From Girls to Women in STEM:

A Qualitative Phenomenological Study

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Abstract

Early engagement of girls in science, technology, engineering, and math (STEM) leads to greater numbers of girls who become women in these fields. Few studies explore the benefit of implementing STEM programs in middle school. Even fewer studies explore benefits those programs may have on meeting girls' interest in STEM when the interest is at its highest level. As a result, the problem is an underemphasis on middle school girls' participation in STEM education. The current qualitative phenomenological study explored the essence and meaningfulness of middle school experiences of 15 women who worked in a STEM field in the United States and Mexico at the time of this research. The study included an investigation into how middle school STEM classes may have influenced participants' decision to become STEM professionals. Participants filled out questionnaires, were interviewed, field notes were taken, and then, participants reviewed and verified their responses through a process called member checking. A 6-step framework was utilized to prepare data and the thematic content analysis approach was used to analyze data. Growth mindset theory and transformational leadership theory provided the framework for this study. Results indicated participants who received support from a combination of teachers, peers, and family, participated in enrichment activities, and who saw female STEM professionals during middle school became women in STEM. Findings from this research may help determine best practices for implementing STEM programs in middle school so more girls become women in these fields.

Keywords: science, technology, engineering, math, STEM, middle school, girls, K–12, U.S. education, transformational leadership, growth mindset

Dedication

I dedicate this journey of becoming Dr. Pantella to my mother, Martha Moyer. She instilled in me a profound love for education and learning as well as the belief I could do anything that I put my mind to.

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Chapter 1: Introduction

Throughout history, women have been seen as less suited for leadership positions than men (Brescoll, 2016). Many girls demonstrate leadership skills and an interest in science, technology, engineering, and math (STEM) in their early school years. By middle school, the interest peaks and begins to decline on the way to high school when programs are unavailable to capture and cultivate the interest (Chiu et al., 2015). Funding for the development of STEM programs has primarily been directed to high schools, despite the overwhelming evidence of girls' interest beginning to decline in middle school (Blotnicky et al., 2018). Studies continue to indicate women are perceived as lacking qualities required to be successful scientists (Carli et al., 2016). By investigating middle school experiences of adult female scientists, findings demonstrated specific areas of improvement for the education of girls in the areas of science, technology, engineering, and math.

An introduction to the study follows. The chapter includes background information, a statement of the problem, the purpose and significance of the study, and research questions. Additionally, a description of theoretical frameworks utilized to support the study, definition of important terms, assumptions, the scope and delimitations, limitations, and a summary are included.

Background of the Problem

Evidence indicated a correlation between early engagement in STEM activities and an increase in the number of girls becoming women who work in these fields (Rodenbusch et al., 2016). Girls often misunderstand how STEM fields work in the real world and how they would fit into career positions for several reasons (Kesar, 2018). Fewer girls become women in STEM when family and peer support is absent and girls fail to see women represented in these fields (Kesar, 2018). Studies indicate boys are not particularly more gifted in math than girls are, but boys tend to overestimate personal ability (Wang & Degol, 2017). According to Prinsley et al. (2016), the global presumption of excellence is due to a greater social reinforcement of math ability towards boys than towards girls.

Spearman (1904) asserted people were born with innate abilities, such as intelligence, that could not be changed. Belief in the innate abilities of human beings was often used as proof to reinforce contemporary social mores, which suggested certain races and the female sex were less intelligent than most men were and therefore less capable (Haimovitz & Dweck, 2017). Recently, growth-oriented models of intelligence have demonstrated intelligence is not limited by race or sex (Dweck, 2016). For the first time in history, women outnumber men in educational attainment worldwide, earning two-thirds of all associate, bachelor, and master degrees (Geiger & Parker, 2018). For the past 10 years, women have also earned more graduate and doctoral degrees than men did (Okahana & Zhou, 2018). Of those degrees, women only comprise 34.5% of master's degrees and 25.2% of doctoral degrees in computers and math (Okahana & Zhou, 2018). In the field of engineering, women hold 26% of master's and 24.8% of doctoral degrees (Okahana & Zhou, 2018).

Women still comprise only one-third of the science and engineering workforce (National Science Board [NSB], 2018). The disparity is also reflected in higher education with women representing only 17.4% of tenure and tenure-track faculty in U.S. colleges of engineering (Roy, 2019). The stark reality is women are underrepresented in four of the 11 fields of graduate study including engineering and computer science (Okahana & Zhou, 2018). Reinking and Martin

(2018) suggested the imbalance may be due to a range of factors such as gendered socialization, peer group influence, and STEM professional stereotyping.

According to Olsson and Martiny (2018), implicit bias may represent a significant factor in careers women pursue. Implicit bias is a combination of attitudes or stereotypes affecting people's understanding, actions, and decisions unconsciously. When asked directly, men and women would say both sexes have equal ability. However, data from thousands of participants in the Implicit Association Test show this belief in equity is not the case (Greenwald et al., 1998). Girod, et al. (2018) found, in academia, men's competency, skills, productivity, and leadership were viewed as better based on gender alone. The implicit bias training implemented by many institutions has done little to close the gap in inequity between men and women institutionally (Pritlove, et. al, 2019). Conrad, et al. (2010) posited that, instead of placing the emphasis on structural systems which frame the beliefs and laws regulating social institutions, too much emphasis is placed on individual choice and this decision diminishes chances for meaningful change. Men and women tend to associate women with liberal arts and men with science (Greenwald et al., 1998). Internal and external perception bias has been observed in middle school children as young as 12 years old and falls along gender stereotypes (Selimbegović et al., 2019). Results of the Implicit Association Test reinforced findings that indicate women begin incorporating gender-stereotype perceptions into self-image early on as young girls (Olsson and Martiny, 2018). When self-limiting beliefs are further reinforced externally by society, the effect shows in the types of careers women pursue.

Over time, gender bias may lead to career choices that devastate women economically when compared to men (Rodenbusch et al., 2016). STEM careers earn 50% more than occupations outside of these fields (NSB, 2018). Women who become mothers experience the economic effect more acutely. According to Lucifora et al. (2017), 1 year after the first child is born, the salary and bonuses of a mother drop to 10% and 40% of nonmothers, respectively. Mothers were also shown to be promoted to managerial positions less often than nonmothers.

Statement of the Problem

The problem is the underemphasis on middle school girls' participation in STEM education (Chiu et al., 2015). Opportunities for the improvement of social conditions for girls and women abound. Data indicate early intervention in education is one area in which a significant difference can be made (Wang & Degol, 2017). Limited amounts of funding for STEM programs find the way to middle school when compared to high school (Rodenbusch et al., 2016). Additionally, few studies explore the benefit of implementing STEM programs in middle school. Even fewer studies explore the benefits those programs may have on meeting girls' interest in science, technology, engineering, and math– when the interest is at its highest level. The focus of this study is on sharing middle school experiences of women working in STEM fields at the time of this research. The information may help determine best practices for implementing STEM programs in middle school so more girls become women in these fields.

Purpose of the Study

The purpose of this qualitative phenomenological study was to advance the literature about women's lived experiences in middle school STEM and to explore how the essence and meaningfulness of the experiences influenced the decision to become professionals in STEM fields. Middle school is defined as grades 6-8 for the purpose of this study. Findings may contribute to the development and implementation of programs in middle school to establish a pipeline of girls who become women in these fields. Research into middle school experiences of 15 professional women with STEM careers from the United States (U.S.) and Mexico was completed using a questionnaire, semi-structured interview, and researcher field notes. To verify the data, participants were given the opportunity to review interview transcripts through a process called member checking. Results from the study may be utilized to determine how middle school STEM programs can be implemented or improved to lead to more girls pursuing degrees in these fields.

Significance of the Study

Studies indicate girls’ interest in STEM subjects peaks during middle school (Chiu et al., 2015; Kesar, 2018; Selimbegović, et al., 2019). Much of the funding and research for these subjects is primarily directed towards high school students (Blotnicky et al., 2018). Consequently, many girls may lose interest before ever being fully exposed to the subjects (Chiu et al., 2015). Improving outcomes for girls and women in STEM subjects is necessary to improve opportunities for women and to diversify these fields (Reinking & Martin, 2018). Results of this study may give school decision-makers insight into identifying programs and policies designed to engage middle school girls in STEM subjects.

The results of the study may demonstrate the critical importance of girls having peer, family and teacher support to reinforce interest in STEM subjects. The findings also demonstrate girls build interest in becoming STEM professionals when able to see a future for themselves through the work of adult female STEM professionals. Girls also build confidence when offered the opportunity to explore one or more STEM fields through after-school clubs and competitive STEM activities. Finally, when girls see women as STEM leaders in the present, a future opens through which more girls become STEM leaders, while simultaneously closing the gender discrimination gap and relegating it to the past. The significance of the findings indicates when given the right support and exposed to female STEM professionals, STEM enrichment opportunities, and female STEM leaders' interest in STEM builds beyond middle school and extends into becoming STEM professionals. By capturing girls' interest at the right time and in the most effective manner, a pipeline for girls to become women in STEM fields may be developed.

Research Questions

The author of the study explored the life experiences of professional women in STEM when they were girls in middle school. Prior studies indicate girls' interest in STEM subjects peaks during middle school. Investigating experiences of women during middle school may offer insight into how to improve outcomes for middle school girls. The following research questions guided the study:

Research Question 1: How does the STEM professional woman describe her lived experience as a girl in middle school STEM classes?

Research Question 2: How does the STEM professional woman relate her exposure to STEM classes during middle school to her decision to pursue a career in STEM?

Theoretical Framework

Theoretical frameworks utilized in this study include transformational leadership (Bass, 1985; Burns, 1978; Downton, 1973) and growth mindset theory (Dweck, 2016). Downton (1973) first developed transformational leadership. Burns (1978) improved upon the theory and Bass (1985) expanded the theory to include methods for measuring leadership success.

Transformational leadership theory is defined as an inspirational method of leadership, which strives to engage employees through a process of intrinsic motivation to help achieve an organizational mission (Jovanovica & Ciricb, 2016). Schools have become more structured like businesses and many principals have not been trained in business leadership and management. Transformational leadership training of educational leaders has led to better performance of administrators and the schools they lead (Anderson, 2017).

Growth mindset theory demonstrates intelligence is changeable, and student attitudes about failure and ability to succeed are linked more to success than any inherent ability (Dweck, 2016). Theories of growth contrast with long held fixed beliefs of intelligence have been promoted by scholars, such as Spearman (1904). Mindset theory applies to educators as well because teachers support students based on personal beliefs about learning. Girls may choose an alternative academic and career path when math and science abilities are not held internally or reinforced externally. (Huang et al., 2019). Consequences of holding fixed beliefs as a student and as an educator may be catastrophic for many girls.

The theories framed the study's research questions in two ways. Growth mindset theory reaffirms all students are capable of learning and improving. Transformational leadership requires leaders to inspire students by engaging them in a vision, which includes girls as an equally important part of the future of science, technology, engineering, and math.

Definitions of Terms

To clarify many terms utilized in the research study, a definition of terms follows. By understanding the terminology, the reader can contextualize the aim of the study.

Ambivalent Sexism Theory. Ambivalent sexism theory was developed to explain the interrelationship between the biological male–female relationship and the pervasive universal masculine dominance in societies (Connor & Fiske, 2019).

Benevolent Sexism. Benevolent sexism consists of affectively positive but condescending attitudes and reactions to women who embrace traditional gender roles. Benevolent sexism can take the form of protective paternalism (protectiveness toward women who are seen as weaker than men), complementary gender differentiation (flattering beliefs about women's morality and sweetness), or heterosexual intimacy (the belief men are incomplete without a woman's love; Kuchynka et al., 2018).

Fixed Mindset. A fixed mindset is a belief intelligence is an inborn and unchangeable state of mind (Spearman, 1904).

Growth Mindset. Growth mindset is a belief intelligence is changeable through learning (Dweck, 2016).

Hostile Sexism. Hostile sexism consists of overtly negative, angry attitudes, and behavior toward women who occupy masculine domains or push for social change; it often takes the form of disparaging attitudes about women's incompetence relative to men's or suspicion and resentment directed at women who are perceived as insubordinate (Kuchynka et al., 2018).

Transformational Leadership Theory. **Transformational leadership theory is** an inspirational method of leadership which strives to engage employees through a process of intrinsic motivation to help achieve an organizational mission (Jovanovica & Ciricb, 2016).

Assumptions

According to Theofanidis and Fountouki (2019), "Assumptions are ideas that are taken for granted and viewed as reasonable and widely accepted" (p. 160). During this study, the assumption was made participants would be honest when answering questions and sharing experiences. Instruments used in this study include a questionnaire, semi-structured interview, and researcher field notes to explore lived experiences of women during middle school STEM classes and are deemed reliable and valid. Objectivity was maintained when collecting and analyzing data by staying open to the outcomes of the research. The chosen methodology offered the most logical and appropriate design for this research project because the research strategy allows one to explore the lived experiences of the participants (Vagle, 2018).

