor et al., 2020). Many women lack awareness of their rights or work opportunities (Zenebe Ede'o et al., 2020).

The feminization of poverty pushes women into low-paying or unpaid homework (Zenebe Ede'o et al., 2020). Economic dependence is associated with the violent nature of a relationship (Basu & Famoye, 2004). Many factors can contribute to financial support, like education, employment, and spouse/partner dynamics (Antai et al., 2014). In addition, many women must adapt to environments and compromise their self-respect and health to survive (Fathima et al., 2020).

Due to a need for a supplemental workforce in low-paying positions, many societies are interested in women assuming the economic roles of men while being trapped in their traditional roles in the home (Zenebe Ede'o et al., 2020). Patriarchal structures fall at the expense of women (Zenebe Ede'o et al., 2020). Unfortunately, the more economically dependent a woman is on her partner, the more violence she experiences in the home (Basu & Famoye, 2004). Socioeconomic inequalities make women vulnerable to abusive relationships that limit access to finances (Antai et al., 2014). As a form of blackmail, women know that if they leave a relationship, they will face economic hardship and loss due to the unequal power in a society that women possess (Antai et al., 2014). Since women engage in household responsibilities, this stunts their ability to fully participate in the economy to foster independence (Basu & Famoye, 2004).

Some partners control a woman's ability to acquire resources, thus limiting their financial freedom (Antai et al., 2014). Partners may monitor how every financial transaction occurs, cause chaos in a woman's employment situation, or harass her about spending money. Economic dependence puts women under their partner's control since women are less likely to leave a partner if they lack financial means (Basu & Famoye, 2004). Training women in financial literacy skills and health can reduce sexual harassment; this has also been suggested to empower women to be more economically independent (Traylor et al., 2005).

Strategies to Support Women in STEM

Various strategies can support women in STEM. In this section, different support elements include mentorship, positive sentiment, and curriculum. These methods can engage women in STEM.

Mentorship

Women face more hardships and uphill battles than men due to underrepresentation in the workplace (Traylor et al., 2020). The high workload in STEM careers and family responsibilities can lead to significant stress; female scientists have fewer publications than men in STEM fields (Fathima et al., 2020). There are many challenges female scientists and researchers face at work (Fathima et al., 2020). A focal point noted within the literature describing how to improve societal gender norms is mentorship. Women are underrepresented in business, STEM, and entrepreneurship across all industries (Traylor et al., 2020). Positive mentorship experiences can attract and retain women in coding and data science careers (Stoeger et al., 2019; Walker & Dalmage, 2016; Young et al., 2019). Mentorship can help attract girls to coding and data science, creating content with a social purpose. Women's lower representation in science and research leads to fewer role models (Fathima et al., 2020). Many articles reference the individualization necessary to appeal to girls pursuing STEM careers. Much of the support needed cannot have a one-size-fits-all approach because gender and life experience significantly impact the support individuals require (Herman et al., 2019).

Makerspaces

Makerspaces can engage girls in projects meant to change the world (Sheffield et al., 2017). In various studies of makerspaces, physical engagement with hands-on material in collaborative environments has shown positive results for girls. Learner-centered teaching, while focusing on unique tools like 3-D printers and electronics, can increase girls' interests in STEM (Kumpulainen & Kajaumaa, 2020). Through an immersive process, makerspaces can engage young girls through interdisciplinary activities that involve reading, writing, and problem-solving (Cierciersky & Styers, 2020). Makerspaces should enhance the educational experience for students and staff (Jones, 2020). Although there are tensions between traditional schooling methods and creative design education, design projects can inherently motivate students to see their potential in the field of STEM (Kumpulainen & Kajaumaa, 2020). Many skills are developed from planning, building, and reflecting on designs (Cierciersky & Styers, 2020). To engage girls in makerspaces, community members can be excellent assets in developing the projects for students to complete (Jones, 2020).

With more robust female representation in curriculum design, girls are more likely to feel encouraged to contribute to projects (Cierciersky & Styers, 2020). Schools should tap into grant funding for special projects to ensure they can occur (Jones, 2020). Due to the financing, there should not be a lack of makerspace access since many grants are available to schools. Since multiple dynamics drive students' engagement, makerspaces should critically prompt students to think and collaborate (Kumpulainen & Kajaumaa, 2020). Educational balance is one of the great benefits of makerspaces. There is a dichotomy between traditional schooling and empowering learning experiences that must be addressed within school systems to ensure that makerspaces have a place in students' daily learning regimens (Kumpulainen & Kajaumaa, 2020).

Positive Sentiment

Girls exhibit a more positive sentiment toward computer science and data science when an aspect of "giving back to the community" is present (Jezierska, 2016). Teachers can enhance girls' STEM interests by requesting solutions to solve world problems that stimulate girls' curiosity and desire to help others (La Paz, 2012). In addition, adequate exposure to science content and inquiry is essential in pulling girls into STEM arenas (Phelan et al., 2017). Underexposure to problems relevant or interesting can cause girls' interests in STEM to wane. Girls' interests in STEM gradually fade as they age, with fewer and fewer women entering STEM as they enter higher education (Van Langen, 2015). To change this narrative, teachers can foster the internal strengths of girls, such as confidence, work ethic, and collaboration (La Paz, 2012). If refocusing on STEM content is not a priority, the labor market will likely continue to display the gender gap (Van Langen, 2015). Teachers can significantly impact this problem by posing hands-on activities and labs to increase girls' confidence and engagement with STEM activities (Phelan et al., 2017). Girls can build trust and proficiency in STEM-related disciplines with more attention. Girls prefer to focus on their community and give back when they work (Johnson et al., 2021).

Curriculum

Teachers can allow creative freedom for girls to design and experiment with topics that interest them, which involve STEM (La Paz, 2012). In terms of the labor market, education needs to continue to rethink and redevelop curricula to encourage young girls to pursue STEM careers. Every organization can benefit from more diversity and generating interest in girls for STEM content significantly impacts their likelihood of entering the field (Van Langen, 2015). With a better-designed curriculum that appeals to girls, schools can recruit and retain future STEM workers through hands-on content that powerfully speaks to girls (Phelan et al., 2017). With a more hands-on curriculum to increase confidence, more girls and families can find STEM more welcoming and possible for girls (Johnson et al., 2021).

Positive imagery regarding women in STEM would increase girls' willingness to pursue STEM careers (Payton & Berki, 2019). With more support for girls following STEM, girls can feel more supported in pursuing technical degrees (Johnson et al., 2021). Since STEM environments are more male-oriented, girls have expressed that familial support is crucial for their emotional well-being as they pursue STEM content (Johnson et al., 2021). Supportive methods can be employed at companies to assist women with balancing work and home life (Herman et al., 2019). The model, which was flexible, adaptable to circumstances, and blended, provided working women with a supportive structure for growth and upward movement while navigating the stresses of family life (Herman et al., 2019).

If more families knew about inclusive opportunities for women to have a family life and a career within STEM, perceptions of the career field for women might change (Johnson et al., 2021). Creating a positive conversation regarding women's STEM opportunities will create less stress for women navigating taking care of their families while also having a livelihood. Women struggle to find high-paying jobs in STEM if they take a career break for family matters (Herman et al., 2019). Women make $0.82 for a man's dollar (Traylor et al., 2020). Innovative feminist pedagogy and programming can expand support for women in STEM to enhance women's opportunities (Herman et al., 2019). Self-confidence, dedication, and hard work are the most commonly adopted strategies for women to adopt to cope (Traylor et al., 2020).

Conclusion

The research regarding girls' participation in STEM fields is thematic. Pay disparities persist in STEM fields (Traylor et al., 2020). In addition, to pay differences, women are vastly underrepresented in STEM fields (Fathima et al., 2020). The main counterpoints found that the themes encourage researchers to view this problem with a fresh outlook (Vitores & Gil-Juárez, 2016). Researchers should not oversimplify the solution by stating we "need a female curriculum" but instead systematically change the current culture underlying the problem (Frieze & Quesenberry, 2019, p. 25). When we label women and minorities as "deviant" from the pipeline, we fail to address the cultural issues that lead girls to avoid computer science (Vitores & Gil-Juárez, 2016, p. 670). Corporations can bring positive STEM experiences to girls from low-income communities as part of this outreach. With positive mentorship, schools can plant seeds to inspire all children that STEM is a viable option regardless of background.

It is hard to envision something that one cannot see. Bringing young women into camps that inspire computer science careers could prove immensely beneficial. A cultural change will require more research regarding mentorship programs, all-female classes to build confidence, and a historical remembrance of women who can inspire future STEM workers. Thus, the need for a way to engage young girls in STEM content appeared throughout the literature review.

Chapter 3: Methodology

This quantitative study aimed to understand whether there are gender-based statistically significant ($p < 0.05$) differences in 11th grade students' perceptions of mathematics and science identity, mathematics and science self-efficacy, and mathematics and science utility. The researcher assumed that cognition and behavior are predictable and explainable (Johnson and Christensen, 2014). The chapter will include assumptions and detailed methods (Creswell, 2013). Throughout the study, the researcher utilized literature and best practices to drive the analysis of all data. In addition, the research study was designed to formulate conclusions that can be used to address the gender gaps in computer science, data science, and STEM careers (Kumar, 2014).

The study utilized traditional quantitative methods that have been well-documented in history (Little, 2014). This topic was driven by discrepancies in math and science identity and self-efficacy between young men and young women, as demonstrated in the literature review (Johnson and Christensen, 2014). Since the STEM gap between young men and young women is an evidence-based problem, research is a way to collect information to better understand the variance in mathematics and science identity, self-efficacy, and utility between young men and young women (Kumar, 2014). There continues to be a need for applied research to answer the practical questions surrounding the significant differences in identity, self-efficacy, and utility between young women and young men (Johnson and Christensen, 2014). The research questions investigated if there was a significant difference between young women and young men in science and math identity, self-efficacy, and utility; within this study, the researcher investigated the differences in students' perceptions of their math and science identities, self-efficacy and utility (Creswell, 2013).

Purpose

The research questions explored students' perceptions regarding mathematics and science identity, self-efficacy, and utility in 11th grade. This study examined differences in young men and young women's perceptions of math and science identity, self-efficacy, and utility through *t*-tests. The research sought to determine if a significant difference exists between math and science identity, self-efficacy, and utility. (Johnson and Christensen, 2014). The study's sample included more than 20,000 participants, which occurred in 2009 (National Center for Educational Statistics, 2016). The large sample size and sampling methods may have reduced bias within the results and increased reliability. Within the 2012 follow-up study, 20,592 students were eligible to take the survey. The questionnaire explored many topics, including high school attendance, grades, school experiences, demographics, family background, and admissions tests.

Research Design

Research design is the blueprint to carry out a study and the plan to obtain answers; the research design creates an environment to deductively test the relationships between variables in the study (Creswell, 2013; Johnson and Christensen, 2014; Kumar, 2014). The research design used the postpositivist worldview, representing the traditional form of research where observation and measurement occur (Creswell, 2013). Students within the study created knowledge of their world throughout schooling. This study used secondary cross-sectional data from the High School Longitudinal Study (National Center for Educational Research; HSLS:09). The researcher investigated whether there are significant differences in young men and young women's math and science identities, self-efficacy, and utility as measured in the High School Longitudinal Study (Christensen, 2014; Johnson & Little, 2014).