Scope and Delimitations

Delimitations are essentially limitations the researcher applied to the study to keep the study within boundaries of the research plan (Theofanidis & Fountouki, 2019). The population for the study included women between the ages of 22 and 65 in the United States and Mexico who worked in STEM fields at the time of this research. An electronic questionnaire and semi-structured video interviews were utilized to facilitate data collection more easily and quickly because participants were in different locations across two countries. Researcher field notes were taken as the final data collection method and together with the questionnaire and semi-structured interviews, triangulated the data. Member checking was used to review the interview transcripts. Because the population of participants was limited to 15, the level of transferability was reduced. A larger population of participants could expand transferability. The results were not generalizable because personal experiences cannot be attributed to larger populations.

Limitations

Limitations are unavoidable weaknesses in the study often due to the research design

(Theofanidis & Fountouki, 2019). The use of an electronic format for questioning participants may have affected the openness of participants because the style may have been perceived as distant. Participants were asked to recount experiences from childhood, which could have been affected by variations in memory recall.

Chapter Summary

Chapter 1 consisted of the problem, the purpose, the significance of the study, and theoretical frameworks used to guide the study. Also, terms encountered throughout the study were defined, the scope was explained, and the limitations of the study were made known. Studies indicate girls' interest in STEM subjects peaks during middle school but most funding for STEM is directed to high schools (Chiu et al., 2015; Wang & Degol, 2017). By capturing girls' interest at the right time and funding appropriate programs, a pipeline for girls to become women in STEM fields may be developed. A total of 15 women from the United States and Mexico who worked in a STEM field participated in the study. Chapter 2 is a review of the literature, which formed the basis of this investigation into the lived middle school experiences of women in STEM and how those experiences may have influenced a decision to become a STEM professional.

Chapter 2: Literature Review

The problem was the underemphasis on middle school girls' participation in science, technology, engineering, and math (STEM) education (Chiu et al., 2015). The purpose of this qualitative phenomenological study was to advance the literature about women's lived experiences in middle school STEM and explore how the essence and meaningfulness of the experiences influenced the decision to become professionals in STEM fields. For the study, middle school was defined as Grades 6–8. The investigation was necessary because there was a gap in the literature demonstrating the significance of beginning STEM education during middle school on the outcome of girls becoming women in STEM fields.

Research, programs, and funding continued to be focused at the high school level without further understanding of short- and long-term benefits of beginning in middle school (Blotnicky et al., 2018; Chiu et al., 2015). The study contributes to the knowledge base by understanding how middle school STEM electives can influence a girl's choice to pursue a STEM career. Chapter 2 includes the literature search strategy, theoretical frameworks for the research, and a literature review. Subheadings include early engagement in STEM for girls; underrepresented women in STEM; state of affairs for women in science; economic loss for women; girls' experience in the classroom; and opportunities for improvement. Chapter 2 concludes with a summary.

Literature Search Strategy

The main source for finding articles relevant to the study was the American College of Education Library. Keywords were entered into the search box to find peer-reviewed journal articles, and within these articles, there were sources listed in references, which further supported the research questions. Keywords and phrases, such as science, technology, engineering, and math middle school; and girls science, technology, engineering, and math were used. Additionally, K–12 STEM U.S. education, transformational leadership, and growth mindset were some search strings used for the research. Google Scholar was utilized to discover other relevant journal articles. Additionally, government and nonprofit websites provided primary source empirical data from which to conclude.

Theoretical Framework

The study included two theoretical frameworks to guide the research. The first, transformational leadership, was developed by Downton (1973), improved by Burns (1978), and expanded by Bass (1985). The transformational leadership style motivates employees intrinsically to believe in the organizational vision. The second framework was the growth mindset theory developed by Dweck (2016). A growth mindset is built upon the belief intelligence can be developed through consistent effort over time and learning from mistakes.

Transformational leadership is viewed as an inspirational way to rally a base to support a vision into reality (Jovanovica & Ciricb, 2016). As schools have become increasingly like businesses, there are concerns principals do not possess the management and leadership skills required to successfully operate a school (Anderson, 2017). Transformational leadership training has been shown to increase the performance of educational leaders and the schools they represent (Anderson, 2017).

Growth mindset theory suggests intelligence and capacity for learning were not fixed aspects of the human mind (Dweck, 2016). Over 30 years ago, Dweck became interested in student attitudes about failure (Dweck & Bempechat, 1983; Dweck & Leggett, 1988; Henderson

& Dweck, 1990). Some students quickly moved past failure, while others did not. Dweck (2016) coined the terms “fixed” and “growth” mindset to distinguish the difference between students and educators who believe abilities are inborn versus those who believe they can change with effort, respectively (Dweck & Leggett, 1988). Dweck (2016) developed the growth mindset theory as an alternative to the long-held belief in fixed models of intelligence derived from Spearman (1904). The theory posits when a person believes in personal capability and is willing to do the work, success is often guaranteed (Dweck, 2016). The mindset may mean people who do not believe in themselves generally do not try (Dweck, 2016).

Girls’ mindsets towards math and science largely determined the pursuit of a science, technology, engineering, or math field (Huang et al., 2019). The purpose of this qualitative phenomenological study was to advance the literature about women’s experiences in middle school STEM and explore how the essence and meaningfulness of the experiences influenced the decision to become professionals in STEM fields. The theories supported the study by keeping in mind all students are capable of learning (growth mindset theory) and change requires leaders (transformational leadership) with the programmatic vision to include girls as part of meeting a global need (Andersen et al., 2018).

Research Literature Review

The problem was the underemphasis on middle school girls’ participation in STEM education (Chiu et al., 2015). Interest in these subjects peaked in middle school where few programs were available to capture girls’ interest (Chiu et al., 2015). The findings of the current study highlighted the importance of engaging girls in middle school with appropriate classes and programs to cultivate and advance interest in science, technology, engineering, and math; and the need to do so with a growth mindset. The author presented arguments from the literature describing the importance of early engagement for girls. The literature review also is a description of the state of affairs for women in science and engineering, the economic effect, the gender gap between various STEM disciplines, girls' experiences in the classroom, and opportunities for improvement.

Early Engagement in STEM for Girls

When students engage in STEM education as early as possible, students' ability and interest in STEM education can remain strong throughout their academic career and beyond (Rodenbusch et al., 2016). Research indicated girls begin losing interest in STEM as high school approaches (Reinking & Martin, 2018). A study from Microsoft indicated reasons range from peer pressure to a lack of role models and support from parents and teachers to a general misperception of what STEM careers look like in the real world (Kesar, 2018).

Hand et al. (2017) explained girls enter middle school with lower confidence in their math abilities than do boys. Though many boys are no more gifted than girls in math, boys tend to overestimate their ability, while girls feel less confident throughout high school (Wang & Degol, 2017). One reason for the discrepancy in each gender's perception from early on was because boys often have their math abilities reinforced while girls do not (Wang & Degol, 2017). Regardless of ability, boys outnumbered girls in these fields simply because of the presumption of excellence (Prinsley et al., 2016).

For over 100 years, students have been limited by fixed mindset theories advanced in education (Haimovitz & Dweck, 2017). Spearman (1904) suggested people were born with fixed abilities, talents, and intelligence which could not be modified. Fixed mindset thinking has been incredibly limiting for genders and underrepresented populations (Haimovitz & Dweck, 2017). The perception was one's future was based on the fate one was born with and there was nothing one could do to change the outcome (Spearman, 1904). Scholars and laypersons who held such views believed intelligence could be measured by a single number, such as an IQ test, and measures of general intelligence influenced performance on cognitive tasks (Spearman, 1904).

Perception is highly dependent on contemporary thinking and social mores at any given time (Chowdhury, 2017). As society evolved and scholars learned more about education and the mind, new, more growth-oriented mindsets paved the way for access to a wider variety of interests by a more diverse population (Huang et al., 2019). Although there is much work to do, the growth mindset theory was an advancement in thinking which allowed for self-determination (Huang et al., 2019). Degol et al. (2018) conducted a longitudinal study to determine why fewer women entered math-based disciplines and found girls with growth mindset beliefs had better scores in math. Meehan et al. (2018) also found proficiency in a subject matter was not the driving force for pursuing a field. Instead, a person's sense of belonging was one of the primary factors, which determined how likely math-based areas would be pursued (Meehan et al., 2018).

Furthermore, the research indicated a lack of role models who look or behave like students in the classroom made imagining oneself in a role more difficult. The phenomenon of belonging uncertainty has had an effect on gender and race (Meehan et al., 2018). Despite women earning 57% of undergraduate degrees in the United States, only 18% were in computer science (NSB, 2018). Moreover, women made up 50% of the workforce but represented relatively low shares of employees in engineering (15%) and computer and mathematical sciences (26%; NSB, 2018).

For the study, the growth mindset theory was the primary theory utilized to guide the research because studies indicated when given the opportunity and proper guidance, abilities, and interest in learning can be improved (Dweck, 2016). The current study demonstrated a connection between girls’ middle school experiences of science and math classes and an interest in pursuing a post-secondary STEM career. The secondary theory that supported the research was transformational leadership theory (Burns, 1978). By adopting a transformational leadership style within administration and staff, a more global mindset towards growth and achievement may be cultivated (Andersen et al., 2018). Combining two theories may lead to improvements in the classroom and in the mindset of staff and administration. As a result, female achievement in STEM fields may also improve (Dweck, 2016).

Gender Gap

The 21st century was the first time in history women were earning bachelor's, master's, and doctoral degrees at a higher rate than men (Geiger & Parker, 2018). Within computer science, engineering, and math fields, women continued to be underrepresented (Wang & Degol, 2017). Furthermore, even when women performed as well or better in STEM subjects than men, women were losing interest in pursuing a career in STEM at much higher rates as well (Wang & Degol, 2017).

Despite women making up half of those awarded college degrees, the National Science Board (NSB, 2018) determined women make up only one-third of the science and engineering workforce. Even though the number of women in science and engineering jobs has risen in the past 2 decades, the disparity between the number of women and men has decreased nominally (NSB, 2018). With fewer women entering these fields, the difference between the number of men and women manifests in the workplace and in higher education. Women represented only 17.4% of tenure and tenure-track faculty in U.S. colleges of engineering (Roy, 2019). Reinking and Martin (2018) completed a summative content analysis in which three of the most common theories for why girls are not entering STEM fields at equal rates as boys, despite equal or better capabilities for the subject matter, were explored. The theories presented are: (a) gendered socialization, (b) peer groups, (c) STEM professional stereotypes.

Gendered Socialization

The first theory focused on socialized gender differences in society. The socialization gender theory, as described by Reinking and Martin (2018), suggested girls and boys in the United States are socialized largely based on pre-set gender roles. Both genders are bestowed with a set of behaviors, attitudes, and personality traits and saddled with an expectation to conform (Reinking & Martin, 2018). Evidence showed, from an early age, boys and girls were socialized differently towards STEM subjects (Wang & Degol, 2017).

Researchers discovered many girls were being overwhelmed by socialized ideas about what a woman should be and negative statements suggesting subpar math abilities even when not the case (Régner et al., 2019). Consciously or unconsciously, these messages were being spread early in a girl’s life (Wang & Degol, 2017). What is more, these messages were broadcasted by teachers and parents, the people society often trusts the most to act as guides (Wang & Degol, 2017).

Peer Groups

For many students, the time during which peer group socialization occurs, especially in middle school, can have a significant influence on choosing academic pursuits (Reinking &

Martin, 2018). If students perceived acceptance from peer groups, then one academic or career path would be selected over other possibilities (Leaper, 2015). Likewise, if girls received a rejection from female and male peers, interest in the subject was less likely to be pursued or at least not as openly (Leaper, 2015). Leaper argued if girls were faced with the consistent dual-gender rejection at a time when socialization through peer groups plays an important role in mental development, the message could be interpreted as girls do not belong in those fields. According to Kerpen (2017), if girls confronted those stereotypes and pressed on with confidence, the gender gap may close more quickly.

STEM Professional Stereotypes

Cheryan et al. (2015) studied stereotypes associated with computer scientists and determined one of the valued characteristics is social isolation, defined as a limited or nonexistent state of contact with other people. As social isolation was considered positive for men and consistent with the way they were socialized, women were socialized to be more interactive (Cheryan et al., 2015). Additionally, so-called male-dominated STEM professions primarily involved the characteristic of social isolation (Cheryan et al., 2015). The value difference supported why some women, who are trained to be more sociable, might be less comfortable in such fields (Cheryan et al., 2015). If stereotypes included a broader range of characteristics, more women might determine a career in technology and engineering were places where they also belonged (Cheryan et al., 2015).

Schuster and Martiny (2017) found a correlation between women's perception of a STEM field being male dominated and feeling less positive about participating was what makes women shy away from those careers. The effect manifests itself in generally unpleasant emotions and a heightened sense of threat in a stereotype-activating situation (Schuster & Martiny, 2017). The scenario presented did not influence either the comfort level of men or men's decisions to pursue a specific field (Schuster & Martiny, 2017).