Instrument

The U.S. Department of Education began the High School Longitudinal Survey (HSLS:09) by surveying 9th-grade students, parents, administrators, math/science teachers, and counselors in 2009-2010 (National Center for Educational Statistics, 2016). High school students' perceptions were the primary purpose of the survey and subsequent research (United States Department of Education, 2016). Students sampled in the base year were selected using a stratified sampling design. The study implemented a follow-up questionnaire in the Spring of 2012 when the original HSLS:09 participants were in 11th grade (National Center for Educational Statistics, 2016). The research questions in this study utilized the 2012 results of the HSLS:09 to examine 11th-grade students' perceptions of their math and science identity, self-efficacy, and utility.

The questionnaire was delivered via the internet and contained questions such as demographics, attendance, gender, future preparations, post-high school plans, influences on thinking, expectations, behavior, and courses taken in math and science. The survey had a design that allowed students to answer the questions with the opportunity to complete the follow-up survey via the web, phone, or in person. Supervisors were hired to administer the tests and were required to complete training to participate. The on-site survey administrators received $100 in compensation with the ability to earn an additional $50 depending on students' participation. Students who participated received $10 upon completing the survey (National Center for Education Statistics, 2016).

Sampling Procedures

The HSLS:09 study was conducted by the non-profit organization RTI International for the National Center for Education Statistics (NCES) in response to the Education Sciences Reform Act of 2002 (20 U.S.C. 1221e). The longitudinal study examined students in secondary and postsecondary environments. The HSLS:09 was the fifth and only ongoing survey that investigates the transition of youth from secondary to post-secondary education (National Center for Educational Statistics, 2016). The survey was field-tested using 24 schools and over 500 students. The field test was used to examine detectable non-response bias in variables. The field test investigated non-response, test-retest reliabilities, and scale reliabilities. Items chosen for the final questionnaire came from an item response theory technique (National Center for Educational Statistics, 2016).

The base year survey included data collection on students and a math skill measurement. A full list of topics covered can be found in the HSLS:09 Base Year Data File documentation (Ingels et al., 2011). The first follow-up was in the Spring of 2012 when most of the sample was in the 11th grade. The sample members did not need to be on-grade level or enrolled to be in the study. The base year themes were utilized, with additional topics appropriate for students entering their final year of high school. The HSLS:09 Base Year to First Follow-Up Data File described, in detail, the nature of the follow-up survey (Ingels et al., 2013).

The base year of the High School Longitudinal Study, 2009-2010, used a stratified, two-stage random sample for the first state (National Center for Education Statistics, 2016). The study targeted Grade 9 students in the fall who attended a public, charter, or private high school in the United States. The student population was then chosen from the random sampling for the second stage. For the follow-up survey in 2012, only schools and students were eligible for the survey if they completed the base survey. There were 10 states represented in the data. The sample contained 25,185 students enrolled in grade 9 and eligible to take the survey, and 20,592 students participated in grade 11 with the follow-up survey. This study investigated the responses from grade 11.

Participants were taking math classes in the Spring of 2012 that included at least one of the following: Algebra III, Trigonometry, Precalculus or Analysis and Functions, Advanced Placement (AP) Calculus AB or BC, Other Calculus, AP Statistics, Other Stats or Probability, International Baccalaureate (IB) Mathematics Higher Level (National Center for Education Statistics, 2016). In addition, participants were taking a science course during the Spring of 2012, including at least one of the following: International Baccalaureate (IB) Anatomy or Physiology, Chemistry III, Advanced Placement (AP) Chemistry, Other biological sciences like botany, marine biology, zoology, International Baccalaureate (IB) Chemistry, Advanced Placement (AP) Environmental Science, International Baccalaureate (IB) Environmental Systems and Societies, Physics II, Advanced Placement (AP) Physics B or C, Other earth or environmental sciences such as ecology, geology, oceanography, or meteorology, 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 courses, An engineering course such as engineering robotics, aeronautical, mechanical or electrical, other science, computer science or engineering course (National Center for Educational Statistics, 2016).

The study's credibility relied on the quality of the procedures used when selecting the sample (Roberts & Hyatt, 2019). HSLS:09 utilized a stratified, two-stage random sample design. The target population was all interested schools of 9th grade students in the 50 states and the District of Columbia in the Fall of 2009. In addition to eligibility, the National Science Foundation asked for design augmentation within California, Florida, Georgia, Michigan, North Carolina, Ohio, Pennsylvania, Tennessee, Texas, and Washington. More details can be found in the HSLS:09 Base-Year Data File Documentation (Ingels et al., 2011). Since the study was quantitative, the larger the sample, the more representative it was of the total population (Roberts & Hyatt, 2019). Student participants completed an in-school survey and mathematics assessment in 2009. No new schools were added to the 2012 survey.

Sample

The survey population included students who participated in the base year of the High School Longitudinal Study, 2009-2013 (National Center for Education Statistics, 2016). The dataset used comes from existing data on a follow-up HSLS:09 survey. Of the 939 eligible public, charter, and private schools from all states and the District of Columbia, 904 of the schools participated, 25,184 students were eligible in 9th grade, and 20,594 11th-grade students participated.

Research Questions and Hypotheses

The research questions guiding this study were:

1. Is there a significant difference in math identity between males and females?
2. Is there a significant difference in science identity between males and females?
3. Is there a significant difference in math self-efficacy between males and females?

4. Is there a significant difference in science self-efficacy between males and females?
5. Is there a significant difference in math utility between males and females?
6. Is there a significant difference in science utility between males and females?

Hypotheses:

H1a: There is a statistically significant difference between male and female students and their mathematics identity.

H1o: There is no statistically significant difference between male and female students and their mathematics identity.

H2a: There is a statistically significant difference between male and female students and their mathematics self-efficacy.

H2o: There is no statistically significant difference between male and female students and their mathematics self-efficacy.

H3a: There is a statistically significant difference between male and female students and their mathematics utility.

H3o: There is no statistically significant difference between male and female students and their mathematics utility.

H4a: There is a statistically significant difference between male and female students and their science identity.

H4o: There is no statistically significant difference between male and female students and their science identity.

H5a: There is a statistically significant difference between male and female students and their science self-efficacy.

H5o: There is no statistically significant difference between male and female students and their science self-efficacy.

H6a: There is a statistically significant difference between male and female students and their science utility.

H6o: There is no statistically significant difference between male and female students and their science utility.

Variables

The variables were statements from the High School Longitudinal Study, 2009-2013 codebook descriptions (National Center for Educational Statistics, 2016). The measures were constructs within the HSLS:09.

Dependent variables

Math identity was measured with the statements “You see yourself as a math person” and “Others see me as a math person.” The items were scaled “1” = Strongly agree, “2” = Agree, “3” = Disagree, and “4” = Strongly disagree. Those who had higher values had a higher math identity. This variable was created through principal components factor analysis, weighted, and standardized to a mean of 0 and standard deviation of 1. Only respondents who provided complete responses were assigned a scale value. The scale's reliability coefficient (alpha) was 0.65 or higher, with a Cronbach’s alpha score of 0.88 (Ingels et al., 2013). The mean of math identity was -0.78, and the standard deviation was 2.63. 57% of young men and 42% of young women strongly agreed that they were seen as math people.

Math self-efficacy was measured with the following statements:

- “I am confident I can do an excellent job on my (Spring 2012) math tests”

- “I am certain I can understand my (Spring 2012) textbook”
- “I am certain I can master skills taught in my (Spring 2012) math course”
- “I am confident I can do an excellent job on my (Spring 2012) math assignments.”

The items were scaled “1” = Strongly agree, “2” = Agree, “3” = Disagree, and “4” = Strongly disagree. The variable was created through principal components factor analysis, weighted, and standardized to a mean of 0 and standard deviation of 1. Only respondents who provided complete responses were assigned a scale value. The coefficient of reliability (alpha) for the scale was 0.65 or higher, with a Cronbach’s Alpha score of 0.89 (Ingels et al., 2013). The mean of math self-efficacy was -1.28, and the standard deviation was 3.16. Within the study, 55% of young men and 45% of young women believed that people could learn to be good at math.

Math utility was measured with the following statements:

- “I think that math is useful for everyday life”
- “I think math will be useful for college”
- “I think that math is useful for my future career”

The items were scaled “1” = Strongly agree, “2” = Agree, “3” = Disagree, and “4” = Strongly disagree. Higher values represent perceptions of more excellent mathematics utility. The variable was created through principal components factor analysis, weighted, and standardized to a mean of 0 and standard deviation of 1. Only respondents who provided complete responses were assigned a scale value. If the student was not taking a fall math class, this variable was set to -7. The coefficient of reliability (alpha) for the scale was 0.65 or higher, with a Cronbach’s alpha score of 0.82. For more information on this scaled score, please see chapter 5 of the Base-Year Data File Documentation (NCES 2011-328; National Center for Education Statistics, 2011). The mean of math utility was -1.55, and the standard deviation 3.20. 52% of young men and 48% of young women see math as beneficial for their future (Appendix C).

Science identity was measured on a scale including “1” = Strongly agree, “2” = Agree, “3” = Disagree, and “4” = Strongly disagree. Sample members who agreed with the statements “You see yourself as a science person” and/or “Others see me as a science person” would have higher values. The variable was created through principal components factor analysis, weighted, and standardized to a mean of 0 and standard deviation of 1. Only respondents who provided complete responses were assigned a scale value. The scale's reliability coefficient (alpha) was 0.65 or higher, with a Cronbach’s alpha score of 0.89. For more information on this scaled score, please see chapter 5 of the Base-Year Data File Documentation (NCES 2011-328; National Center for Education Statistics, 2011). The mean of science identity was -0.79, and the standard deviation was 2.66. 53% of young men and 47% of young women saw themselves as science people.

Science self-efficacy was measured with the statements, “You are certain that you can understand the most difficult material presented in the textbook used in this class.” The agreement scale indicated was utilized using “1,” “2,” “3,” and “4,” where “1” = Strongly agree, “2” = Agree, “3” = Disagree, and “4” = Strongly disagree. Higher values represented higher science self-efficacy. The variable was created through principal components factor analysis and standardized to a mean of 0 and standard deviation of 1. Only respondents who provided complete responses were assigned a scale value. If the student indicated that he or she was not taking a fall science class, this variable was set to -7. The scale's reliability coefficient (alpha) was 0.65 or higher, with a Cronbach’s alpha score of 0.82. For more information on this scaled score, please see chapter 5 of the Base-Year Data File Documentation (NCES 2011-328; National Center for Education Statistics, 2011). The mean of science self-efficacy was -1.97, and the standard deviation 3.46. 55% of young men and 45% of young women believed that most people could learn to be good at science.

Science utility was measured with the statements, "Do you see your science class as useful for a future career?" The agreement scale indicated was utilized using "1," "2," "3," and "4," where "1" = Strongly agree, "2" = Agree, "3" = Disagree, and "4" = Strongly disagree. Higher values represented perceptions of greater science utility. The variable was created through principal components factor analysis and standardized to a mean of 0 and standard deviation of 1. Only respondents who provided a full set of responses were assigned a scale value. If the student indicated that he or she was not taking a fall science class, this variable was set to -7. The scale's coefficient of reliability (alpha) was 0.65 or higher, with a Cronbach's alpha score of 0.92. For more information on this scaled score, please see chapter 5 of the Base-Year Data File Documentation (NCES 2011-328; National Center for Education Statistics, 2011). The mean of science utility was -1.97, and the standard deviation 3.44. 51% of young men and 49% of young women believed that science was useful for everyday life.