Song et al. (2017) found when young women were exposed to negative gender stereotypes about math, they generally chose not to pursue a math-based field. Participants of the study completed a questionnaire in which five areas were evaluated to determine the result of math-related stereotypes on girls (Song et al., 2017). In each category, there was a negative association between girls and math, including the area of sexual attraction. Song et al. (2017) referenced a study by Plante et al. (2013) showing math-gender stereotypes were influencing girls as early as sixth through eighth grades in Canada because stereotypes affected girls' career intentions.

Differences in choices men versus women make in science, technology, engineering, and math fields were well documented (National Center for Science and Engineering Statistics [NCSES], 2019; National Science Board [NSB], 2018; Wang & Degol, 2017). Men tend to choose physical sciences more frequently than women, and women choose behavioral sciences more often than men. Stout et al. (2016) found physical science careers are more associated with self-direction and self-promotion (agency); whereas behavioral sciences are perceived as possessing more communal qualities such as working for the betterment of others.

The authors also found when women perceived physical sciences as more communal, the disparity between genders went away (Stout et al., 2016). The disparity also dissolved when men perceived greater agency opportunities in behavioral sciences (Stout et al., 2016). Stout et al.

suggested there is an opportunity to decrease the gender disparity between the so-called hard and soft sciences by demonstrating the communal and agentic aspects in both fields.

Minority Girls and Women in STEM

Due to a fixed mindset approach in education, many girls and racial minorities were excluded from opportunities, especially in science, technology, engineering, and math fields (Huang et al., 2019). Historically, many believed each gender and race were imbued with innate physical and intellectual abilities and limitations (Lynn, 2019). Some considered this mindset a part of a bygone era; however, as recent as 2017, a study by the NCSES showed 86% of women with a science and engineering doctoral degree were White or Asian (NCSES, 2017). Only 2.7% were African American, 3.6% Latinx, and 3.1% are other racially underrepresented women (NCSES, 2017). Only 6% of bachelor's degrees in engineering were awarded to underrepresented women (NCSES, 2017). Underrepresented people were awarded 11% of science and engineering (S&E) research doctorates despite comprising 27% of the population and about 30% of the labor force (NCSES, 2019).

Kang et al. (2019) analyzed indicators of science, technology, engineering, and math identities and a sense of self across various racial groups in middle school. Results demonstrated no significant difference with STEM identities (Kang et al., 2019). With support in place, all middle school girls may benefit regardless of gender or race (Kang et al., 2019). Identification with STEM careers remained positive when reinforced at home, outside of school, and in STEM classes (Kang et al., 2019). The research indicated, despite the narrowing of gender gaps in these fields, the distance for low-income and underrepresented groups remains wide due to students' private goals, perception of self, and how compatible they feel with identity, rather than a result of differences in achievement (Kang et al., 2019).

In general, the underrepresentation of girls in technical fields has existed since the 18th and 19th centuries (Collins et al., 2020). Then, women were trained to be housewives and low-skilled workers while men were given opportunities to study technical subject matter requiring a high level of skill (Collins et al., 2020). Although there is more equality in the 21st century, largely stereotypes have remained and created an unconscious gender bias (Collins et al., 2020).

The underrepresentation has been worse for women of color but most data outlining the state of science, technology, engineering, and math education have been based on White girls and women (Collins et al., 2020). Inaccuracies such as these, skew data and offer a diminished capacity to do something meaningful to improve the situation for all girls (Collins et al., 2020). The limited presence of minority women continued in contemporary education whereby many underrepresented girls were placed in lower-performing math classes rarely leading to advanced classes required to pursue a science, technology, engineering, and math field in college (Collins et al., 2020). In many underrepresented-centered schools, advanced courses are not even offered. Less than 11% of Black girls, compared to nearly 58% of White girls were enrolled in gifted and talented programs (Collins et al., 2020).

The underrepresentation may be explained by underdeveloped science, technology, engineering, and math identity (Collins, 2018). Lacking confidence in themselves and not seeing themselves as innovators, Black girls' self-concept does not develop with these identities incorporated (Collins, 2018). As has been previously stated, girls need to see themselves in specific roles so they may consider those roles an opportunity for themselves (Collins et al., 2020). Historically, role models for Black girls in STEM have been lacking and the curriculum has frequently disregarded contributions and lived experiences of successful Black scientists, engineers, and mathematicians (Collins et al., 2020).

State of Affairs for Women in Science and Engineering

NSB (2018) found the workforce consisted of near-equal percentages of college-educated men and women, but only 28% of science and engineering professionals were women. The difference in the numbers of women who became science and engineering professionals was a mere 6% increase since 1993 (NSB, 2018). An examination of recent data showed, as of 2018, only 13% of engineers and 26% of computer scientists were women (United States Bureau of Labor Statistics, 2018). Only 3% of bachelor's degrees were awarded to women in engineering and computer science (Yoder, 2018).

As many as 61% of female engineers reported having to prove themselves repeatedly to get the same level of respect and recognition as male colleagues (Li et al., 2016). In a study by Xu (2017) with a weighted sample of 15,048 college graduates, only 14.7% majored in science, technology, engineering, or math. Out of the 14.7%, only one-third were women (Xu, 2017). Only 30% of women who earned bachelor’s degrees in engineering were still working in engineering 20 years later (Corbett & Hill, 2015). Women who have left the engineering profession cited organizational climate as the reason for departure (Fouad et al., 2016).

Though women can be found more frequently in such areas of STEM as biology, women are underrepresented in STEM degrees, such as engineering and computer science (Wang & Degol, 2017). A NSB report (2018) indicated both male and female students enrolled in advanced placement classes in high school, 81% of men enrolled in computer science compared to only 19% of women. From 1997 to 2016, the number of women with bachelor's degrees in computer science has dropped from 27% to 19% (NCSES, 2019). The highest portion of women in science and engineering fields were in psychology with women comprising 70% of graduates at each educational level (NCSES, 2019). Additionally, biological sciences–such as biochemistry, microbiology, and evolutionary biology–had a high proportion of women, 51% to 58%, depending on the field and degree level (NCSES, 2019).

Stereotype and Implicit Bias

Stereotypes and implicit bias may play an important role in the career women pursue (Olsson & Martiny, 2018). Stereotype bias is considered significant when the result of a person's evaluation is related to a negative view of oneself (Olsson & Martiny, 2018; Rice & Barth, 2017). If a woman was taking a math test and lived in a society that communicated, directly or indirectly, women were bad at math, the message could influence test outcomes (Olsson & Martiny, 2018). Although many people would immediately say there is no difference between men's and women's ability to be successful in science and engineering careers, there exists an unconscious implicit bias influencing one's perception (Greenwald et al., 1998).

The Implicit Association Test, offered by Project Implicit through Harvard University, allows anyone to go online and take a test which measures implicit bias (Greenwald et al., 1998). The bias test was originally called for in a paper by Greenwald and Banaji (1995). The challenge was met with the Implicit Association Test, which was described in further detail by Greenwald et al. (1998). According to the Kirwan Institute for the Study of Race and Ethnicity (2012), implicit bias is a combination of attitudes or stereotypes unconsciously affecting a person's understanding, actions, and decisions.

Project Implicit's website had a variety of tests available. One test, related to the subject matter, called the gender-science Implicit Association Test, evaluated the gender one associates with science versus liberal arts degrees (Greenwald et al., 1998). A vast majority of people continued to associate women with liberal arts and men with science (Régner et al., 2019). The undercurrent of bias effected women directly from a young age and the evidence presented showed the consequences continued throughout women's entire lives (Rodenbusch et al., 2016).

When evaluations continuously show women and men rating each other along clear gender stereotypes, the perception has been incorporated into one's self-image (Régner et al., 2019). Self-limiting beliefs reinforced by external beliefs about oneself influence the career and life decisions made throughout a person's life (Mote, 2019). Although biases exist, the important task is to become aware of and manage them within oneself and among one another and lead to better decision-making throughout life (Mote, 2019).

Fiske (2018) developed a stereotype content model (SCM) to explain two persistent ways people perceive individuals and groups. The two ways were given the terms warmth (trustworthiness, friendliness) and competence (capability, assertiveness). Perceived social structure (cooperation and status) determined stereotypes (warmth and competence), which determined emotional prejudices (pride, pity, contempt, envy), and finally, emotions predict discrimination (active and passive help and harm; Fiske, 2018). Cross-culturally, Fiske's model demonstrated while women gain stereotypic warmth, women lose in terms of competency, which is the opposite case for middle-aged men (Fiske, 2017).

Ambivalent sexism theory was developed to explain the interrelationship between the biological male-female relationship and the pervasive universal masculine dominance in societies (Connor & Fiske, 2019). Often, gender differentiation is managed by creating prescriptive stereotypes (what genders should do) which are different than descriptive (how genders are; Fiske, 2018). The prescriptive approach is maintained by utilizing two interconnected methods of sexism: hostile sexism and benevolent sexism.

Hostile sexism is reserved for women who rebel against the prescribed stereotype and can include career women, feminists, and lesbians as a few examples (Fiske, 2018). The women were treated with contempt and a barrage of insults and denigration to get them into line with the gender expectations (Fiske, 2018). Women in the hostile sexism category were considered high in competency but low in warmth. Women exposed to benevolent sexism are typically treated in a patronizing manner because they were willing to be subordinate to men and stay in support roles such as cheerleader, secretary, and housewife (Fiske, 2018). Although some claimed the behavior elevated women, Fiske demonstrated the treatment serves only to undermine female independence and achievement as women were perceived to be incompetent but warm in a benevolent sexism construct.

Kuchynka et al. (2018) explored the influence of benevolent and hostile sexism on outcomes of university women in science, technology, engineering, and math. Results showed women perceived more benevolent sexism versus hostile sexism. The outcome was many men perceived these women as incompetent and reacted towards them paternalistically; moreover, men supported and preferred benevolent protective paternalism over hostile sexism (Kuchynka et al., 2018).

Some women in the study indicated a lower interest in pursuing science, technology, engineering, and math majors; lower sense of independent ability; and lower GPA if weakly identified to a STEM major (Kuchynka et al., 2018). The phenomenon also held for women exposed more to hostile sexism (Kuchynka et al., 2018). Women who were strongly identified and high in self-efficacy showed no association between perceived sexism and an interest in pursuing a STEM major (Kuchynka et al., 2018).

According to Kuchynka et al. (2018), the loss of women in university STEM courses could be due to a consistent exposure to benevolent sexism when commitment to a science, technology, engineering, or math focus was not entirely formed. Additionally, though professors may be inclined to offer female students additional help to show support, the study revealed possible detrimental outcomes (Kuchynka et al., 2018). The evidence indicated a direct correlation between the amount of paternalistic protection given to a woman and the shutting down of cognitive abilities due to a developing perception of inadequacy frequently resulted in disengagement in STEM subjects (Kuchynka et al., 2018).

Media Portrayals of Women in STEM

Media has played a significant role in portraying and reinforcing stereotypes of science, technology, engineering, and math professionals (Steinke, 2017). Determining when and how representations influence girls in their career decision-making process may help mitigate the effects. (Steinke, 2017). Weitekamp (2015) reviewed a popular television show, “The Big Bang Theory,” in which the stereotype of nerd and physicist was challenged. Although the show offered a view of female physicists, female characters in the show were depicted as locked in a struggle between dual roles of supporting main male characters while also attempting to establish themselves as working scientists (Weitekamp, 2015).

Warren et al. (2016) studied another popular television show, CSI (Crime Scene Investigators), which had been on air for 15 years. The authors investigated 3 years of the show where Sara Sidle, played by Jorja Fox, was assigned stereotypical roles to the scientist in the script (Warren et al., 2016). The investigation focused on Sara because Sara remained on the show until the finale in 2015; but other roles of women on the show were also studied (Warren et al., 2016). Results indicated gender bias was scripted for the character (Warren et al., 2016). The show reaffirmed stereotypes of female characters displayed as female nerds who also had power and prestige while struggling to be good friends, lovers, and mothers (Warren et al., 2016).

According to Bhatt et al. (2015), the human mind seeks patterns organically to organize and classify the world. Stereotypes reinforced by media may not be deliberate, but instead are subconscious applications of the mind's interpretation of observations over time (Bhatt et al., 2015). When the media becomes aware of these gender biases and stereotypes, an opportunity exists to challenge the status quo and present an alternative (Bhatt et al., 2015) image.

Women, specifically Black women, were human computers after World War II before computers became the electronic devices known to contemporary society (Benson, 2017). The role of women computers in aiding the National Aeronautics and Space Administration [NASA] in the space program was largely unknown until portrayed in the 2016 release of Hidden Figures (Benson, 2017). Media can present an image to the masses of who can participate and how they participate in an occupation and can influence women's choices to pursue a field or not (Payton & Berki, 2019). Computer Science Degree Hub (2021) presented a list of the 30 most influential living people in computer science and only one was a woman, Sophie Wilson, who invented and sold the Acorn microcomputer over 40 years ago in 1978.