Independent variable

Sex was the independent variable in this study. Students were asked in the survey, "What is your sex?" and were provided with two answer options, male and female.

Reliability and Validity

Since the study of this phenomenon could fill a present need, reliability and validity must be at the center of the research. Favorable math and science identities have promoted persistence in computer science training (Lavakumar, 2021). Self-reported levels of understanding related to confidence have also contributed to STEM, computer science, and data science training completion (Bettin et al., 2020). Reliability refers to the accuracy or precision of a measurement process, or in other words, consistency over replications of the testing procedure (Crocker & Algina, 1986). Reliability has various measurement tactics, including Cronbach's alpha (Crocker & Algina, 1986). Within the HSLS:09 survey, weighted reliability scores were measured (National Center for Educational Statistics, 2016). The IRT-estimated reliability of the HSLS:09 follow-up survey was 0.92. Validity is the correctness of the interpretation or conclusion achieved from applying a measure (DeVellis, 2012). The validity of constructs on the mathematics assessment utilized the National Council of Teachers of Mathematics standards, the mathematics frameworks of the Nation's Report Card and the Trends in International Mathematics and Science Study, and the review of an expert panel.

Data Analysis

The data provided by the HSLS:09 longitudinal study are open to the public (National Center for Education Statistics, 2016). Since the research and data are open to the public, special permissions to access the data are not required in this case. Precautions were taken in the data collection phases to maintain the subjects' privacy in this study. The researcher was authorized to use the data for educational research purposes. Bethel's IRB provided authorization that the study met educational and research requirements. All credit goes to the study's original authors, who collected the data.

The researcher conducted six *t*-tests and examined the assumptions of the six *t*-tests. The *t*-tests examined whether there were statistically significant differences in the mean values of girls' and boy's responses to the science and math identity, self-efficacy, and utility factors. The null hypothesis was rejected when $p < 0.05$. The data was analyzed using DataLab, a web-based platform that provides access to data collected by the National Center for Education Statistics (NCES).

Limitations

There are limitations to this study. The study was about gender, a social construct, but the survey was about sex (biological). This was a limitation regarding our understanding of the effects of gender and gender socialization. HSLS:09 collected responses from schools in over 50 states. The responses only reflected that of one country. The data generated only showed one generation of students on one occasion. Depending on the students' moods, their answers may not have accurately reflected their sentiments. The numeric nature of the responses also may not have accurately depicted the students' actual feelings or opinions since there are predetermined numeric responses to questions in quantitative research. The sample did not include all students in the 11th grade but a subset of students who took the original survey in the 9th grade.

The survey data are over 10 years old, which could lead to inaccurate applications and analysis. National campaigns to improve women's participation in STEM, data science, and computer science may have impacted students' perceptions over the last decade, leading to potentially different results in how students view science and math identity, self-efficacy, and utility. While there are still disparities in STEM participation in education and the workforce, there have been women graduating and working in those areas. Higher rates of women participating could impact students' identity, as they would be more likely to see someone with their gender identity in a position. In addition, changes in curricular standards, including the

Common Core State Standards, may have impacted the nature of the problem over the last 10 years. Various states have created numerous STEM efforts to create spaces for students to learn about computer science, data science, and STEM. There are still access issues to quality and robust programs, but the last decade has prompted initiatives that address the inequity within STEM spaces through K12 initiatives.

The researcher also utilized pre-existing data from the HSLS:09 Longitudinal Survey. Due to the lack of data collection, there may have been current trends that would have emerged if the researcher had collected data in the present day. The survey was structured to analyze the school experience and home environment. If the researcher had created an instrument, there would have been room for more exploratory analyses regarding the additional activities and courses that might inspire girls.

Delimitations

One delimitation of the study was the focus only on quantitative research. Since the researcher only measured survey outcomes, this influenced the investigation results. The researcher did not get a robust, in-depth understanding of whether participants' scientific identity had changed since qualitative research is not involved in this study. In addition, the specific survey itself was a delimitation. Because the study followed up with the same group as the original study, the survey was a delimitation.The sample was constrained by the initial participation of participants. If students were not in the original survey study, they were not eligible to participate.

Ethical Considerations

Ethics are principles and guidelines that help us uphold things we value (Johnson and Christensen, 2014). Ethical issues could arise in studies, and researchers must protect their research participants (Creswell, 2013). Research ethics are the principles developed to guide researchers (Johnson and Christensen, 2014). The researcher has received training on the responsibilities of ethical and valuable research. Various events inspired the movement for research ethics in history when ethical practices were absent. The National Research Act of 1974 responded to mistreating human subjects (Roberts & Hyatt, 2019). In addition to many others, The National Research Act appeared in training for research ethics. The researcher completed the Collaborative Institutional Training Initiative (CITI). One component of the CITI training was reading "The Belmont Report," which outlined the main ethical principles that should be followed (Roberts & Hyatt, 2019).

In research, three principles of beneficence, respect for people, and justice are cornerstones of ethical practices. It was paramount that the risks outweigh the benefits, and vulnerable populations should not be exploited (Roberts & Hyatt, 2019). CITI training also taught about research misconduct and the ramifications of such a misstep (Johnson & Christensen, 2014). Once the committee approved the proposal, the author of this study approached Bethel's Institutional Review Board for Research for permission to move forward with a level one research study. The researcher was committed to full adherence to ethical principles, as recommended by the IRB.

From the Belmont Report (2021), respect for persons should appear in research studies, which includes securing participants' informed consent to participate in the study. The researchers at NCES followed standard ethical guidelines and required parents' active or passive consent. The U.S. Department of Education was authorized by federal law (Public Law 107-279) to conduct HSLS:09, and parents were informed that the data would be used only for statistical purposes and would not be disclosed or used in identifiable form for any other purpose except as required by law. Parents were also informed that no individual data (such as names or addresses) would be reported. Finally, in the consent form, researchers noted that participation in the study was voluntary, there would be no penalty if parents or children decided not to participate, and children could choose not to answer any question.

Further, in the consent form, NCES researchers noted that there would be no risks to children from participating in the study. The data collected were intended to be used in analyses to understand students' course-taking behaviors, motivation and achievement, and how students decide what to do during and after high school. Participating students received a clear backpack filled with educational items as an incentive. The dataset disclosed by NCES was altered to protect participants' identity, which was not disclosed in the public data, and procedures to employ automatic weighting are recommended when analyzing the data online in DataLab.

Chapter Four: Results

In Chapter Three, the researcher outlined the course of action for this study. The following chapter allows the researcher to explain the study, the sample, the model, and hypotheses testing and reporting significant differences between variables.

Research Questions and Hypotheses

The researcher developed research questions and hypotheses to drive the study.

Research Question

The research questions guiding this study were:

1. Is there a significant difference in math identity between males and females?
2. Is there a significant difference in science identity between males and females?
3. Is there a significant difference in math self-efficacy between males and females?
4. Is there a significant difference in science self-efficacy between males and females?
5. Is there a significant difference in math utility between males and females?
6. Is there a significant difference in science utility between males and females?

Hypotheses:

H1aa: There is a statistically significant difference between male and female students and their mathematics identity.

H1ao: There is no statistically significant difference between male and female students and their mathematics identity.

H1ba: There is a statistically significant difference between male and female students and their mathematics self-efficacy.

H1bo: There is no statistically significant difference between male and female students and their mathematics self-efficacy.

H1ca: There is a statistically significant difference between male and female students and their mathematics utility.

H1co: There is no statistically significant difference between male and female students and their mathematics utility.

H2aa: There is a statistically significant difference between male and female students and their science identity.

H2ao: There is no statistically significant difference between male and female students and their science identity.

H2ba: There is a statistically significant difference between male and female students and their science self-efficacy.

H2bo: There is no statistically significant difference between male and female students and their science self-efficacy.

H2ca: There is a statistically significant difference between male and female students and their science utility.

H2co: There is no statistically significant difference between male and female students and their science utility.

The overall results for each hypothesis are explained more fully in the following sections for each dependent variable: math identity, math self-efficacy, math utility, science identity, science self-efficacy, and science utility.

Sample

The researcher gained IRB approval for the study on November 6, 2022. The survey was sent to 25,185 eligible 11th-grade students in 2012. In total, 20,594 of those students responded, of whom 49.8% of the respondents were male and 50.2% were female. The researcher utilized the weighted sample sizes to enhance representativeness, as recommended by the National Center for Education Statistics. The weighted sample had over 3,000,000 respondents.

Data Analysis: Assumptions

Within the study, the appropriate assumptions for *t*-tests were met. The sample size was adequate, the dependent variables were normally distributed, and there was homogeneity of variance (Field, 2009). The observations were independent, and each subject was contained in only one group (Field, 2009). DataLab was utilized to analyze the data via the *t*-tests. The researcher tested hypotheses in various areas, where sex was the independent variable. Dependent variables in the study were math identity, math self-efficacy, math utility, science identity, science self-efficacy, and science utility. Four of the six *t*-tests demonstrated statistically significant differences by students' sex.

Results

Math Identity

Math identity measured the ways in which a student viewed themselves in terms fo mathematics. There was a significant relationship between math identity and sex. Utilizing the weighted samples, there were 3,660,610 responses to the math identity questions. Of those responses, 1,636,842 were male, and 1,653,737 were female. Table 1 includes the means and standard errors for each of the dependent variables by 11th grade students' sex. The questions measuring this construct included "I see myself as a math person" (S2MPERSON1) and "Others see me as a math person" (S2MPERSON2). The agreement scale indicated was utilized using "1," "2," "3," and "4," where "1" = Strongly agree, "2" = Agree, "3" = Disagree, and "4" = Strongly disagree. The results show significant differences in math identity between young men and young women, $t(3{,}660{,}609) = 5.88$, $p < 0.001$. On average, young men were significantly more confident than young women in their math identity (M = 0.1116, SE = 0.02138 and M = 0.00, SE = 0.000, respectively). Table 2 and Table 3 show students' responses to one of the items by sex.