Economic Loss for Women

Gender bias may lead to career choices which may further lead to enormous missed economic opportunities for women (Rodenbusch et al., 2016). Science, technology, engineering, and math occupations earn 50% more than nonscience, nontechnology, nonengineering, and nonmath occupations, according to the NSB (2018). The choice of a STEM versus nonSTEM occupation has had a serious effect on a woman's ability to appreciate the same economic benefits as male counterparts (NSB, 2018). Improving rates of inclusion to engage girls in engineering and computer science classes from curriculum design to opening minds may alleviate the discrepancy between genders (Ogle et al., 2017; Savaria & Monteiro, 2017).

The European Union investigated the STEM pipeline as an avenue to achieve greater gender equality for women and to generate overall economic benefit for the European Union and a specific benefit for women (Morais Maceira, 2017). Women exiting universities with science, technology, engineering, and math degrees command a higher salary providing greater benefit to themselves and the European Union (Morais Maceira, 2017). The European Union was as equally interested as the United States in training a competitive global workforce (Morais Maceira, 2017). More women occupying these fields means a greater source of qualified technical workers in a country with less need to outsource (Morais Maceira, 2017).

In some Arab countries, such as Saudi Arabia and the Gulf States, there was an imbalance in favor of women in STEM (Islam, 2017). Women comprised 59% of computer science graduates in Saudi Arabia, while the United Kingdom and the United States retain only 16% and 14%, respectively (Islam, 2017). Few Arab women were employed in a position after the university due to the negative social perceptions of women in these fields and they fulfilled almost no leadership positions (Islam, 2017). Although equal opportunity has existed, social and gender stereotypes have limited roles men and women fulfill and the economic benefit available to each gender (Islam, 2017).

Mothers Versus NonMothers

Frintner et al. (2019) evaluated 12 years of personnel records from a well-known, large, family-friendly French company, and found the birth of a woman's first child had a dramatic consequence for a woman's economic potential. While women were nonmothers, earning potential remained largely the same; but, 1 year after the first child was born, the earning of mothers fell to 10% of nonmothers and 40% of individual bonuses (Frintner, et al., 2019).

Over the next 9 years, after the first child was born, no data showed a catch-up effect for mothers. Mothers were less often promoted to managerial positions (Frintner et al., 2019). Juhn and McCue (2017) confirmed these discrepancies in pay between genders and among mothers and nonmothers. Despite arriving at a time in history where women possess higher educational attainment than men, the parity was not reflected in workplace earnings (Juhn & McCue, 2017). In 1960, the parity in wages was 0.61 and 45 years later the gap was only minimally filled at 0.79 (Juhn & McCue, 2017). Although men and women may start with similar approximate earnings, motherhood was a major factor for differences over time between men and women (Juhn & McCue, 2017).

Household Contributions

As a population, women are more educated than men, couples often form partnerships with similar levels of education (Van Bavel et al., 2018). However, even in dual-earner households with similar levels of education, the stereotype of the male breadwinner persisted and often led to men increasing work hours while women decreased them proportionally to manage the family (Cherlin, 2016). The U.S. and European data are shown in a study by Van Bavel and Klesment (2017), which demonstrated a cliff effect in women's and men's earnings. Generally, studies have shown women's contribution to household income increased with education (Steiber et al., 2016; Van Bavel & Klesment 2017). The financial contribution to the household declined at about 50% or when women would begin to out earn men (Van Bavel et al., 2018). Regardless of financial parity, women still did more of the housework and unpaid labor in the household than men (Van Bavel et al., 2018).

Changing the workplace by attempting to add equal numbers of women and men may not be enough. Statistics have shown women earning more STEM degrees without equal numbers of women entering these fields of work (Weisgram & Diekman, 2015). A change in the work environment to support realities many women face as a part of daily life, such as starting a family, may offer greater retention of women in the workplace and women's economic benefits (Weisgram & Diekman, 2015). An equitable work environment framework, which supports these realities without bias or punishment against women professionals, may open additional opportunities for women (Juhn & McCue, 2017).

Girls' Experiences in the Classroom

Hughes and Roberts (2019) conducted a study to determine the role an informal science, technology, engineering, and math camp had on 145 middle school girls. Results indicated a girl's identification with these subjects depended largely on an openness to challenge (Hughes & Roberts, 2019). Providing girls with opportunities where they can succeed instead of challenges to fail, may help to build confidence in pursuing more challenging problems (Hughes & Roberts, 2019). A cross-sectional study among 1,364 Swiss secondary school students close to graduation was conducted to determine which of three subjects, chemistry, physics, and math, had the most masculine image (Makarova et al., 2019).

Results revealed math had the greatest association with masculinity by both sexes, followed by physics and chemistry (Makarova et al., 2019). In the study, women did not attribute significantly greater masculinity to any one of the three subjects (Makarova et al., 2019). Males showed vast differences in the perception of math as masculine versus physics and chemistry where no significant difference was attributed (Makarova et al., 2019). The masculine perception of math and science held by both sexes may offer insight into why fewer women find themselves pursuing fewer math-based post-secondary degrees compared to men (Makarova et al., 2019).

Casad et al. (2017) evaluated the effect of stereotype threat on the math test performance of middle school girls. Stereotype threat occurs when a stereotyped person perceives they will be judged based on negative associations and inadequacy within the stereotype (Spencer et al., 2016). Previous studies demonstrate girls are influenced by stereotype threat on math tests in general but especially when they are told the test was evaluative of overall ability (Casad et al., 2017). Cases of stereotype bias remain pervasive across various disciplines for women, and the phenomenon begins as early as 6 years old (Bian et al., 2017).

Casad et al. (2017) investigated the effect of stereotype threat on middle school girls in standard versus honors math classes. The hypothesis was if girls are already recognized as high performers in math and placed in an honors class, there may be a protective effect against stereotype threat for the group (Casad et al., 2017). The research was conducted in the classroom where girls learned math to establish a realistic performance environment (Casad et al., 2017).

Additionally, girls were evaluated using the following categories: (a) attitude, (b) perception of math validity (discounting) and (c) engagement (Casad et al., 2017). Results showed within the context of honors math, a protective effect was demonstrated in attitude, perception of math validity, and engagement. No such effect was observed during the taking of a math test (Casad et al., 2017).

To better understand the K–12 preparation required to support successful adult science, technology, engineering, and math professionals, funding can be funneled to the right places (Ufnar and Shepherd, 2020). Despite the national call for science, technology, engineering, and math education at the K–12 level, the United States Department of Education (2018) data showed, of the 80% of middle schools offering Algebra 1, only 24% were enrolled. Algebra 1 was often a prerequisite for high school classes in science, technology, engineering, and math areas, putting many students at a disadvantage before even entering high school (United States Department of Education, 2018). Without proper preparation, the U.S. education system could continue to fall behind in preparing students to become professionals in a global technology market.

Opportunities for Improvement

Degol et al. (2018) and Dweck (2016) demonstrated the importance of a growth mindset in classroom engagement by helping teachers and students to be more successful than more traditional and limiting mindsets. Growth mindset theory has demonstrated effective effort, belief in oneself, and enough training can provide opportunities for measurable growth in all people (Dweck, 2016). Growth mindset theory has become the new standard for education in many regions (Rattan et al., 2015). By using growth mindset theory as the framework for studying the influence of middle school STEM classes on girls' desire to pursue STEM careers as adults, the study may demonstrate how a more inclusive approach could lead to a more diverse population of STEM professionals (Dweck, 2014).

As the workforce has transformed into a global marketplace focused on technical skill sets and competencies, students may consider preparing as early as possible for this reality (Kislyakov et al., 2019). Additionally, if men and women were both capable of success in all fields of STEM, then society and education may want to make appropriate adjustments to support both genders even if the support may look different for one gender versus another (Kislyakov et al., 2019). As such, girls and boys may prepare for professional objectives without stereotype threat or social prejudice (Kislyakov et al., 2019). A lack of preparation for the science, technology, engineering, or math field of choice was directly linked to job dissatisfaction, job change within a technical field, or departure from STEM fields entirely, which was a more frequent occurrence among girls (Kislyakov et al., 2019).

Developing Teacher Expertise

To better prepare students, teachers may benefit from increased self-efficacy in subjects they teach (Craig et al., 2017). As state and federal governments have been calling for more robust and integrated science, technology, engineering, and math curriculum, teachers need to be equipped with the knowledge and ability to provide meaningful lessons (The White House Office of Science and Technology Policy, 2018). Additionally, because much of science, technology, engineering, and math curriculum have an inquiry or project-based focus, a multi-disciplinary approach was also required (Schmidt & Fulton, 2016). Teachers may have specialized in one of the sciences and now they are being asked to integrate multiple disciplines into the classroom (El Nagdi et al., 2018). Without proper education and professional development, teachers may find themselves profoundly disadvantaged in preparing students for the 21st-century world in which they live and work (The White House Office of Science and Technology Policy, 2018).

Formal and informal preservice programs in the STEM curriculum have been shown to increase levels of teacher self-efficacy (Craig et al., 2017). Training models integrating science, technology, engineering, and math subjects with pedagogy have proven to be effective methods of increasing the self-efficacy of teachers in an inquiry-, project-based classroom (Eckman et al., 2016). Essentially, teachers may be able to effectively communicate acquired knowledge in the newly integrated subject matter. Knowledge of the subject matter was not enough to be effective (Wells, 2019). By creating programs to provide adequate preparation for teachers to impart knowledge of science, technology, engineering, and math subjects with confidence, students can have a more robust and comprehensive learning experience (Wells, 2019). Students may be better prepared for more complicated concepts with each new academic level they encounter and ultimately the workforce (Wells, 2019).

Modernizing Education for Subject Integration

A new approach to teaching was largely driven by the 21st-century realization of a global workforce market (Suarta et al., 2017). To create additional security for one's nation, the domestic educational system should offer the opportunity to create a competitive and capable workforce (The White House Office of Science and Technology Policy, 2018). Many jobs in the 21st century fully integrate science, technology, engineering, and math (The White House Office of Science and Technology Policy, 2018). Much of the U.S. educational system still teach these fields as single subjects but infrequently demonstrating the connection between a concept and its connection to other fields of science, technology, engineering, and math (Kelley & Knowles, 2016).

Test scores in math and science within the United States have only improved modestly over the past 2 decades (NSB, 2018). When comparing math and science scores of 15-year-olds in the United States to other countries in international assessments, students performed below average in math and average in science (NSB, 2018). Regardless of whether a student pursued a STEM career, the United States has acknowledged skills from learning these subjects, such as computational thinking, problem finding and problem solving, and innovation are critical for the success of each citizen (The White House Office of Science and Technology Policy, 2018). Data from ACT (2018), a college admissions test, showed only about 20% of high school seniors were prepared for a major in STEM (ACT, 2018).

Because science, technology, engineering and math subjects are taught separately from one another, students often cannot make connections among them (Akaygun & Aslan-Tutak, 2016; Blackley et al., 2017). The challenge was to find a framework to connect pedagogy to the integration of these subjects (Kelley & Knowles, 2016). Although funding has been provided for decades, there has not been a clear vision on how to implement a program to adequately prepare students for the competitive global workforce (English, 2016). Focus has remained on improving math and science scores, but there has been no integration between these subjects or among them with technology and engineering (Akaygun & Aslan-Tutak, 2016; Blackley et al., 2017).

One conceptual framework for an integrated science technology, engineering, and math curriculum was the intentional creation of a blended curriculum, which included concepts from two to four of the fields. (Kelley & Knowles, 2016). For example, a physics class could include concepts related to math and engineering, and a math class may show how technology could be used to solve an engineering problem. While each subject has core concepts, classes could also be focused on an integrated approach to teaching the subject (Blackley et al., 2017).

Another conceptual framework proposed by Thibaut et al. (2018) included five distinct areas of focus while integrating science, technology engineering and math education. Key points included the integration of STEM content, problem-centered learning, inquiry-based learning, design-based learning, and cooperative learning (Thibaut et al., 2018). Studies indicted students who learn through an integrated system outperform counterparts who studied single subjects (Thibaut et al., 2018). Despite the evidence, transforming an education system deeply rooted in fragmented silos of knowledge was an enormous undertaking in curriculum development alone (Thibaut et al., 2018).

Because data indicated students do not make integrated leaps in knowledge when leaving each specialized class, explicit demonstration of the connection to students during the integration process was important (Guzey et al., 2016; Pearson, 2017). Furthermore, teacher education on the pedagogical methods to seamlessly guide the learning process within an integrated framework was crucial to the success of the curriculum redesign (Thibaut et al., 2018). Another useful distinction was between the use of problem-based learning versus project-based learning (Brassler & Dettmers, 2017).

While both utilize an iterative process, they are distinct in the method of guidance and expected outcome. Project-based lessons have a specific desired outcome where the teacher helps to guide students to achieve the goal (Brassler & Dettmers, 2017). Problem-based lessons also have an outcome, but the strategy and the product can vary when the problem has been solved (Brassler & Dettmers, 2017). Teachers may give less direct instruction because the methodology relies on the demonstration of integrated understanding to develop a unique solution or product (Brassler & Dettmers, 2017).

Gap in the Literature

The review of the literature suggested various reasons why girls may not enter science, technology, engineering, and math fields at the same rate as boys (Hughes & Roberts, 2019; Makarova et al., 2019). The gap was in learning from women in STEM fields how middle school STEM classes influenced the decision to continue in high school, through college, and to eventually pursue one of these fields as a career (Juhn & McCue, 2017). Programs at the middle school could be better designed to support girls in pursuit of science, technology, engineering, and math fields, creating an early pipeline of confident and prepared female students (Kang et al., 2019). Additionally, developing a greater awareness of social stereotyping and bias could lead to building programs to consciously work to eliminate bias so girls would feel empowered to succeed (Bian et al., 2017; Kislyakov et al., 2019; Kuchynka et al., 2018).

Chapter Summary

Despite no significant difference in math and science ability between girls and boys, considerably fewer girls are pursuing science, technology, engineering, and math careers. Careers in computer science and engineering are particularly underrepresented with only 28% of women participating in these careers (NSB, 2018). Most female leaders in science, technology, engineering, and math fields who possess a doctoral degree are White or Asian, leaving women of color to make up under 4% of leaders in science, technology, engineering, and math fields in each racial category (NCSES, 2017).

Two areas of improvement include the integration of STEM subjects and teacher development. The history of education found students sitting quietly listening to teachers who were experts in specific topics. As the world has grown in complexity, a passive education method is no longer effective. A drive toward integrated learning allowed students to participate in hands-on, project-based learning to dynamically educate and prepare students for the 21st-century global market (Thibaut et al., 2018).

Teachers who have been traditionally taught to be experts in one field of science, technology, engineering, or math now need to be trained in all subjects. With these skills, teachers may deliver lessons, which show students meaningful multi-disciplinary connections. Providing professional development opportunities to prepare teachers to use a multi-disciplinary approach may help build skills and confidence required to meet the emerging contemporary education model.

The consequences of the demographic makeup start early and follow throughout a student's academic and professional life. The review of literature for this study shows women are disadvantaged by the social, economic, and educational systems. A need existed to address the educational and professional disparities, which continue to affect women throughout life. Implicit bias and stereotype models have shown members of society are indoctrinated subconsciously with patterns of thinking which hold women back from certain roles.

Research indicated society largely operates using a prescriptive model of socialization delineating how men and women should act rather than a descriptive model, which defines how women and men are. The use of hostile and benevolent sexism has reinforced a system of gender-based social control which has largely kept both genders within the social framework. Gender-based social control has limited the possibilities for individuals to fully express talents and abilities. Many women in science, technology, engineering, math majors, have opted out entirely due to the pressure and never found a way into a STEM career.

Women who become mothers have a more difficult road compared to men or women who are not mothers. Upon the birth of the first child, one study showed a woman's compensation dropping to 10% of pre-birth status. Nearly 10 years after giving birth, there were no signs of catching up financially or of career advancement opportunities (Frintner et al., 2019). Additionally, in couples where men and women have equal education, women tend to stop contributing before reaching a point where a contribution would equal more than the male partner. Research indicated the male stereotype of remaining the breadwinner has persisted (Cherlin, 2016). In families with children, the phenomenon can mean men taking on more hours and women reducing paid work to manage children and unpaid work at home.

Despite women attaining more education than men, women are still employed at lower rates than men. Many women quit because conditions are not favorable, or conditions are hostile towards women and especially mothers. Research has shown simply adding more women to the workplace was not a successful method of closing the gender gap. Conditions in the workplace should be considered so they accommodate realities of women's lives instead of asking women to be identical to men and punishing women when starting a family though men were not (Juhn & McCue, 2017).

Working to design programs and curriculum to reach girls earlier and with more effective methods, may inhibit the influence sexism and bias would have had on preventing many girls from pursuing a career in a STEM field (Connor & Fiske, 2019). Instead of patronizing girls through patriarchal social methods which destroy confidence, educators, parents, and society could work to put into place evidence-based models which lead to successful outcomes for girls.

Chapter 3 details the qualitative phenomenological research method, which was utilized to interview and collect data from the 15 research subjects. Data collected was used to evaluate the gap in the literature of girls' experience in science and math classes in middle school. Women who worked in a science, technology, engineering, or math field at the time of this research in the United States and Mexico shared middle school experiences and related how the system may be improved to benefit the education of more girls in these fields.

Chapter 3: Methodology

The purpose of this qualitative phenomenological study was to advance the literature about women's lived experiences in middle school STEM and to explore how the essence and meaningfulness of the experiences influenced the decision to become professionals in STEM fields. For this study, middle school was defined as Grades 6–8. The study was necessary because there is a gap in the literature demonstrating the significance of beginning STEM education during middle school on the outcome of girls becoming women in STEM fields. Programs and funding continue to focus at the high school level without further understanding of the short- and long-term benefits of beginning in middle school. The study contributes to the knowledge base by understanding how middle school STEM classes can influence a girl's choice to pursue a STEM career.

Since the national push for STEM education started less than 10 years ago (United States Department of Education, 2018), gathering data on benefits of early implementation of STEM courses in K–12 education is important. The study took place in the United States and Mexico and included 15 women with a range of ages between 22–65 years old who worked in STEM careers at the time of research. Results of the study could be shared with public and private schools so resources may be properly allocated to create rigorous STEM programs to encourage girls to pursue STEM careers.

The current study was an exploration of the essence and meaningfulness of the life experiences of women in STEM when they were in middle school. The following research questions guided the study:

Research Question 1: How does the STEM professional woman describe her lived experience as a girl in middle school STEM classes?

Research Question 2: How does the STEM professional woman relate her exposure to STEM classes during middle school to her decision to pursue a career in STEM?

The research design and rationale, role of the researcher, research procedures, data collection, data analysis, reliability and validity of the data, ethical procedures, and appendices are reviewed in this chapter.

Research Design and Rationale

A qualitative phenomenological method was the chosen research design. Phenomenological methodology allows participants to freely describe the essence and meaningfulness of the lived experiences and ascertain the meaning of a particular phenomenon (Vagle, 2018). A qualitative methodology is appropriate for this study because participants were interviewed to share their lived experiences in middle school STEM classes and determine how middle school STEM classes influenced participant decisions to become STEM professionals. One major benefit of this type of methodology is precise data about what participants think and how they feel about a given topic. The study included a LinkedIn recruitment advertisement (see Appendix A) demographic screening questionnaire (see Appendix B), informed consent (see Appendix C), online 2 question questionnaire (see Appendix D), semi-structured interview protocol (see Appendix E), and researcher field notes as a part of the phenomenological method. The methods were suitable for this research context because data could be gathered from a variety of sources, such as academia and industry. Questions were designed utilizing a phenomenological interview method with the structure for phenomenological interviewing consisting of three main domains: contextualization (natural attitude and life-world), apprehending the phenomenon (modes of appearing, natural attitude), and clarifying the phenomenon (imaginative variation and meaning; Bevan, 2014).

Role of the Researcher

The researcher was an interviewer who gathered the impressions of women in STEM fields on the middle school years and how those years influenced participants to become STEM professionals. Participants were previously unfamiliar to the researcher. Participants from a pool of random, qualified potential subjects completed a demographic screening questionnaire (see Appendix B), gave informed consent (see Appendix C), completed a preliminary two question online questionnaire (see Appendix D), were interviewed using a semi-structured interview protocol (see Appendix E), and researcher field notes were taken. No conflict of interest existed between the researcher and participants. No participants had a supervisory role over the researcher and the researcher had no supervisory role over participants. Participants were recruited from a variety of organizations such as schools, private companies, and government organizations across the United States and Mexico via an advertisement posted on a professional networking site. Participants varied in age (22–65) and were all women, possessed a minimum of a bachelor's degree in a STEM field, and practiced in a STEM field at the time of the study.

Research Procedures

The study explored women’s lived experiences in middle school STEM classes and how those STEM classes influenced women to pursue a STEM career. The study was conducted using phenomenological methods. Phenomenology is ideal for this study because the method allows for real-world lived experiences to be gathered from participants (Levitt et al., 2018).

Population and Sample Selection

Judgment (or purposive) sampling is a selection method which allows selection of participants based on specific criteria (Sharma, 2017). In this phenomenological study of 15 women, the sample population met the following criteria: (a) female, (b) 22–65 years old, (c) a minimum education of a bachelor's degree in a STEM field, (d) self-identified as working in a STEM field (e) located in the United States or Mexico on the demographic screening tool (see Appendix B). Potential candidates who did not meet these criteria were excluded from the sample population. Creswell (2012) acknowledged there is no specific answer to the question of sample size; “the number may be several, ranging from 1 or 2 to 30 or 40 because of the need to report details about each individual or site" (p. 209). LinkedIn, a professional networking website, was utilized to post a recruitment advertisement (see Appendix A). Potential participants were asked to complete a demographic questionnaire to gather background data and to ensure sample criteria were met (see Appendix B). Respondents interested in answering two study questions (see Appendix D) or a full interview (see Appendix E) were given an explanation of the research and prompted to affirm informed consent (see Appendix C) before engaging further. Potential participants provided an email address if they wished to participate in an interview. The interview protocol used in the study can be found in Appendix E.

Instrumentation

Three instruments were used to collect data for this study. As STEM professionals, participants reflected on perceptions of middle school STEM classes during an initial two-question questionnaire (see Appendix D), followed by the choice to participate in an in-depth, semi-structured individual interview (see Appendix E). The interview structure has been shown effective when examining integrated STEM education (Yıldırım & Sevi, 2016). Researcher field notes were used as a third instrument and to triangulate the data (Creswell & Creswell, 2018). Interview transcripts were member checked by participants to ensure validity.

Initial Questionnaires

Five questions in a demographic questionnaire were used to screen for participants (see Appendix B). Creswell and Creswell (2018) indicated closed-ended questions are appropriate when the goal is to easily compare answers. The initial qualifying electronic questionnaire consisted of closed-ended questions to determine eligibility for study participation. After answering the qualifying questions, potential candidates were asked to indicate interest in responding to an additional two questions only (see Appendix D) or also participating in an interview (see Appendix E). If candidates responded affirmatively, electronic informed consent was solicited (see Appendix C) before proceeding with any additional questions or an interview.

The Interview and Protocol

The semi-structured interview has been shown effective when examining integrated STEM education (Yıldırım & Sevi, 2016). In addition to basic questions designed using Bevan (2014) as a framework, participants were asked questions for clarification or depth of understanding as needed. Data is limited on women's perspectives of middle school STEM classes and how the experiences influenced the pursuit of a STEM career. To ensure the content of the interview protocol was appropriate, the research instruments (two-question questionnaire (see Appendix D) and interview questions (see Appendix E)) were validated by subject matter experts for use in the study (see Appendix F). The structure for phenomenological interviewing outlined by Bevan (2014) involves three areas: (a) contextualization, which allows a person to describe personal experiences as a narrative; (b) apprehending the phenomenon, which directs the focus of the interview onto the area of interest by asking progressively more descriptive questions; and (c) clarifying the phenomenon, which uses elements of the experience or the whole experience and exploring the phenomenon itself. Bevan's structure uses a technique called imaginative variation, which asks a participant to imagine how a given situation might influence the phenomenon. The technique clarifies the phenomenon while still maintaining the integrity of the questioning format. The method for each of the three interview structures includes, respectively, (a) descriptive or narrative context questions; (b) descriptive and structural questions of models of appearing; and (c) imaginative variation.

The structure of the interview process was modeled on Bevan's (2014) interview framework. Contextualizing questioning allowed the researcher to provide an opportunity for the participant to reconstruct and describe experiences in relation to the specific event of having been a middle school girl who became a STEM professional. Apprehending the phenomenon, allows the researcher to focus on the experience of interest. As required, more descriptive questions were used to explore the phenomenon in detail. Finally, clarifying the phenomenon involves a method known as imaginative variation developed by Husserl (1970). Participants were asked to imagine how a change to a given scenario may have influenced the outcome. Asking a question in this manner is useful because the participant can identify invariants without negating variants by describing how experiences would change within a set of specific criteria. Resulting answers help to further clarify data and add process validity. Finally, the interview responses were verified through the process of member checking.

Researcher Field Notes

According to Creswell and Creswell (2018), field notes are a valuable component to qualitative research because the notes enrich the data and provide additional context for analysis. Phillippi and Lauderdale (2017) shared several useful functions for field notes which include reflection, identification of bias, facilitation of coding, as well as increasing rigor and trustworthiness. As a result, field notes offer context to support and inform data analysis and will be used in this study. The data was triangulated through the use of a questionnaire, semi-structured interview protocol, and researcher field notes.