Table 1

Descriptive Statistics for Variables Used in Analysis

Continuous Variables Used in Analysis	*M*	*SE*	*Weighted Sample Size*
Math identity (female)	0.0000	0.0000	1,654,737
Math self-efficacy (female)	0.0000	0.0000	1,635,937
Math utility (female)	0.0000	0.2659	1,649,996
Science identity (female)	0.0000	0.0000	1,643,856
Science self-efficacy (female)	0.0000	0.0000	1,618,509
Science utility (female)	0.0000	0.0000	1,641,399
Math identity (male)	0.1116	0.0214	1,636,842
Math self-efficacy (male)	0.1230	0.0217	1,608,187
Math utility (male)	0.0401	0.0229	1,608,187
Science identity (male)	0.0861	0.0205	1,626,087
Science self-efficacy (male)	0.1213	0.0212	1,586,845
Science utility (male)	0.0000	0.0000	1,620,953

Table 2

Descriptive Statistics for "I See Myself as a Math Person"

Categorical Variables Used in Analysis	*Male (%)*	*Female (%)*
Strongly Agree	17.2	12.6
Agree	32.1	27.9
Disagree	31.0	34.2
Strongly Disagree	19.6	25.4

Table 3

Descriptive Statistics for "Others See Me as a Math Person"

Categorical Variables Used in Analysis	*Male (%)*	*Female (%)*
Strongly Agree	13.7	11.0
Agree	36.7	34.8
Disagree	33.2	34.3
Strongly Disagree	16.3	19.8

Math Self-Efficacy

Math self-efficacy beliefs measured students' confidence in themselves in mathematics. There was a statistically significant relationship between math self-efficacy and sex. Using weighted samples, there were 3,607,413 total responses to the math self-efficacy questions. Within those responses, 1,608,187 were male, and 1,635,937 were female. Questions that measure this included "I am confident I can do an excellent job on (Spring 2012) math tests" (S2MTESTS), "I am certain I can understand the (Spring 2012) math textbook" (S2MTEXTBOOK), "I am certain I can master skills taught in my (Spring 2012) math course" (S2MSKILLS), and "I am confident I can do an excellent job on (Spring 2012) math assignments" (S2MASSEXCL). The agreement scale indicated was utilized using "1," "2," "3," and "4," where "1" = Strongly agree, "2" = Agree, "3" = Disagree, and "4" = Strongly disagree. The results show significant differences in math self-efficacy between young men and young women, $t(3,607,412) = 6.15$, $p < 0.001$. On average, young men were significantly more confident than young women in math self-efficacy beliefs (M = 0.1230, SE = 0.02173, and M =

0, SE = 0.000, respectively). Table 4, Table 5, Table 6, and Table 7 show students' responses to one of the items by sex.

Table 4

Descriptive Statistics for "I am Confident I Can Do an Excellent Job on my Math Tests"

Categorical Variables Used in Analysis	*Male (%)*	*Female (%)*
Strongly Agree	21.1	14.2
Agree	50.0	47.7
Disagree	23.4	29.3
Strongly Disagree	5.5	8.8

Table 5

Descriptive Statistics for "I am Certain I Can Understand my Math Textbook"

Categorical Variables Used in Analysis	*Male (%)*	*Female (%)*
Strongly Agree	15.9	11.2
Agree	42.0	38.9
Disagree	29.9	34.7
Strongly Disagree	12.1	15.3

Table 6

Descriptive Statistics for "I am Certain I Can Master Skills in My Math Course"

Categorical Variables Used in Analysis	*Male (%)*	*Female (%)*
Strongly Agree	20.0	15.7
Agree	53.6	54.1
Disagree	20.9	23.8
Strongly Disagree	5.5	6.4

Table 7

Descriptive Statistics for "I am Confident I Can Do an Excellent Job on Math Assignments"

Categorical Variables Used in Analysis	*Male (%)*	*Female (%)*

Strongly Agree	23.0	18.2
Agree	54.3	53.3
Disagree	18.3	22.3
Strongly Disagree	4.4	6.2

Math Utility

Math utility measured students' opinions regarding the practicality of math for their lives. There was not a statistically significant relationship between math utility and sex. With the weighted sampling method, there were 3,645,933 total responses to the math identity questions. Of those responses, 1,632,925 were male, and 1,649,996 were female. Questions that measured this included "I think math is useful for everyday life" (S2MUSELIFE), "I think math will be useful for college" (S2MUSECLG), and "I think that math is useful for my future career" (S2MUSEJOB). The agreement scale indicated was utilized using "1," "2," "3," and "4," where "1" = Strongly agree, "2" = Agree, "3" = Disagree, and "4" = Strongly disagree. The results show no significant difference in math utility between young men and young women, $t(3,645,932) = 0.94$, $p > 0.05$. On average, there was no difference in confidence in math utility between young men and young women (M = 0.0401, SE = 0.02296 and M = 0.0066, SE = 0.02659, respectively). Table 8, Table 9, and Table 10 show students' responses to one of the items by sex.

Table 8

Descriptive Statistics for "I Think That Math is Useful for My Everyday Life"

Categorical Variables Used in Analysis	*M(%)*	*F (%)*
Strongly Agree	35.0	32.0
Agree	50.2	53.5
Disagree	11.2	12.0
Strongly Disagree	3.6	2.5

Table 9

Descriptive Statistics for "I Think That Math is Useful for College"

Categorical Variables Used in Analysis	*M(%)*	*F (%)*
Strongly Agree	50.3	48.0
Agree	46.4	48.2
Disagree	2.5	3.2
Strongly Disagree	0.9	0.6

Table 10

Descriptive Statistics for "I Think That Math is Useful for My Future Career"

Categorical Variables Used in Analysis	*M(%)*	*F (%)*
Strongly Agree	41.0	39.0
Agree	47.8	49.6
Disagree	8.7	9.0
Strongly Disagree	2.6	2.3

Science Identity

Science identity was a measurement of a student's feelings towards their science abilities. There was a statistically significant relationship between science identity and sex. Utilizing the weighted samples, there were 3,648,771 total responses to the science identity questions. Of those responses, 1,626,087 were male, and 1,643,856 were female. Questions that measured this included "I see myself as a science person" (S2SPERSON1) and "Others see me as a science person" (S2SPERSON2). The agreement scale indicated was utilized using "1," "2," "3," and "4," where "1" = Strongly agree, "2" = Agree, "3" = Disagree, and "4" = Strongly disagree. The results show significant differences in science identity between young men and young women, $t(3,648,770) = 4.30$, $p < 0.001$. On average, young men were significantly more confident than young women in their science identity (M = 0.0861, SE = 0.02048 and M = 0, SE = 0.000, respectively). Within the Table 11 and Table 12 below, there is a breakdown of responses by gender.

Table 11

Descriptive Statistics for "I See Myself as a Science Person"

Categorical Variables Used in Analysis	*M(%)*	*F (%)*
Strongly Agree	16.1	14.1
Agree	36.7	32.4
Disagree	35.9	38.4
Strongly Disagree	11.3	15.0

Table 12

Descriptive Statistics for "Others See Me as a Science Person"

Categorical Variables Used in Analysis	*M(%)*	*F (%)*
Strongly Agree	12.5	11.5
Agree	33.0	32.1
Disagree	43.4	43.0
Strongly Disagree	11.1	13.5

Science Self-Efficacy

Science self-efficacy beliefs were a measure of a student's confidence to succeed in science courses. There was a statistically significant relationship between science self-efficacy and sex. With the weighted sampling method, there were 3,559,428 total responses to the science self-efficacy questions. Of those responses, 1,586,845 were male, and 1,618,509 were female. Questions that measured this included "I am confident I can do an excellent job on (Spring 2012) science tests" (S2STESTS), "I am certain I can understand the (Spring 2012) science textbook" (S2STEXTBOOK), "I am certain I can master skills taught in (Spring 2012) science course" (S2SSKILLS), and "I am confident I can do excellent job on my (Spring 2012) science assignments" (S2SASSEXCL). The agreement scale included "1" = Strongly agree, "2" = Agree, "3" = Disagree, and "4" = Strongly disagree. The results show significant differences in science self-efficacy beliefs between young men and young women, $t(3{,}559{,}427) = 6.07$, $p < 0.001$. On average, young men were significantly more confident than young women in science self-efficacy beliefs (M = 0.1213, SE = 0.02115, and M = 0, SE = 0.000, respectively). Table 13, Table 14, Table 15 and Table 16 show students' responses to one of the items by sex.

Table 13

Descriptive Statistics for "I am Confident I can do an Excellent Job on Spring 2012 Science Tests"

Categorical Variables Used in Analysis	*M(%)*	*F (%)*
Strongly Agree	22.0	16.2
Agree	50.4	45.4
Disagree	22.0	31.4
Strongly Disagree	5.6	6.9

Table 14

Descriptive Statistics for "I am Certain I can Understand my Science Textbook"

Categorical Variables Used in Analysis	*M(%)*	*F (%)*
Strongly Agree	19.8	14.9
Agree	45.0	40.1
Disagree	26.7	33.9
Strongly Disagree	8.4	11.1

Table 15

Descriptive Statistics for "I am Certain I can Master Skills Taught in Science"

Categorical Variables Used in Analysis	*M(%)*	*F (%)*
Strongly Agree	21.9	16.1
Agree	50.0	51.6
Disagree	22.5	25.8
Strongly Disagree	5.5	6.5

Table 16

Descriptive Statistics for "I am Confident that I can Do an Excellent Job on Science Assignments"

Categorical Variables Used in Analysis	*M(%)*	*F (%)*
Strongly Agree	25.0	20.6
Agree	53.2	51.9
Disagree	17.5	22.2
Strongly Disagree	4.3	5.3

Science Utility

Science utility was a measurement of students' opinions regarding the usage of science in their daily lives. There was not a statistically significant relationship between science utility and sex. Utilizing the weighted samples, there were 3,627,216 total responses to the science utility questions. Of those responses, 1,620,953 were male, and 1,641,399 were female. Questions that measured this included "I think science is useful for everyday life" (S2SUSELIFE), "I think science will be useful for college" (S2SUSECLG), and "I think science is useful for future career" (S2SUSEJOB). The agreement scale indicated was utilized using "1," "2," "3," and "4," where "1" = Strongly agree, "2" = Agree, "3" = Disagree, and "4" = Strongly disagree. The results show no significant differences in science utility between young men and young women, $t(3{,}627{,}216) = 0.00$, $p > 0.05$. On average, there was no difference in confidence in science utility between young men and young women (M = 0, SE = 0.000 and M = 0, SE = 0.000, respectively). In Table 17, Table 18, and Table 19 below, there is a breakdown of responses by gender.

Table 17

Descriptive Statistics for "Teenager Thinks Science is Useful for Everyday Life"

Categorical Variables Used in Analysis	*M(%)*	*F (%)*

Strongly Agree	20.7	19.7
Agree	48.9	50.1
Disagree	25.9	26.6
Strongly Disagree	4.5	3.7

Table 18

Descriptive Statistics for "I Think Science is Useful for College"

Categorical Variables Used in Analysis	*M(%)*	*F (%)*
Strongly Agree	33.6	33.5
Agree	57.5	57.0
Disagree	6.9	8.0
Strongly Disagree	2.0	1.4

Table 19

Descriptive Statistics for "I Think Science is Useful for my Future Career"

Categorical Variables Used in Analysis	*M(%)*	*F (%)*
Strongly Agree	28.2	32.8
Agree	49.1	49.1
Disagree	17.5	15.0
Strongly Disagree	4.6	3.1

Summary

Throughout the analysis, the results suggest there are significant differences in young men and young women's perceptions within the fields of math and science. Math identity, science identity, math self-efficacy, and science self-efficacy showed statistically significant differences by sex. Math utility and science utility did not show statistically significant differences by sex. In Table 20, there are summaries of t and p values by dependent variables.

Table 20

Summary of Values by Dependent Variable

Dependent Variable	*t*	*p*
Math identity	5.888	<0.001
Math self-efficacy	6.150	<0.001

Math utility	0.940	>0.05
Science identity	4.300	<0.001
Science self-efficacy	6.070	<0.001
Science utility	0.000	>0.05

The study demonstrated statistically significant results from four of the six hypotheses. Mathematics identity, mathematics self-efficacy science identity, and science self-efficacy had statistically significant differences, by sex. In Table 21, the hypotheses, along with the results and summaries, are listed to provide the various conclusions that occurred after completing the statistical analysis. Table 21 illustrates to the reader whether specific hypotheses were rejected or failed to be rejected, along with the statistical reasoning for the decision.