Subject Matter Expert Review

A review by subject matter experts provided the investigator an opportunity to determine if there were flaws, limitations, or other issues with the interview design. Names of content experts were collected through LinkedIn, a professional network. The experts were asked to assess the interview questions and offer feedback for improvement. Advice was shared via email and mutually agreeable adjustments were made until the interview was determined to be appropriate for the study (see Appendix F). According to Creswell and Creswell (2017), this step was important because any necessary revisions could be made before initiating the study.

Data Collection

Creswell and Creswell (2018) indicated data collection is a systematic process involving choosing the correct study method and the appropriate types of data collection. The current study used a phenomenological method and collected data through questionnaires, interviews, and field notes.

Questionnaires were administered online through Google Forms and responses were collected automatically by the program (see Appendices B & D). Interviews were held online via

Google Meet or Zoom at the participant's request. Interviews were documented using written notes, audio, and video to ensure validity. Researcher field notes were also taken to provide additional context. If additional information or clarification was needed after the initial interview, participants were contacted by phone, video conference, or email. Interviews were approximately 60 minutes in length. Video conference interviews were scheduled at a mutually agreeable time. Interviews of all participants were concluded within approximately 1 to 2 months. Participants received their interview transcripts via email to verify the contents for accuracy. To protect participant privacy, numbers were used to identify participants in the report. Once screened and qualified, participants were chosen on a first come, first served basis. For example, the first participant who was interviewed was given number 1 and so forth until all 15 slots were filled for the study. Data including, transcripts, audio and video recordings, and email communications were secured on a password-encrypted laptop. Participants were thanked for their contributions to this research and made aware of the conclusion and publication of the study.

Data Analysis

Clarke and Braun's (2014) 6-step framework was utilized to prepare data for this study as the framework remains one of the most influential approaches towards thematic analysis in the social sciences (Maguire & Delahunt, 2017). Steps in the framework are as follows:

1. Become familiar with the data
2. Generate initial codes
3. Search for themes
4. Review themes

5. Define themes
6. Write-up

Codes are a way to reduce large amounts of data into small meaningful chunks. Open coding was applied as codes were developed while working through the coding process. Coding was completed by hand by working through hard copies and, where possible, fed into Microsoft Excel to code and identify themes as described by Bree and Gallagher (2016). Because the research addressed specific research questions, a theoretical thematic analysis instead of an inductive analysis was utilized. All in-person, audio, and video data were transcribed verbatim. To ensure additional reliability, participants were asked to check transcribed statements for accuracy through a process called member checking (Mertler, 2017).

Data were analyzed utilizing the thematic content analysis method. Thematic content analysis is a technique utilized to isolate, review, and describe patterns (or themes) within data (Clarke & Braun, 2014). The method minimally organizes and still provides meaningful analysis of data. Clarke and Braun (2014) suggested this type of analysis should be the first qualitative method learned due to the benefit provided in various forms of analysis. According to Clarke and Braun, thematic content analysis is more of a method rather than a methodology, which means the method is flexible and ideal for this study.

The first step was to become fully immersed in the data by watching, listening and transcribing the video interviews and making field notes on the initial impressions. Second, after becoming familiar with the data, initial codes were generated using NVivo. The third step in the process is a search for themes, which are interpretations of the analyzed code. NVivo was also utilized to organize the codes into themes and subthemes. In the fourth step, the themes undergo a deeper review to determine if any need to be discarded, combined, or refined. During the fifth step, the themes and subthemes were further refined by assigning names. In the final step, the analysis was interpreted within the context of the research questions framing this study. Quotes from participants were provided as evidence to support the validity of thematic analysis.

Reliability and Validity

Qualitative research is based on subjective, interpretive, and contextual data. It is critical, reliable and valid results, which can undergo scrutiny and be useful to other researchers, can be provided. Four aspects must be considered in this process: (a) credibility, (b) transferability, (c) dependability, and (d) confirmability.

Credibility

Credibility, sometimes called internal validity, refers to the trustworthiness of research findings. To ensure credibility, participants were first asked to complete a survey, then to be interviewed, and field notes were taken. The three instruments permitted triangulation of research findings and added credibility to research findings. Participants checked transcribed statements for accuracy through a process called member checking (Mertler, 2017). Member checking is a validation tool that ensures the intent of the participant being interviewed.

Transferability

Transferability, often known as external validity, is the degree to which the findings of a study can be generalized by the reader. Demonstrated findings are transferable to different contexts, situations, times, and populations, and is the responsibility of the person doing the research. In this study, transferability was established by including a variety of age groups and STEM fields in the study (Hammarberg et al., 2016).

Dependability

Dependability, often known as reliability, establishes the repeatability of the study. In other words, whether the study could be repeated and render similar findings. In this qualitative phenomenological study, audit trails were utilized as a strategy to ensure dependability. Audit trails establish a paper trail for the research providing a detailed record of the research process (Lub, 2015). The tool can also be helpful for another researcher to follow when analyzing the study. Audit trails were used for research processes as well as analysis of the codes and themes naturally emerging from NVivo. Clusters of themes and sub-themes were developed from the data based on frequency of occurrence. The themes are presented in Table 2.

Confirmability

Confirmability is a method of establishing objectivity in qualitative research (Korstjens & Moser, 2018). To add confirmability to the study, data were analyzed using thematic analysis before reporting findings (Maguire & Delahunt, 2017). The method ensured results were based on participants' responses to interview questions.

Ethical Procedures

The web-based National Institutes of Health course entitled protecting human research participants, which is required by American College of Education for all researchers who work with human research participants, was successfully completed. Participants were supplied Informed Consent documentation (see Appendix C) approved by American College of Education. All participants participated voluntarily and in congruence with requirements set forth by the Institutional Review Board (IRB). Participants were previously unfamiliar and randomly selected based solely on meeting qualifications to participate in the study. An electronic demographic questionnaire (see Appendix B), a two-question questionnaire (see Appendix D) and semi-structured interview protocol (see Appendix E), and researcher field notes were utilized to triangulate the data. Participants were given the opportunity to review their interview transcripts to validate the data (Department of Health and Human Services, 2016). Additional questions were asked during the interview for depth and clarification of statements. Participants' personal information was coded by applying a number to represent each person. Electronic study data was stored on a password-protected computer. Data will be retained for 3 years after the completion of the research in accordance with the Code of Federal Regulations 46.115, which specifies how IRB records should be handled. When on paper, all personally identifiable information will be shredded and recycled at the conclusion of the retention period. Personally identifiable information stored electronically on a computer will be destroyed using a commercially available software application designed to remove all personally identifiable links from the storage device.

Chapter Summary

STEM education programs in middle school can possibly have an influence on whether girls pursue STEM careers. Research into this phenomenon is limited and further information is needed to determine the effect of STEM education at this age level. Fifteen women with a minimum of a bachelor's degree who worked in a STEM field completed a screening questionnaire and were interviewed to determine lived middle school STEM experiences and how middle school influenced the decision to become STEM professionals. Researcher field notes were taken to provide additional context. The three instruments triangulated data and added credibility to the study. Data were transcribed and checked by participants for accuracy through a process called member checking to ensure the accuracy of all statements. Data were organized and analyzed using thematic content analysis. Chapter 4 is a review of the results of this phenomenological study of middle school STEM classes on women who decided to pursue STEM careers.

Chapter 4: Research Findings and Data Analysis Results

The purpose of this qualitative phenomenological study was to advance the literature about women's lived experiences in middle school STEM and to explore how the essence and meaningfulness of the experiences influenced the decision to become professionals in STEM fields. The first question asked participants about lived experiences in middle school STEM classes. The second question inquired about how women were influenced in middle school to become a woman in STEM. Chapter 4 begins with a description of the participant selection procedures and subsequent interview process. Then, results and themes emerging from semi-structured interviews are shared with consideration of research questions.

Research Question 1: How does the STEM professional woman describe her lived experience as a girl in middle school STEM classes?

Research Question 2: How does the STEM professional woman relate her exposure to STEM classes during middle school to her decision to pursue a career in STEM?

Data Collection

Fifteen female participants from the United States and Mexico, ages between 22–65 years, with at least a Bachelor of Science degree in a STEM field and working in a STEM profession, participated in semi-structured interviews. Participants self-identified as working in a STEM field. Participants were solicited via an ad posted on LinkedIn, an internet-based professional network (see Appendix A). A Google form was used as a screening tool for the demographic questionnaire (see Appendix B) to determine eligibility for the study. All participants gave informed consent electronically (see Appendix C) if they chose to answer any questions beyond the first five on the demographic questionnaire. All data were aggregated automatically into a Google spreadsheet and this information was used to determine which candidates would be chosen for the study. After giving consent, candidates were given the opportunity to answer only two questions or to also continue with the full semi-structured interview. Once consent was given and eligibility determined, participants were emailed directly to schedule an interview time using an online scheduling program, called JotForm.

Interviews were approximately 1 hour in length and recorded using Zoom or Google Meet. Interviews were transcribed utilizing Otter.ai, an artificial intelligence-based platform designed to analyze and transcribe voice to text. A total of 50 people applied to participate in the study. Thirty-eight eligible participants completed the two-question option after giving informed consent and from this list, 33 participants also agreed to be interviewed. The first 15 who responded to the Study Welcome Email (see Appendix G) were selected to participate. Potential candidates were informed by email that the maximum number for the study had been reached and their participation was no longer required (see Appendix H). All interviews were conducted over 2 months from August to September 2020. Participants were emailed transcriptions of each interview to member check and add feedback. Field notes were taken during the semi-structured interviews and provided additional context to the investigation and to triangulate the data.

Among participants, 53% were between the ages of 22–35; 26.7% from 36–45; 13.3 % from 46–55; and 6.7% ranged from 56–65. Table 1 shows the STEM degrees obtained and the age range. All participants' names were kept confidential and can only be identified by using participation codes listed in Table 1.

Table 1

Participant Codes, Ages, and STEM degree

Participant codes	Age range	STEM degree
1	22–35	Wildlife Conservation Biology
2	36–45	Civil Engineering
3	36–45	Math & Engineering
4	56–65	Physiology
5	22–35	Biology
6	36–45	Technology
7	36–45	Science
8	46–55	Math
9	22–35	Science
10	46–55	Biology
11	22–35	Math
12	22–35	Biochemistry & Molecular Biology
13	22–35	Nuclear Engineering
14	22–35	Chemical Engineering
15	22–35	Atmospheric & Oceanic Studies

Note. Table 1 shows the demographics and participant codes used for this study.

Data Analysis and Results

Data were collected and analyzed using the structure for phenomenological interviewing outlined by Bevan (2014). The structure involved three areas: (a) contextualization, which allows a person to describe their experience as a narrative, (b) apprehending the phenomenon, which directs the focus of the interview onto the area the researcher is interested in by asking progressively more descriptive questions, and (c) clarifying the phenomenon, which uses elements of the experience or the whole experience while exploring the phenomenon itself. Questionnaires and semi-structured interviews for this study were conducted according to protocol.

All questionnaire data was completed by potential participants using a Google form. The demographic (see Appendix B) and basic two-question interview responses (see Appendix D) were automatically populated to a Google sheet to be used for further analysis. Before any participant answered the two questions (see Appendix D) or participated in the semi-structured interviews (see Appendix E), informed consent was affirmed electronically within the Google form (see Appendix C). All participants were given the opportunity to review their interview statements for accuracy via email using member checking. Researcher field notes were organized to enrich the data and provide additional context for data interpretation (Creswell & Creswell, 2018).

Clarke and Braun's (2014) 6-step framework was utilized to prepare the data for this study for coding and thematic analysis. The steps include:

1. Becoming familiar with the data
2. Generate initial codes
3. Search for themes
4. Review themes
5. Define themes
6. Write up

Main themes that arose from all participants concentrated on the following areas: (a) middle school, (b) support, and (c) lack of female leadership. Subthemes emerged under middle school and support allowing for more targeted information. The three subthemes under middle school included: (a) teacher influence, (b) exposure to female STEM professionals, and (c) STEM enrichment opportunities. The theme support included two subthemes: (a) peers, and (b) family.

Themes and codes were identified through NVivo and manually when naturally emerging. Google Sheets was used to categorize and analyze themes and codes and part of the audit trail. Themes emerging as a result of each interview question were organized according to the two research questions:

Research Question 1: How does the STEM professional woman describe her lived experience as a girl in middle school STEM classes?

Research Question 2: How does the STEM professional woman relate her exposure to STEM classes during middle school to her decision to pursue a career in STEM?

Table 2 demonstrates the thematic code and frequency participants shared the response. Themes, codes, and responses are qualitative findings intended to inform readers of women's perspectives and lived experiences in middle school STEM classes.

Table 2

Organic Themes Emerging from Interviews

Thematic code	No. of participants expressing the theme
Middle school	
Teacher influence	13
Exposure to female STEM professionals	15
STEM enrichment opportunities	15
Support	
Peers	9
Family	15
Lack of female leadership	9

Note. (*n* = 15). A summary of organic themes emerging from interviews and the number of participants expressing the theme.