Table 21

Hypotheses Testing

Hypothesis	Result	Summary
H1aa: There is a statistically significant difference between male and female students and their mathematics identity.	Failed to reject	There is a statistically significant difference in math identity by gender
H1ao: There is no statistically significant difference between male and female students and their mathematics identity.	Reject	There is a statistically significant difference in math identity by gender
H1ba: There is a statistically significant difference between male and female students and their mathematics self-efficacy.	Failed to reject	There is a statistically significant difference in math self-efficacy by gender
H1bo: There is no statistically significant difference between male and female students and their mathematics self-efficacy.	Reject	There is a statistically significant difference in math self-efficacy by gender
H1ca: There is a statistically significant difference between male and female students and their mathematics utility.	Reject	There is not a statistically significant difference in math utility by gender
H1co: There is no statistically significant difference between male and female students and their mathematics utility.	Failed to reject	There is not a statistically significant difference in math utility by gender

H2aa: There is a statistically significant difference between male and female students and their science identity.	Failed to reject	There is a statistically significant difference in science identity by gender
H2ao: There is no statistically significant difference between male and female students and their science identity.	Reject	There is a statistically significant difference in science identity by gender
H2ba: There is a statistically significant difference between male and female students and their science self-efficacy.	Failed to reject	There is a statistically significant difference in science self-efficacy by gender
H2bo: There is no statistically significant difference between male and female students and their scienec self-efficacy.	Reject	There is a statistically significant difference in science self-efficacy by gender
H2ca: There is a statistically significant difference between male and female students and their science utility.	Reject	There is not a statistically significant difference in science utility by gender
H2co: There is no statistically significant difference between male and female students and their science utility.	Failed to reject	There is not a statistically significant difference in science utility by gender

In Chapter Five, the researcher will further discuss the analysis and implications of the results and provide recommendations for the intended use of the research.

Chapter 5: Discussion, Implications, Recommendations

Overview of the Study

This study aimed to explore the differences between young men and young women's perceptions of mathematics and science. As stated throughout the document, many gaps within the industry perpetuate a gender gap in data science, computer science, and STEM fields. Over the last 20 years, fewer and fewer women have pursued mathematics and science careers (National Center for Education Statistics, 2020). Women comprise 35% of the students studying STEM in higher education worldwide (Grimalt‐Álvaro, 2021). Societal views of gender roles can impact young girls' willingness to participate in coding and data science activities (Kang et al., 2019; Stoeger et al., 2019; Wei-Cheng Mau et al., 2020).

There are societal barriers depending on gender expectations and the socialization of gender-specific roles, which begin during children's formative years (Coyle & Liben, 2020). Chores within the home environment and other responsibilities can negatively impact girls' access to various educational programs. Girls with more responsibilities for chores have less time for education and extracurriculars. Household responsibilities can impact economic participation and relevance (Basu & Famoye, 2004). Due to duties at home, girls may be deterred from participating in extracurricular activities. Some of these responsibilities are constructed by gender roles. In addition to gender roles, economics play a large part in data science, computer science, and STEM disparities. Parental poverty can negatively impact girls' access to technology education (Guttman, 2001). Another element of the data science, computer science, and STEM gap deal with workplace mentorship. Underrepresentation in the workplace can create difficulties for women in many more male-dominated professions (Traylor et al., 2020).

To complete the study, the researcher utilized pre-existing data to analyze the statistically significant differences in identity, self-efficacy, and utility by sex. The study utilized pre-existing data from the High School Longitudinal Survey. In total, 20,594 of students responded to the survey within the study. Within the respondents, 49.8% of the respondents were male and 50.2% were female. The researcher utilized the weighted sample sizes to enhance representativeness. According to the weighted sample sizes, there were over 3,000,000 respondents to represent the national population.Throughout the literature review and data analyses, the researcher completed a nationally representative quantitative study that measured the differences between young men and young women's perceptions of mathematics and science. The study's results aimed to fill the gap in research by answering six research questions and associated hypotheses.

The High School Longitudinal Study implemented a follow-up questionnaire in the Spring of 2012 when the original HSLS:09 participants were in 11th grade (National Center for Educational Statistics, 2016). Within the survey, students were asked to provide insights into their identities. The HSLS:09 was a longitudinal survey that investigated the transition of youth from secondary to post-secondary education (National Center for Educational Statistics, 2016). This chapter will discuss the data, connections to available literature, and recommendations for future research.

Research Questions

The research questions guiding this study were:

1. Is there a significant difference in math identity between males and females?
2. Is there a significant difference in science identity between males and females?
3. Is there a significant difference in math self-efficacy between males and females?

4. Is there a significant difference in science self-efficacy between males and females?
5. Is there a significant difference in math utility between males and females?
6. Is there a significant difference in science utility between males and females?

Research Question 1: Significant Differences in Math Identity by Sex

A t-test was used to determine that a significant relationship exists between math identity and sex. Achievement can impact identity within mathematics, leading to college STEM majors enrollment (Alhadabi, 2021). Within the study, 17.2% of young males and 12.6% of young females strongly agreed that they see themselves as “math” people. This identity dichotomy demonstrated the perception differences between young men and young women.

Research Question 2: Significant Differences in Science Identity by Sex

A t-test was used to determine that a significant relationship exists between science identity and sex. Identity can significantly impact the pursuit of careers in science. According to the study, 11.3% of young males and 15.0% of young females strongly disagreed that they are “science” people. More females than males disagree with exhibiting a science identity, which prompts a need for continued study.

Research Question 3: Significant Differences in Math Self-Efficacy by Sex

A t-test was used to determine that a significant relationship exists between math self-efficacy and sex. According to the study, 38.1% of young women disagreed that they could do an excellent job on math tests compared to 28.9% of young men. Therefore, efforts to build young women’s confidence in taking math tests would help to improve their beliefs in their math efficacy. Teachers could provide extra encouragement to women or make statements like “I have found that young men and women score about the same on this math test” to remove stereotype threat. Math achievement was essential for STEM pursuit throughout the study; struggles to master algebra are well-documented and are a barrier to higher mathematics (Sharpe & Marsh, 2022). Students that significantly struggle in algebraic classrooms are presented with many barriers to enter STEM study in college. Young women report lower mathematics self-efficacy than young men, but their actual performance does not differ significantly.

Research Question 4: Significant Differences in Science Self-Efficacy by Sex

A t-test was used to determine that a significant relationship exists between science self-efficacy and sex. Confidence continues to lack for girls in STEM, computer science, and data science. There have been causal associations studied between achievement and self-efficacy (Sakellariou, 2022). According to the study, 21.9% of young men strongly agreed that they can master skills taught in science classes versus 16.1% of young women. This difference could be addressed through more applied pedagogies that allow girls to build confidence in science. The statistically significant results regarding the self-efficacy differences between young men and young women were not surprising. Curriculum and pedagogy have not morphed in the way that researchers have recommended; thus, there has not been a large-scale change in self-efficacy. For example, there is an association within research between museum attendance and science achievement (Suter, 2014). But, there are not many school settings that are implementing real-world experiences into science courses.

Research Question 5: Significant Differences in Math Utility by Sex

A t-test was used to determine that no significant relationship exists between math utility and sex. There are more young women than young men that agree with the utility of mathematics. The usefulness and need for mathematics and science were not found to differ by gender. According to the study, 50.2% of young men and 53.5% of young females agreed that math is useful for everyday life. Since there is not a difference in utility perception, it appears that the young women surveyed felt that mathematics was useful for their lives, careers, and future college work.

Research Question 6: Significant Differences in Science Utility by Sex

A t-test was used to determine that no significant relationship exists between science utility and sex. Within the study, 48.9% of young men and 50.1% of young women agreed that science is useful for every day life. When either gender was asked about the subject's utility, there was no statistically significant difference between the responses. There is not a statistically significant difference by sex in terms of utility perceptions. Young women surveyed felt that science was useful for their lives, careers, and future college experiences.

Discussion and Implications

The present study provided research findings regarding the gender gap within STEM, data science, and computer science. This study's results indicate a significant difference in young men and young women’s perceptions of mathematics and science. Prior researchers have mentioned that perception of mathematics and science identity, self-efficacy, and utility could vary by gender. Johnson and Christensen (2014) comment that there are practical questions surrounding the significant differences in identity, self-efficacy, and utility that continue to be unanswered. Female gender identities and STEM interests have been cited to potentially cause the struggle for girls to identify with technical content (Selimbegović et al., 2019). Niese et al. (2019) commented that self-beliefs can create a bias that can impact the motivation to study certain areas. There are no nationally represented studies to quantify the perceptions differences by sex yet, though. In this section, the researcher will further discuss the findings of the data analysis along with the implications of the analysis.

Math and Science Identity

Girls' self-perception is the strongest indicator of STEM education and career pursuits (Kang et al., 2019). The perceived value of inclusiveness or cohesiveness within various job fields seems to be a priority when women select professions. Young men's fields of choice are driven by STEM subjects, while young women's fields of choice are based on confidence in mathematics (Sakellariou & Fang, 2021). For example, young men are driven to engineering and physics because of their interesting applications, while young women are drawn to activities in which they feel confidence and interest. Identity within a society can significantly influence young girls' opinions of entering specific career fields (Michell et al., 2017).

The STEM identity component creates social expectations for how a person learns and behaves, which can cause aversion to the field (Grimalt‐Álvaro, 2021). Stereotypes are internalized by young men and young women as early as second grade regarding math, science, and reading (Todd & Zvoch, 2017). These stereotypes may be contributing to the reason there is a statistically significant difference in young men and young women's mathematics and science identities.

Perceptions of gender roles have historically impacted young girls' willingness to participate in coding and data science activities (Kang et al., 2019; Stoeger et al., 2019; Wei-Cheng Mau et al., 2020). According to Matic and Jadhan (2018), the #MeToo Movement has improved women's overall experience, providing more pathways to share their stories. Perception of abilities and talents can drive girls to participate in certain activities. Alhadabi

(2021) stated that grit, self-efficacy, and grades had impacted students' interest in STEM careers. Self-perception in the computing workforce can inhibit or enhance girls' willingness to participate in activities (Berman & Bourne, 2015). Sakellariou and Fang (2021) stated that self-efficacy predicts motivation within various domains; girls' identities are greatly impacted by social and ethnic realms. Perception can normalize behaviors depending on how a girl sees herself (Khan & Rodrigues, 2017). Computer science, data science, and STEM careers may feel out of reach for some girls; because of this self-perception, girls remain outside the fields.

Confidence is significantly impacted by achievement; Sharpe and Marsh (2022) described how struggles in algebra pose barriers for students to qualify for STEM jobs. Race, ethnicity, socioeconomics, gender, and prior achievement have been shown to impact students entries into STEM fields. Students have developed weak science identities and negative perceptions of science in the United States (Alhadabi, 2021). Higher interest in a subject has been shown to create stronger identities within that topic.

Girls' interests in STEM gradually fade as they age (Van Langen, 2015). The statistically significant difference in identity between young men and young women in this study demonstrates the chasm that begins for students as they mature. The data science, computer science, and STEM pipeline are impacted due to the significant differences in perception. Within the study, we have seen the difference in perception. If this perception is not addressed, this could potentially mean that the gender gap in STEM, computer science, and data science careers will continue to exist.

Math and Science Self-Efficacy

This study also demonstrated a significant difference in young men and young women's mathematics and science self-efficacy. It is important to study students' experiences earlier in the academic pipeline to prevent some of this bias (Kurban & Cabrera, 2019). Cultural stereotypes, family, and peers influence girls' motivations to be the next scientists, mathematicians, and engineers (Anderson & Cross, 2014). Familial education and better counseling advice could be a place to begin addressing the gender gaps in STEM, computer science, and data science. Gender roles could provide more insight into the gaps within careers. Women often face unpaid or low-wage labor due to their gender or social status (Folberg, 2020). Various societal resources are often impacted by gender, leading to inequities in data science, computer science, and STEM (Froehlich et al., 2020). Culture and attitudes toward norms can significantly impact women's access to lucrative careers (Von Hippel et al., 2011). Stereotypes are perpetuated by leadership within organizations that seek power (Vesvio et al., 2005). Psychology can impact the gender equality dynamic within our society (Folberg, 2020).

The delivery of content is another element of the research study that has been referenced. Regarding pedagogy, there have been recommendations for classes to be more appealing to girls and their preferences. Girls have been more excited about computer science and data science when there is a community aspect to the content (Jezierska, 2016). Applied STEM coursework has increased mathematics and science self-efficacy in students, although the patterns differ by gender (Subett & Plasman, 2018). This focus on theory versus application within pedagogy could begin to address the gender gap within STEM, computer science, and data science.

In terms of implication, there is a confidence issue that requires attention. Currently, identifying with STEM as a whole presents a pedagogical issue, as reinforcing one way to be a

STEM person is damaging (Grimalt‐Álvaro et al., 2021). If the self-esteem differences between young men and young women are not addressed, the gender disparities in STEM, computer science, and data science will persist. Some of this may stem from gender equality in higher education and the workforce (Riegle-Crumb & Peng, 2021). Implications of this lack of self-confidence will mean that girls do not try to enter various STEM fields, leaving those fields underrepresented.

Math and Science Utility

The researcher could not conclude that gender differences exist between young men and young women regarding mathematics utility and science utility. In previous research, the modality and purpose of the delivery were more of a focus rather than the potential use of the material. For example, female representation in curriculum design could change girls' interests in learning about the topics (Cierciersky & Styers, 2020).

Many girls would prefer to implement the mathematics and science learning through projects that they enjoy (Cierciersky & Styers, 2020). Costs may be causing curricular redesign problems (Jones, 2020). Financials and workforce are critical issues that have been cited as potential reasons for the lack of engaging pedagogies for girls. Since multiple dynamics drive students' engagement, collaborative lessons could potentially draw more girls into the topic (Kumpulainen & Kajaumaa, 2020). The results within the research were not surprising, as there were no previous citations of girls undervaluing mathematics or science. Instead, girls see the importance of the topics but do not currently feel drawn to them. There is a dire need for more engaging curricula and lessons to create spaces for girls to enjoy mathematics and science topics.

If this is not addressed, there will continue to potentially be a gender gap within the STEM, computer science, and data science fields.

Limitations

In addition to the limitations listed in Chapter 3, the researcher has added supplemental limitations as areas of note. The researched used pre-existing data that is over 10 years old. Due to the use of previous data and a pre-designed instrument, elements of this study did not specifically address computer science and data science in the way that the researcher had hoped. In addition, since the researcher's main area of interest was underserved young women, the non-responsive group that did not articulate their perceptions could have changed the analysis. Since young women were given the choice to respond, the students of most interest (homeless, truant, low income) may not have been represented in the data.

Recommendations

This section will detail the various recommendations for each dependent variable, according to the data from the study and other pieces of research from the literature review.

Math and Science Identity

Future research is needed regarding the stigmas associated with STEM, computer science, and data science; race, gender, and socioeconomic status perceptions are still unstudied. Riegle-Crumb and Peng (2021) addressed the various stereotypes that exist within specific majors and the consequences of those stereotypes. Interventions for closing the gender gap have been shown to only work for girls with above-average confidence in their abilities (Sakellariou & Fang, 2021). Family factors impact educational pursuits and career aspirations; more advocacy programs should focus on traditionally underserved students, including longitudinal studies for female and minority students (Mau & Li, 2018). From primary to secondary education, there could be studies conducted to investigate why STEM interest drastically declines for girls (Grimalt‐Álvaro, 2021).

Belief studies regarding the malleability of learning abilities and perception studies could begin addressing the gender gaps in STEM, computer science, and data science (Van Aalderen-Smets et al., 2018). Benavent et al. (2020) suggested that the promotion of long-term changes in attitudes in schools and communities could also be a solution. In addition to further research, focusing on teaching pedagogies could also positively impact the gender gap. Social-emotional support and instruction have significantly impacted students' motivation, attitudes, and confidence (Zhu & Kaiser, 2022). Positive classroom atmospheres that support learning can give girls the experience they need to feel confident in their science and mathematics identities.

Math and Science Self-Efficacy

The lack of efficacy among young women compared to young women could contribute to the gender gap in STEM, computer science, and data science. This positivity bias could be an area for future research (Sakellariou, 2022). Previous experts have also suggested that computer science and analysis courses could be girls-only to work on self-esteem (Crombie et al., 2002; Pearl et al., 1990; Saujani, 2019). It has been shown that working within mixed-gender groups can lead to discouragement and a lack of confidence.

Teaching practices have been shown to significantly impact self-efficacy and achievement (Shu & Kaiser, 2022). Many social and cognitive factors within research can impact achievement and persistence; there could be a need to focus on non-cognitive factors like skills, attitudes, and behavior to address the gender gap problem (Donahue et al., 2016). Female students with higher self-efficacy are less likely to feel inferior to their male counterparts (Riegle-Crumb & Peng, 2021). Girls that are pursuing STEM show higher scores on academic and psychological variables versus girls interested in homemaking (Mau & Li, 2018).

La Paz (2012) commented that teachers can work on identity and self-efficacy by fostering confidence and collaboration. Race, gender, socioeconomics, mathematics interest, and science self-efficacy are the most significant predictors of STEM aspiration (Mau & Li, 2018). As research continues to address the gender gap, it is critical to find ways to enroll more women in STEM, computer science, and data science in order to achieve better solutions (Benavant et al., 2020).

Not many cited studies have found ways to change the self-confidence disparities. Since Western society depends on technology and innovation, research must begin to study ability beliefs and girls' educational interests (Van Aalderen-Smeets et al., 2018). Going forward, this will require a lot of research and attention in order to find innovative solutions. Career decision-making is a complex process, and the stereotype threat within STEM fields can significantly impact self-efficacy (Franz-Odendaal, 2020). With an increased understanding of the significant differences between young men and young women, we hope that curricular and pedagogical changes can occur to dismantle this problem. Thoughtful and innovative solutions to this problem are necessary to start addressing the gender gaps within the job market.

Math and Science Utility

One area of study that could produce tangible results regarding utility surrounds STEM schools and their orientation. STEM high school effectiveness and policies may impact girls' interest in pursuing the field. Vaval et al. (2019) stated that there are varying definitions of STEM, and the focus of high schools and pedagogy could impact girls' interests. Another element of study could surround the algebra gaps within schools; studying the topics conceptually over procedurally could create more spaces for girls to find more utility within these environments (Sharpe & Marsh, 2022). Applied STEM experiences, such as engineering projects, museum visits, and laboratories, could create more robust connections for students with content (Kurban & Cabrera, 2019). These various areas of study could prompt more entry points for girls to find the utility of science and mathematics interesting.

Organizations have focused on creating safe spaces for women to find mentorship within STEM fields. Women are pursuing higher education but not data science, computer science, or STEM careers (National Center for Education Statistics, 2020). Computer science remains one of the lowest areas of graduation for women (National Center for Education Statistics, 2020). Continued research is necessary to solve the gender gap problems present within the industry, in addition to finding mentors for young women to feel safe in STEM fields. Lack of representation, not perceived utility, could be an area for future research.

Underrepresentation in the workplace is another area for research (Traylor et al., 2020). Donahue et al. (2016) commented that student perceptions of teacher attitudes can impact their interests in STEM, computer science, and data science. Personal beliefs to succeed are created with confidence, which is vital for STEM careers (Sublett & Plasman, 2018). Data science, computer science, and STEM careers, coupled with family responsibilities, can cause significant stress for women due to the stringent requirements of the field (Fathima et al., 2020). Various workplaces require extreme dedication while placing the family second.

Female scientists and researchers face many challenges at work (Fathima et al., 2020). Mentorship is an area of study that could provide much merit. Women are underrepresented in data science, computer science, STEM education, and workforce fields (Traylor et al., 2020). Positive mentorship experiences can attract and retain women in various positions (Stoeger et al., 2019; Walker & Dalmage, 2016; Young et al., 2019). Social purpose and collaboration have been cited as strategies that more research could support. There is a lack of female role models in data science, computer science, and STEM careers (Fathima et al., 2020). Continued research is necessary for this area to enhance the situation.

Conclusion

Disparities by gender have existed in computer science, data science, and STEM careers for over 40 years (Vitores and Gil Juárez, 2016). The reason for the gap is still hard to pin down, along with solutions to the issues. Numerous interventions have not strongly impacted this area (Donahue et al., 2016; Emeagwali, 2016; Payton and Berki, 2019). In the K-12 space, some schools and non-profit groups have designed girls-only clubs in order to build confidence in computer science and data science. Saujani (2019), the CEO of Girls Who Code, supported girls-only coding courses in conjunction with mentorship. Many corporations have donated funds to provide training and mentorship to women pursuing STEM careers. Doerschuk et al. (2016) commented on ExxonMobil's grant, in partnership with Lamar University, to diversify the STEM space through multidisciplinary approaches to teaching. Corporations that provide specific funding and experiences can enhance access to STEM for girls and minority students, despite funding issues.

This body of work suggests there are significant differences between young men and young women regarding math and science perception. Specifically, there were significant differences in students' math identity, science identity, math self-efficacy, and science self-efficacy by gender. Students' beliefs greatly predict behavior, choice, and practices (Sakellariou, 2022). Data shared throughout this document demonstrate the need for more research into the gender gaps in math and science. The gender gap has remained persistent over time, so continued research could prove useful. Women's career choices are more complex to predict than men's career choices, so there is a need for continued study in this area to solve the problems (Franz-Odendaal et al., 2020). Diversity within institutions matters, and the gender gaps in data science, computer science, and STEM could finally be addressed with better representation of women in these career areas.