Middle School

The middle school theme includes three sub-themes. Teacher Influence describes the influence STEM teachers had on participants during middle school. The following sub-themes: Exposure to Female STEM Professionals and STEM Enrichment Opportunities are reflections of participants on how more girls could become engaged in STEM and go onto careers in STEM.

Nearly all participants (13 of 15) mentioned the positive influence of a teacher in middle school who influenced students through the passion for STEM and the encouragement they gave students. Participant # 1 shared how a teacher helped inspire her to study biology:

> My teacher asked me if I would help her dissect a cow's brain. And that was absolutely wonderful because before that, I never realized how large a cow's brain is. She just really inspired me. She fed the flame of knowledge when it came to wildlife and a lot of things.

Participant # 15 shared:

> I remember in that week [of class], I learned about astronomy and space science. I think we had to create some type of booklet. This sparked my interest, and I was just interested in the different planets. From that point on, I was just really interested in becoming an astronomer.

Participant # 10 discussed the importance of seeing strong female teachers, stating "I think that seeing strong female teachers like my biology teacher, physiology teacher, my chemistry teacher in high school, yeah, you realize that I could do that."

All 15 participants indicated there needs to be greater exposure to female STEM professionals in middle school and beyond to help capture girls' interest. Participant #10 described her experience this way:

> When I got to college, I think my genetics teacher was female. Most of my bio teachers, most of my Chem teachers, and all of my physics teachers were male. I think it was really important for me at the high school level, to see that women can be scientists.

Another theme in which all participants concurred was in STEM enrichment. Examples included higher quality education, after-school programs, field trips, and competitions. Participant #11 mentioned the importance of high-quality education in getting more girls into STEM careers. The participant described high-quality education and enrichment opportunities as being “a type of privilege that you are born with,” also saying, “that it is unfortunate, but that helped a lot of the girls in my high school go into STEM careers.”

Participant # 13, who was a nuclear engineer, recounted becoming interested in nuclear engineering and how middle school classes helped shape her decision. “I got into nuclear [engineering] because the Fukushima nuclear accident happened in 2011 during seventh-grade.” The participant was highly affected by the event and discovered her passion for STEM at that moment. The participant also stated, “Because I was in the advanced math classes, I was able to get into the advanced math in high school.”

Participant # 7 felt “the stigma that girls are not good at math” despite having proof that is false because her aunt is a nuclear engineer. The participant further emphasized the importance of using STEM and STEAM (science, technology, engineering, art, and math) programs in more effective ways to help get more girls to become STEM professionals, stating:

> One of the biggest things that I think needs to occur is the opportunity to engage in project-based learning that is truly STEAM-based, because women are a lot of times

> drawn to humanities and to the arts. If you put [arts and humanities] outside of STEM, then you isolate [the girls].

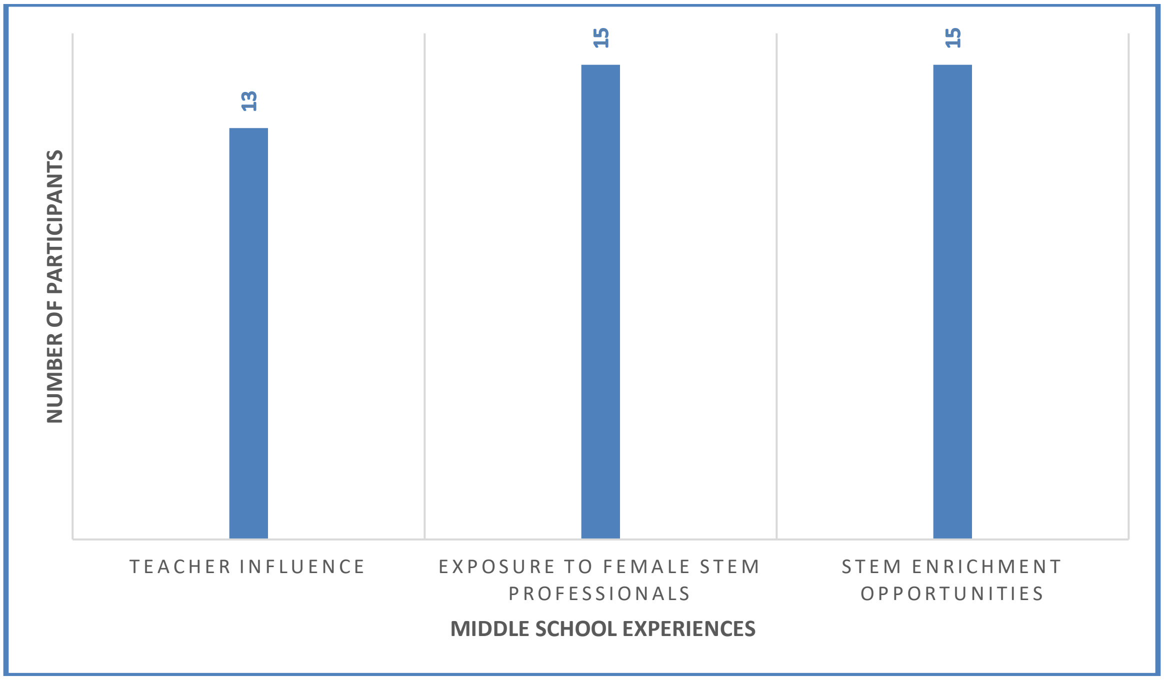
Participant # 2 felt it was important to change the mindset of how girls and boys think about STEM, saying:

> In middle school, I just don't think we expose kids in general [to STEM opportunities]. I don't think we give them enough ideas of how [what they are learning] fits into their end game. These guys are thinking; I want to be a YouTuber. I want to be a professional gamer, right? They're not thinking I want to be the guy that designs the platform upon which people are uploading all these YouTube videos.

Figure 1 illustrates the significance of support in influencing a girl's pursuit of a STEM career. Types of support include teacher influence and support from friends and family. Data from research question 1 indicates girls who have the support of family and peers along with a teacher influence, continue to careers in STEM.

Figure 1

Research Question 1 Analysis: Women's Experiences in Middle School STEM



Note. Number of participants experiencing one or more themes in middle school; teacher influence, exposure to female STEM professionals, and STEM enrichment opportunities.

Support

The second theme is Support. Throughout the interviews, participants acknowledged the importance of support in the journey to become STEM professionals. Types of support referenced included subthemes of Family and Peer Support. All 15 participants received Family Support for academic and professional choices.

One participant described having support from parents, friends, and teachers and acknowledged how support translated into the self-confidence to pursue a career in engineering. Another participant described how the after-school STEM-based activities provided by her mother developed self-confidence in STEM subjects throughout her academic journey.

Additionally, the participant would work side-by-side with her father on practical repairs, such as changing car brakes, working on lawnmowers or learning how to fix the vacuum cleaner. All of these experiences further supported her developing STEM interests through the middle school years. Only 9 of 15 participants expressed receiving support from friends. Participant # 15 explained the importance of Peer Support:

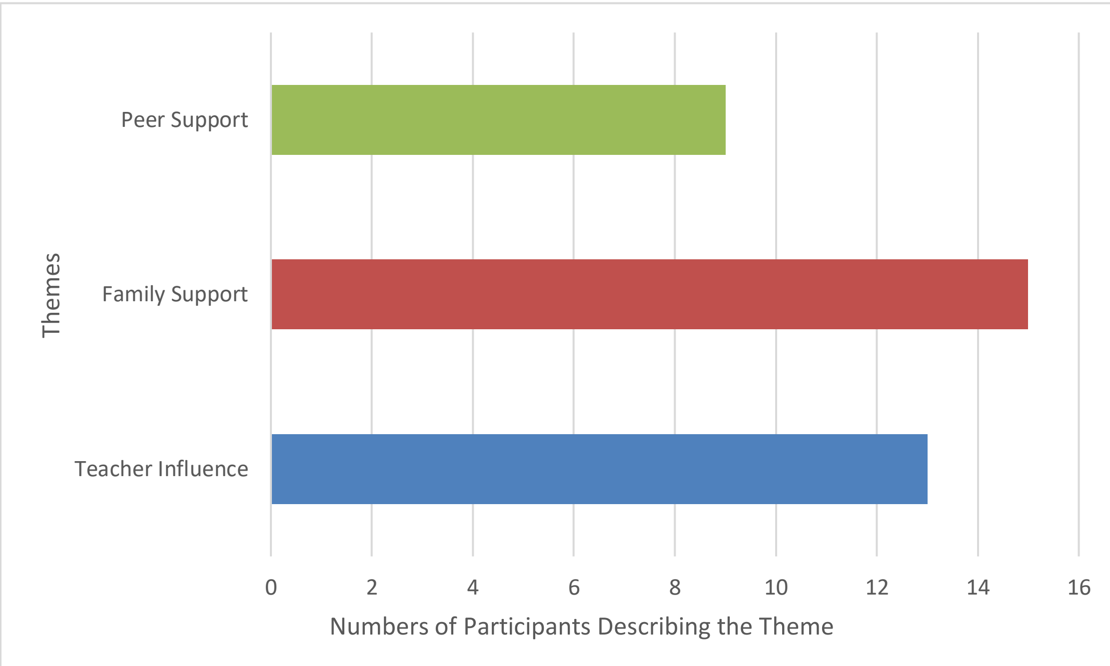
> I feel like getting girls to go into STEM needs a very good support group. I had my family. I had some friends not a lot, but a few. The teachers definitely were just like, ‘you're very smart, very bright,’ like having that type of support and encouragement is very, very useful. I think that's something that is needed for girls of all backgrounds to kind of encourage them to consider going into STEM. If they don't want to go into STEM, they don't have to, but if they're good at it, they shouldn't be told, no. There should be more encouragement, like - you're really good at this and even being told that as a young girl.

Participant # 3, who studied engineering and teaching, described feeling supported by friends and family, noting her dad especially had an influence because her dad reinforced the message “I can do whatever I put my mind to.” As a result, the family and friend support added to the positive encouragement from teachers and from participating in after school activities like Math Olympics.

Research questions 2 focused on the experiences of women when they were in middle school and how those experiences influenced them to become women in STEM. Indicated in Figure 2, three areas of experience emerged in the coding analysis: (a) peer support, (b) family support, and (c) teacher influence.

Figure 2

Research Question 2 Analysis: Factors Influencing the Pursuit of a STEM Career



Note. Figure 2 shows which themes naturally emerged when participants were asked questions about the factors influencing the pursuit of a STEM career. Family support was most frequently mentioned, followed respectively by teacher influence, and peer support.

Female Leadership

The third theme is the lack of female leadership. Nine of 15 participants noted the importance of women in STEM leadership roles in making a difference in getting more girls to become women in STEM and into STEM leadership. One participant stated, “It is just not that common to speak to other female [teacher] colleagues in computers or tech. I don't think there was one single other female in my school district that I spoke to.”

Participants indicated after school STEM-based programs and field trips were enrichment opportunities which allowed the participants to appreciate the practical application of what students were learning in class. Often, a teacher took notice and encouraged the participant to pursue a math club or go on a field trip. Reinforcement of the participant's ability combined with opportunities to cultivate academic ability, influenced these girls to pursue STEM careers later in life.

By the time participants arrived at the university, participants observed a noticeable lack of representation of women, especially in engineering. Often, the participant was the only woman in the classroom or at a workplace. Participant # 9 noted the lack of women in leadership in her university forensics class. "When I was in my forensics crime scene program, there were probably equal amounts of guys and girls [students]. However, none of the criminal justice or forensics teachers were female." Participants indicated exposure to female STEM professionals in middle school could improve the number of girls who become women in STEM because female students could "see that women can be scientists." The study indicated a relationship between having support, teacher influence, STEM enrichment opportunities, and exposure to female STEM professionals, and women pursuing a STEM career.

Reliability and Validity

The study ensured credibility by purposively sampling a population of women in the United States and Mexico to share lived experiences in middle school STEM classes and how classes may have influenced the decision to become women in STEM. As Table 1 depicted, the 15 participants consisted of women in the United States and Mexico with at least a bachelor's degree in a STEM subject, working in STEM, and were enrolled in STEM classes in middle school. To maintain credibility and dependability within the study, member checking was implemented. The transcript from each interview was emailed to the respective participant and provided the participant the opportunity to help maintain the internal validity and dependability of the study and accuracy of answers and reflect on answers and overall experience. Through member checking, participants were offered the opportunity to expand on answers where necessary.

All interviews were conducted using the semi-structured interview protocol (see Appendix E). Follow-up questions were asked to clarify or expand on participants' sentiments. NVivo, a qualitative data analysis software was utilized to auto code themes. Manual thematic analysis and coding were also performed using Google Sheets because many themes and codes emerged naturally leaving digital thematic analysis unnecessary. The dependability of data collected is sufficient for the research study, and data collection was conducted in a professional manner by reading and rereading interview answers and field notes.