References

Alhadabi, A. (2021). Science interest, utility, self-efficacy, identity, and science achievement among high school students: An application of Sem Tree. *Frontiers in Psychology*, *12* (643120), https://doi.org/10.3389/fpsyg.2021.634120

Andersen, L., & Cross, T. (2014). Are students with high ability in math more motivated in math and science than other students? *Roeper Review*, *36*(4), 221-234. https://doi.org/10.1080/02783193.2014.945221

Antai, D., Antai, J., & Anthony, D. W. (2014). The relationship between socio-economic inequalities, intimate partner violence and economic abuse: A national study of women in the Philippines. *Global Public Health*, *9*(7), 808-826. 10.1080/17441692.2014.917195

Basu, B., & Famoye, F. (2004). Domestic violence against women, and their economic dependence: A count data analysis. *Review of Political Economy*, *16*(4), 457-472. 10.1080/0953825042000256685

Benavent, X., de Ves, E., Forte, A., Botella-Mascarell, C., Lopez-Inesta, E., Rueda, S., Roger, S., Perez, J., Portales, C., Dura, E., Garcia-Costa, D., & Marzal, P. (2020). Girls4STEM: Gender diversity in STEM for a sustainable future. *Sustainability*, *12*(15), 6051. https://doi.org/10.3390/su12156051

Berkeley Research Development Office . (n.d.) *Broader impacts/education and outreach.* University of California Berkeley. https://vcresearch.berkeley.edu/brdo/broader-impacts-education-and-outreach

Berman, F., & Bourne, P. (2015). Let's make gender diversity in data science a priority right from the start. *PLoS Biology*, *13*(7), 1-5. 10.1371/journal.pbio.1002206

Bettin, B., Jarvie-Eggart, M., Steelman, K. S., & Wallace, C. (2020). Infusing computing identity into introductory engineering instruction. In *2020 IEEE Frontiers in Education Conference (FIE)* (pp. 1-5). IEEE.

Bloodhart, B., B., Balgopal, M. M., Casper, A. M. A., McMeeking, L. B. S., & Fischer, E. V. (2020). Outperforming yet undervalued: Undergraduate women in STEM. *PLoS ONE*, *15*(6), 1-13. 10.1371/journal.pone.0234685.

Borum, V., & Walker, E. (2012). What makes the difference? Black women's undergraduate and graduate experiences in mathematics. *Journal of Negro Education*, *81*(4), 366-378. 10.7709/jnegroeducation.81.4.0366

Brown, S. D., Unger Hu, K. A., Mevi, A. A., Hedderson, M. M., Shan, J., Quesenberry, C. P., & Ferrara, A. (2014). The multigroup ethnic identity measure-revised: measurement invariance across racial and ethnic groups. *Journal of Counseling Psychology*, *61*(1), 154-161. https://doi.org/10.1037/a0034749

Cohoon, J. (2001).Toward improving female retention in the computer science major. *Communications of the ACM*, *44*(5), 108-114. https://dl.acm.org/doi/10.1145/374308.374367

Coyle, E., & Liben, L. (2020). Gendered packaging of a STEM toy influences children's play, mechanical learning, and mothers' play guidance. *Child Development*, *91*(1), 43-62. 10.1111/cdev.13139

Crocker, L., & Algina, J. (1986). *Introduction to classical and modern test theory.* Harcourt Brace.

Crombie, G., Abarbanel, T., & Trinneer, A. (2002). All-female classes in high school computer science: Positive effects in three tears of data. *Journal of Educational Computing Research*, *27*(4), 385-409. https://doi.org/10.2190/VRD4-69AF-WPQ6-P734

Creswell, J. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage Pub.

Dare, E. (2015). *Understanding middle school students' perceptions of physics by gender* [doctoral dissertation]. University of Minnesota.

Delaney, J. (2018). Seeking gender inclusiveness in software development. *Communications of the ACM*, *61*(9), 15. 10.1145/3237008

Dept of Computer Science. (n.d.). *What is computer science?* Undergraduate Computer Science at University of Maryland. https://undergrad.cs.umd.edu/what-computer-science

DeVellis, R. (2012). *Scale development theory and applications* (3rd ed., Vol. 26). Sage publications.

Doerschuk, P., Bahrim, C., Fowler, J. R., & Kruger, J. (2016). Closing the gaps and filling the STEM pipeline: A multidisciplinary approach. *Journal of Science Education & Technology*, *25*(4), 682-695. 10.1007/s10956-016-9622-8

Donahue, E. (2016). *Expecting success: Factors influencing ninth graders' science self-efficacy* [doctoral dissertation]. The City University of New York.

Emeagwali, N. (2016). Women in STEM: Their evolution, triumphs and challenges. *Techniques: Connecting Education & Careers*, *91*(8), 14-19.

Elective Staff. (2021). *From the College Board Review Archive: The gender gap in advanced placement computer science*. The Elective.

Fathima, F. N., Awor, P., Yen, C.-C., Gnanaselvam, N. A., & Zakham, F. (2020). Challenges and coping strategies faced by female scientists—A multicentric cross sectional study. *PLoS ONE*, *15*(9), 1-14. 10.1371/journal.pone.0238635

Field, A. (2009). *Discovering statistics using SPSS* (3rd ed.). SAGE Publications.

Folberg, A. (2020). Global perspectives on women and work. *Journal of Social Issues*, *76*(3), 464-483. 10.1111/josi.12396

Franz-Odendaal, T. A., Blotnicky, K. A., & Joy, P. (2020). Math self-efficacy and the likelihood of pursuing a STEM-based career: A gender-based analysis. *Canadian Journal of Science, Mathematics and Technology Education*, *20*(3), 538-556. https://doi.org/10.1007/s42330-020-00105-7

Frieze, C., & Quesenberry, J. (2019). How computer science at CMU is attracting and retaining women: Carnegie Mellon University's successful efforts enrolling, sustaining, and graduating women in computer science challenge the belief in a gender divide in CS education. *Communications of the ACM*, *62*(2), 23-26. 10.1145/3300226

Froehlich, L., Olsson, M. I. T., Dorrough, A. R., & Martiny, S. E. (2020). Gender at work across nations: Men and women working in male‐dominated and female‐dominated occupations are differentially associated with agency and communion. *Journal of Social Issues*, *76*(3), 484-511. 10.1111/josi.12390

Glass, R. (2017). How to really encourage women in computing. *Communications of the ACM*, *60*(8), 8-9. 10.1145/3117849

Grimalt‐Álvaro, C., Couso, D., Boixadera-Planas, E., & Godec, S. (2021). "I see myself as a STEM person": Exploring high school students' self‐identification with STEM. *Journal of Research in Science Teaching*, *59*(5), 720-745. https://doi.org/10.1002/tea.21742

Guttman, C. (2001). When girls go missing from the classroom. *UNESCO Courier*, *54*(5), 13.

Herman, C., Gracia, R., Macniven, L., Clark, B., & Doyle, G. (2019). Using a blended learning approach to support women returning to STEM. *Open Learning*, *34*(1), 40-60. 10.1080/02680513.2018.1554475

Hirn, R. G., Hollo, A., & Scott, T. M. (2018). Exploring instructional differences and school performance in high-poverty elementary schools. *Preventing School Failure*, *62*(1), 37-48. 10.1080/1045988X.2017.1329197

Ingels, S. J., Pratt, D. J., Herget, D. R., Burns, L. J., Dever, J. A., Ottem, R., Rogers, J. E., Yin, R., Leinwand, S., & LoGerfo. (2011). *High School Longitudinal Study of 2009 (HSLS:09): Base-year data file documentation (NCES 2011-328)*. National Center for Education Statistics, Institute of Education Statistics, US Department of Education.

Ingels, S. J., Pratt, D. J., Herget, D. R., Dever, J. A., Fritch, L. B., Ottem, R., Rogers, J. E., Kitmitto, S., Leinwand, S., & Christopher, E. (2013). *High School Longitudinal Study of 2009 (HSLS:09) Base year to first follow-up data file documentation (NCES 2014-361)*. National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education.

Kurban, E., & Cabrera, A. (2019). Building readiness and intention towards STEM fields of study: Using HSLS:09 and sem to examine this complex process among high school students. *The Journal of Higher Education*, *91*(4), 620-650. https://doi.org/10.1080/00221546.2019.1681348

Jezierska, J. (2016). STEM like a woman. *Techniques: Connecting Education & Careers*, *91*(8), 29-33.

Jones, T. (2020). Making makerspaces more functional and sustainable. *Teacher Librarian*, *48*(2), 44-46

Johnson, R., & Christensen, L. (2014). *Educational research: Quantitative, qualitative, and mixed approaches* (5th ed.). Sage.

Kang, H., Barton, A. C., Tan, E., Simpkins, S. D., Rhee, H.-Y., & Turner, C. (2019). How do middle school girls of color develop STEM identities? Middle school girls' participation in science activities and identification with STEM careers. *Science Education*, *103*(2), 418-439. 10.1002/sce.21492

Khan, Z., & Rodrigues, G. (2017). Stem for girls from low income families: Making dreams come true. *Journal of Developing Areas*, *51*(2), 435-448. 10.1353/jda.2017.0056

Kumar, R. (2014). *Research methodology: A step-by-step guide for beginners*. SAGE.

Kumpulainen, K., & Kajamaa, A. (2020). Sociomaterial movements of students' engagement in a school's makerspace. *British Journal of Educational Technology*, *51*(4), 1292-1307. 10.1111/bjet.12932

La Paz, K. (2012). Girls in STEM: Unlocking potential. *Technology & Engineering Teacher*, *72*(1), 9-10.

Lavakumar, A. (2021). *Fostering computer science identity among underrepresented minority students: An exploration of contributing factors*. [Doctoral dissertation, Regis College].

Lewis, A. (2006). Washington scene. *Education Digest*, *72*(2), 70-73.

Li, G., & Scientist, N. (2021). Discrimination is still a problem in STEM. *New Scientist*, *250*(3333), 20-21. 10.1016/s0262-4079(21)00785-5

Little, T. (2014). *The Oxford handbook of quantitative methods*. Oxford University Press.

Liu, G. (2008). Improving title I funding equity across states, districts, and schools. *Iowa Law Review*, *93*(3), 973-1013.

Lynn, C. D., Howells, M. E., & Stein, M. J. (2018). Family and the field: Expectations of a field-based research career affect researcher family planning decisions. *PLoS ONE*, *13*(9), 1-25. 10.1371/journal.pone.0203500

Maclin, B. J., Bustamante, N. D., Wild, H., & Patel, R. B. (2020). "To minimise that risk, there are some costs we incur": Examining the impact of gender-based violence on the urban poor. *Global Public Health*, *15*(5), 734-748. 10.1080/17441692.2020.1716036

Matic, A., & Jadhav, P. (2018). Gender bias in STEM: How medical communicators can act. *AMWA Journal: American Medical Writers Association Journal*, *33*(4), 152-156, https://aimbiomedical.com/gender-bias-article/

Mau, W., & Li, J. (2018). Factors influencing STEM career aspirations of underrepresented high school students. *The Career Development Quarterly*, *66*(3), 246-258. https://doi.org/10.1002/cdq.12146

Michell, D., Szorenyi, A., Falkner, K., & Szabo, C. (2017). Broadening participation not border protection: how universities can support women in computer science. *Journal of Higher Education Policy & Management*, *39*(4), 406-422. 10.1080/1360080X.2017.1330821

Minnotte, K., & Pedersen, D. (2021). Turnover intentions in the STEM Fields: The role of departmental factors. *Innovative Higher Education*, *46*(1), 77-93. 10.1007/s10755-020-09524-8

Niese, Z. A., Libby, L. K., Eibach, R. P., & Carlisle, C. (2019). I can see myself enjoying that: Using imagery perspective to circumvent bias in self-perceptions of interest. *Journal of Experimental Psychology General*, *148*(12), 2258-2276. 10.1145/3319422

Nwankwo, U., & Pisa, M. (2021). Why the world needs more women data scientists. *Center For Global Development.* https://www.cgdev.org/blog/why-world-needs-more-women-data-scientists

Office for Human Research Protections (OHRP). (2021). *The Belmont Report*. HHS.gov. https://www.hhs.gov/ohrp/regulations-and-policy/belmont-report/read-the-belmont-report/index.html#:~:text=2.,to%20secure%20their%20well%2Dbeing

Oracle. (2018). *What is data science?* Oracle. https://www.oracle.com/data-science/what-is-data-science/

Pan, L., & Ye, J. (2017). "Children of great development": Difficulties in the education and development of rural left-behind children. *Chinese Education & Society*, *50*(4), 336-349. 10.1080/10611932.2017.1382137

Payton, F., & Berki, E. (2019). Countering the negative image of women in computing. *Communications of the ACM*, *62*(5), 56-63. 10.1145/3319422

Pearl, A., Pollack, M. E., Riskin, E., Wolf, E., Thomas, B., & Wu, A. (1990). Becoming a computer scientist. *Communications of the ACM*, *33*(11), 47-57. 10.1145/92755.92757.

Phelan, S. A., Harding, S. M., & Harper-Leatherman, A. S. (2017). BASE (Broadening Access to Science Education): A research and mentoring focused summer STEM camp serving underrepresented high school girls. *Journal of STEM Education: Innovations & Research*, *18*(1), 65-72. https://www.jstem.org/jstem/index.php/JSTEM/article/view/2200/1844

Riegle-Crumb, C., & Peng, M. (2021). Examining high school students' gendered beliefs about math: Predictors and implications for choice of STEM College majors. *Sociology of Education*, *94*(3), 227-248. https://doi.org/10.1177/00380407211014777

Reshma Saujani on getting girls into computer science. (2019). *Educational Leadership*, *76*(5), 10-11.

Roberts, C., & Hyatt, L. (2019). *The dissertation journey: A practical and comprehensive guide to planning, writing, and defending your dissertation*. Corwin, a SAGE Company.

Robnett, R., & John, J. (2020). "It's wrong to exclude girls from something they love." Adolescents' attitudes about sexism in science, technology, engineering, and math. *Child Development*, *91*(1), e231-e248. 10.1111/cdev.13185

Sakellariou, C. (2022). The reciprocal relationship between mathematics self-efficacy and mathematics performance in US high school students: Instrumental variables estimates and gender differences. *Frontiers in Psychology*, *13*.10.3389/fpsyg.2022.941253

Sakellariou, C., & Fang, Z. (2021). Self-efficacy and interest in STEM subjects as predictors of the STEM gender gap in the US: The role of unobserved heterogeneity. *International Journal of Educational Research*, *109*(101821), 10.1016/j.ijer.2021.101821

Sallop, L., & Kirby, S. (2007). The role of gender and work experience on career and work force diversity expectations. *Journal of Behavioral & Applied Management*, *8*(2), 122-140. 10.21818/001c.16717

Selimbegović, L., Karabegovic, M., Blazev, M., & Burusic, J. (2019). The independent contributions of gender stereotypes and gender identification in predicting primary school pupils' expectancies of success in STEM fields. *Psychology in the Schools*, *56*(10), 1614-1632. 10.1002/pits.22296

Seong, W., & Borgonovi, F. (2020). Students' teaching career expectations by gender and ability levels in science and math: The role of salary and numeracy skills. *European Journal of Education*, *55*(3), 405-427. 10.1111/ejed.12407

Sharpe, S., & Marsh, D. (2022). A systematic review of factors associated with high schoolers' algebra achievement according to HSLS:09 results. *Educational Studies in Mathematics*, *110*(3), 457-480. https://doi.org/10.1007/s10649-021-10130-4

Sheffield, R., Koul, R., Blackley, S., & Maynard, N. (2017). Makerspace in STEM for girls: a physical space to develop twenty-first-century skills. *Educational Media International*, *54*(2), 148-164. 10.1080/09523987.2017.1362812

Shein, E. (2018). Broadening the path for women in STEM: Organizations work to address "a notable absence of women in the field." *Communications of the ACM*, *61*(8), 19-21. 10.1145/3231170

Spaulding, D., Kennedy, J. A., Rozsavolgyi, A., & Colon, W. (2020). Differences in outcomes by gender for peer mentors participating in a STEM persistence program for first-year students. *Journal of STEM Education: Innovations & Research*, *21*(1), 5-10.

Stoeger, H., Debatin, T., Heilemann, M., & Ziegler, A. (2019). Online mentoring for talented girls in STEM: The role of relationship quality and changes in learning environments in explaining mentoring success. *New Directions for Child & Adolescent Development*, *2(*168), 75-99. 10.1002/cad.20320

Sublett, C., & Plasman, J. S. (2018). How does applied STEM coursework relate to mathematics and science self-efficacy among high school students? evidence from a national sample. *Journal of Career and Technical Education*, *32*(1). 10.21061/jcte.v32i1.1589

Suter, L. (2014). Visiting science museums during Middle and high school: A longitudinal analysis of student performance in science. *Science Education*, *98*(5), 815-839. https://doi.org/10.1002/sce.21116

Talaue, F. (2014). Social equity and access to a Philippine STEM school. *Theory Into Practice*, *53*(1), 33-40. 10.1080/00405841.2014.862120

Todd, B., & Zvoch, K. (2017). Exploring girls' science affinities through an informal science education program. *Research in Science Education*, *49*(6), 1647-1676. https://doi.org/10.1007/s11165-017-9670-y

*The truth about equality in STEM. (*2020). *New Scientist*, *245*(3274), 22-23. https://10.1016/s0262-4079(20)30591-1

Torre, M. (2014). The scarring effect of "women's work": The determinants of women's attrition from male-dominated occupations. *Social Forces*, *93*(1), 1-29. 10.1093/sf/sou059

Traylor, A. M., Ng., L. C., Corrington, A., Skorinko, J. L. M., & Hebl, M. R.(2020). Expanding research on working women more globally: Identifying and remediating current blindspots. *Journal of Social Issues*, *76*(3), 744-772. 10.1111/josi.12395

Ujifusa, A. (2015). Some school choice backers tepid on Title I portability proposal. *Education Week*, *35*(10), 16-19.

U.S. Department of Education. (2018). *Title I, part of a program*. https://www2.ed.gov/programs/titleiparta/index.html#:~:text=Schools%20in%20which%20children%20from,of%20the%20lowest%2Dachieving%20students.

Van Aalderen-Smeets, S. I., van der Molen, J. H. W., & Xenidou-Dervou, I. (2018). Implicit STEM ability beliefs predict secondary school students' STEM self-efficacy beliefs and their intention to opt for a STEM field career. *Journal of Research in Science Teaching*, *56*(4), 465-485. https://doi.org/10.1002/tea.21506

Van Langen, A. (2015). Girls and STEM choice in Dutch education: The strong gender segregation and the good practice of the stimulation policy. *Gender Studies & Research*, *13*, 26-39.

Vaval, L., Bowers, A. J., & Rangel, V. S. (2019). Identifying a typology of high schools based on their orientation toward STEM: A latent class analysis of HSLS:09. *Science Education*, *103*(5), 1151-1175. https://doi.org/10.1002/sce.21534

Vitores, A., & Gil-Juárez, A. (2016). The trouble with "women in computing": a critical examination of the deployment of research on the gender gap in computer science. *Journal of Gender Studies*, *25*(6), 666-680. 10.1080/09589236.2015.1087309

Vescio, T., Gervais, S. J., Snyder, M., & Hoover, A. (2005). Power and the creation of patronizing environments: The stereotype-based behaviors of the powerful and their effects on female performance in masculine domains. *Journal of Personality & Social Psychology*, *88*(4), 658-672. 10.1037/0022-3514.88.4.658

Von Hippel, C., Issa, M., Ma, R., & Stokes, A. (2011). Stereotype threat: Antecedents and consequences for working women. *European Journal of Social Psychology*, *41*(2), 151-161. 10.1002/ejsp.749

Walker, D., & Dalmage, S. (2016). The STEM conference for girls: Providing access to opportunity. *Techniques: Connecting Education & Careers*, *91*(8), 40-44.

Wang, M. T., & Degol, J. (2017). Gender gap in science, technology, engineering, and mathematics (STEM): Current knowledge, implications for practice, policy, and future directions. *Educational Psychology Review*, *29*(1), 119-140. 10.1007/s10648-015-9355-x

Wei-Cheng, M., Chen, S.-J., Li, J., & Johnson, E. (2020). Gender difference in STEM career aspiration and social-cognitive factors in collectivist and individualist cultures. *Administrative Issues Journal: Education, Practice & Research*, *10*(1), 30-46. 10.5929/2020.10.1.3

Welsch, D., & Winden, M. (2019). Student gender, counselor gender, and college advice. *Education Economics*, *27*(2), 112-131. 10.1080/09645292.2018.1517864

Wenhold, H., & Harrison, K. (2021). Emerging adults and gender norms: Everyday life experiences, media Perceptions, attitudes, and future expectations. *Gender Issues*, *38*(4), 420-437. 10.1007/s12147-020-09270-3

World Health Organization. (n.d.). *Gender and health*. https://www.who.int/health-topics/gender#tab=tab_1

Wright, T. (2016). Women's experience of workplace interactions in male-dominated work: The intersections of gender, sexuality and occupational group. *Gender, Work & Organization*, *23*(3), 348-362. 10.1111/gwao.12074

Xu, Y. (2015). Focusing on women in STEM: A longitudinal examination of gender-based earning gap of college graduates. *Journal of Higher Education*, *86*(4), 489-523. 10.1353/jhe.2015.0020

Yenor, S. (2021). Feminism--What the critics missed: Nature was supposed to trump the politics of gender. Here's why it didn't. *Modern Age*, *63*(1), 7-14.

Young, J., Young, J. R., & Ford, D. Y. (2019). Culturally relevant STEM out-of-school time: A rationale to support gifted girls of color. *Roeper Review, 41*(1), 8-19. doi:10.1080/02783193.2018.1553215.

Zenebe Ede'o, A., Ketebo, J. H., & Chala, B. W. (2020). Feminization of multidimensional urban poverty in sub‐Saharan Africa: Evidence from selected countries. *African Development Review*, *32*(4), 632-644. 10.1111/1467-8268.12466.

Zhu, Y., & Kaiser, G. (2022). Impacts of classroom teaching practices on students' mathematics learning interest, mathematics self-efficacy and mathematics test achievements: A secondary analysis of Shanghai data from the International Video Study Global Teaching Insights. *ZDM - Mathematics Education*, *54*(3), 581-593. https://doi.org/10.1007/s11858-022-01343-9

Appendix A: IRB Submission Documents

BETHEL
UNIVERSITY

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

November 6, 2022

Lauren Mauel
Bethel University
St. Paul, MN 55112

Re: Project: *Perceptions of Math and Science in Young Girls*

Dear Lauren Mauel,

On November 5, 2022, 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 November 5, 2023.

Sincerely,

Safary Wa-Mbaleka, EdD, PhD
Chairperson, EdD in Leadership Level Two IRB Committee