To ensure dependability, the use of an audit trail was implemented. All raw data, including field notes, have been kept in a notebook, locally on a computer, or in the Cloud. Data reduction and analysis were processed using Google spreadsheets. Thematic coding was performed on NVivo and the query matrix was downloaded as a portable document file as a part of the research record. All thematic coding that emerged naturally was analyzed in Google Sheets and maintained there. All versions of materials and instruments are available on the Google cloud by reviewing the version history.

Chapter Summary

The research population and data analysis procedures are outlined in Chapter 4. Major themes from the phenomenological interviews of the middle school experiences of 15 women working in STEM careers are detailed. Themes and sub-themes were organized based on two research questions. Experiences of participants in middle school and how the time may have influenced the decision to pursue a STEM career are presented. Finally, participants described experiences at the university and in the workplace.

Further analysis of participants' experiences in middle school and in STEM careers is provided in Chapter 5. The analysis is based on the two research questions and includes interpretations related to the theoretical framework. Finally, recommendations are given for how more girls can become women in STEM.

Chapter 5: Discussion and Conclusion

Historically, fewer women pursue STEM careers compared to men, particularly in areas of technology and engineering. Data demonstrated girls begin losing interest in pursuing a STEM-focused career in middle school (Kesar, 2018). The purpose of this qualitative phenomenological study was to advance the literature about women's lived experiences in middle school STEM and to explore how the essence and meaningfulness of the experiences influenced the decision to become professionals in STEM fields. Research findings add to the existing body of research on women and girls in STEM with an additional focus on middle school experiences. The research focused on answering two questions.

Research Question 1: How does the STEM professional woman describe her lived experience as a girl in middle school STEM classes?

Research Question 2: How does the STEM professional woman relate her exposure to STEM classes during middle school to her decision to pursue a career in STEM?

Theories framing the research were transformational leadership and growth mindset. Transformational leadership is a style of leadership which encourages leadership by example to create organizational buy-in and intrinsic motivation in the workplace (Bass, 1985; Burns, 1978; Downton, 1973). Participants reflected on ways leadership could design schools to have more opportunities for girls in STEM, specifically exposure to female STEM professionals, field trips, after-school clubs, competitions, and hands-on learning. Growth mindset theory was developed to demonstrate that intelligence and capacity for learning were not fixed aspects of the human mind (Dweck, 2016). The theory includes the position when a person believes in their capability, is given the opportunity, and is willing to do the work, success is often possible. Participants discussed experiences in middle school and the influence family, friends, and teachers had on confidence in STEM courses and ultimately the pursuit of STEM careers.

Chapter 5 begins with a summary of findings related to two research questions. Questions are followed by a discussion of findings, interpretations, conclusions, limitations, and recommendations. Finally, implications for leadership are presented.

Findings, Interpretations, and Conclusions

The data analysis revealed three themes. The first theme was middle school, with subthemes of teacher influence, exposure to female STEM professionals, and exposure to STEM enrichment opportunities. Support is the second theme, with subthemes of family support and peer support. Finally, the third emergent theme is female leadership.

Growth Mindset Theoretical Framework

Data reaffirm the growth mindset theory framework which states, students and educators who believe in themselves, have support, and put in the effort can succeed (Dweck, 2016). Throughout the study, participants spoke on the importance of support in the pursuit of academic and professional careers. Each woman had at least two forms of support, whether from family, peers, or a teacher. Participants' self-confidence was reinforced by seeing and learning from female STEM professionals in middle school. Having the opportunity to participate in afterschool STEM activities or field trips further cemented this self-belief. A study by Microsoft (Kesar, 2018) suggested girls start losing interest in STEM subjects during middle school when lacking peer, family, or teacher support. Data in this study confirm findings in the Microsoft study.

Transformational Leadership Theoretical Framework

The data also reinforces the second theoretical framework for the study. Transformational leadership encourages leadership by example and intrinsic buy-in to a larger vision (Bass, 1985; Burns, 1978; Downton, 1973). Anderson (2017) found the transformational leadership style increased the performance of educational leaders and schools. Huang et al. (2019) demonstrated girls' mindsets towards math and science directly correlate with the pursuit of a STEM field. Data from this phenomenological study expanded on the findings of Huang et al. (2019) and demonstrated how the transformational leadership style can be extended to better support girls in becoming women in STEM. More girls may pursue a career in STEM when middle school leadership commits to and adequately supports a more equitable vision of STEM education. Girls deserve the opportunity to enjoy the same benefits their male counterparts have received throughout the years. In an equitable middle school environment, girls are also encouraged and supported by teachers, peers and family, introduced to female STEM professionals, female leadership, and exposed to STEM enrichment opportunities.

Research Question 1

Research question 1 examined how women's perception of middle school STEM classes influenced the decision to become a STEM professional. Semi-structured interviews revealed the significance of peer and family support and teacher influence in the participant's decision to pursue a STEM career. Of the 15 participants, 13 expressed the influence of a teacher in their positive perception of middle school and her decision to become a STEM professional (see Figure 1). Peer support was a significant factor for nine respondents and all participants stated family had an influence on perception of middle school STEM classes and the decision to become a woman in STEM (see Figure 1).

Middle school sub-themes of exposure to female STEM professionals and STEM enrichment opportunities were expressed by all participants as being factors which influenced participants to enjoy STEM in middle school and to continue to careers in STEM. Participants noted one or more of the following examples of enrichment opportunities: after-school STEM clubs, field trips, and competitions. Participants also indicated seeing women in STEM had a positive influence on the interest and pursuit of a STEM career. Results reaffirm findings from Rodenbusch et al. (2016) demonstrating the earlier students engage in STEM, the stronger STEM abilities remain during through an academic career.

Fifteen female participants in this study stated how abilities and interests were reinforced and supported by one or more of the following sources: (a) family, (b) peers, (c) teachers, and (d) female STEM professionals. As a result, each participant became a STEM professional. Findings indicate, by changing the perception of capabilities of girls and boys and taking actions against the intrinsic bias, more girls in middle school may consider and pursue careers in STEM.

Wang and Degol (2017) showed girls entering middle school with lower confidence than boys. One reason is the support and reinforcement boys receive in math when compared to girls. As a result, boys populate these fields in greater numbers than girls simply because of assumed excellence (Prinsley et al., 2016). Ambivalent sexism, a social theory developed by Connor and Fiske (2019) suggested gender differentiation is managed by creating rigid stereotypes within pervasive universal masculine dominant societies. Stereotypes reinforce gender-based behavior by using hostile and benevolent sexism. The enforcement of roles undermines female empowerment and independence to openly pursue interests in nonsupport roles because women are perceived to be incompetent in those roles. Kuchynka et al. (2018) explored how women were affected by hostile and benevolent sexism while weakly identified with a STEM career. Findings suggest women frequently do not pursue STEM careers when interests are not fully formed, and the girls are consistently exposed to benevolent sexism. Mote (2019) demonstrated self-limiting beliefs, reinforced externally, influence the career and life decisions throughout one's life. With family, peer, and teacher support, participants in this study had the confidence to pursue STEM in middle school and eventually careers in STEM.

Research Question 2

Research question 2 examined participants' lived experiences in middle school STEM classes. . Three sub-themes emerged: teacher influence, exposure to female STEM professionals, and STEM enrichment opportunities. Of the three sub-themes, all participants shared the positive influence of exposure to female STEM professionals and STEM enrichment opportunities. Thirteen participants were influenced by a teacher at the middle school level. The lived experiences in middle school affected academic choices and influenced decisions to continue into a STEM field.

Meehan et al. (2018) demonstrated a lack of role models who look or act like students in a classroom, made seeing oneself in that role more difficult. Reinking and Martin (2018) found girls begin losing interest in STEM fields in middle school as high school approaches. Findings in the present study show the phenomena do not have to persist. When girls in middle school receive positive teacher influence, exposure to female STEM professionals, and STEM enrichment opportunities, girls pursue careers in STEM.

Researchers have discovered the negative outcomes of gendered socialization or the rigid ideas of what a boy or girl should be (Régner et al., 2019). Often, unfounded negative statements about the math ability of girls persist and become reinforced by teachers, parents, and friends who are trusted community guides. As a result, many girls may not pursue careers in math or any STEM subject because there is a lack of confidence (Wang & Degol, 2017). Findings of this study indicate participation in middle school STEM enrichment activities, such as math competitions, build confidence and reinforces messages communicated by teachers and female STEM professionals.

Findings in this study support the first theoretical framework, growth mindset theory (Dweck, 2016) because participants continuously believed they could be successful in STEM and had those beliefs reinforced throughout middle school. Each participant became a woman in STEM through a combination of peer or family support, teacher influence, exposure to female STEM professionals, and STEM enrichment opportunities in middle school. Findings show girls can achieve at least as well as boys in STEM subjects and continue to STEM careers with the right combination of influences. Furthermore, when combined with the second theoretical framework, transformational leadership, educators and administrators can lead schools in which a growth mindset drives the transformation of educational outcomes and improve opportunities for girls. All students can achieve, and teachers and administrators are empowered with tools to actively create this outcome as demonstrated by Anderson (2017) and confirmed by these findings.

Limitations

The study focused on lived middle school experiences of women working in a STEM field. A limitation of qualitative research is the inherent lack of statistical data which would be present in quantitative research. The small population of participants (15) offers a general understanding and possible trend in lived experiences of female STEM professionals during middle school. A larger sample size could provide more detail and additional data. Another limitation could be regions in which the study was performed. Data is from a small population in the United States and Mexico only.

Transferability of the Research

In qualitative research, which is subjective, interpretive, and contextual, findings should undergo scrutiny to ensure reliable and valid results. Results of the study are transferable to a diverse sample population of women because a wide age range was utilized (22–65 years old). The study was also open to women working in any field in STEM within the United States and Mexico.

Credibility of the Research

The credibility of the study was achieved using a variety of methods. Participants were screened with a questionnaire to determine qualification and asked to be interviewed. All semi-structured interviews were videoed, audio-recorded, transcribed, and member checked. Finally, field notes were taken and organized. The use of two instruments (semi-structured interviews and field notes) served to triangulate research findings and ensure credibility to data.

Dependability of the Research

The use of audit trails ensured the dependability or repeatability of the study. Another researcher could utilize records to repeat or further analyze data for additional study. Confirmability was established using thematic analysis through NVivo and manually, and then organized in a spreadsheet before reporting findings. The process ensured findings are based on participants' responses to the interview questions.

Recommendations

As a result, local, state, and federal policies should focus on creating opportunities for educators to be trained in growth mindset theory and its application to positively support students in STEM subjects in school. Families should be invited to school events, which show real benefits of girls entering STEM careers and how the options can benefit the girls economically and intellectually throughout their lives. Through these efforts, educational leaders can create a pipeline of technically proficient professionals and close the technology gap the United States has been experiencing globally.

Schools Invite STEM Lecturers

Schools should adopt a growth mindset reinforcing practical ways girls are equally capable to become engineers, computer scientists, physicists, chemists and biologists. Schools should communicate the growth mindset using a transformational leadership style, which creates global buy-in from staff, students, parents, and the community. Further focus on creating field trips, competitions, after-school programs, hands-on curriculum in STEM, and exposing students to female STEM professionals should be employed to better engage female students in middle school.

By incorporating recommendations stated in the previous paragraph, individuals, families, organizations, schools, and the community can begin affecting the social change, which would include girls as a relevant part of the larger social, educational, and workforce conversation. The United States falls behind many other nations in producing a globally competitive, technologically qualified workforce (United States Department of Education, 2018). At the same time, women have largely been left out of consideration for these jobs until recently (National Science Board [NSB], 2018). As a nation, the United States should implement programs and policies to make the best use of its human resources. Change begins with one's mindset (Dweck, 2016). When a growth mindset is combined with transformational leadership, appropriation of financial and human resources, and a fierce commitment to developing an equitable society of opportunity for all, Americans can begin to meet the demands of a global society (Andersen et al., 2018).

Girls Should See Themselves in STEM

Research findings demonstrate the important role support plays in girls' academic and ultimately professional pursuits. Participants in this study received at least two forms of support from three areas: (a) teacher, (b) family, or (c) peers. Participants were also exposed to women professionals in STEM and enrichment opportunities which reinforced their abilities and budding interest in STEM subjects.

The implication of this study for leadership is a greater awareness of the need to ensure girls have teacher, family, and peer support at the middle school level. Furthermore, girls benefit from being exposed to female STEM professionals and extracurricular STEM enrichment opportunities such as math and STEM clubs or field trips related to STEM. With these components in place, women in this study went on to become women in STEM. Educators have a duty to offer students the opportunity to excel. Educational leadership should align their policies, programs, curriculum, and professional development to support girls and provide the opportunity for girls to become women in STEM and leaders in STEM.

Implications for Leadership

The focus of this phenomenological study was on lived middle school experiences of women working in STEM fields. Findings indicate when girls receive the required support of friends, family, and educators, and are exposed to female role models and enrichment activities, the girls build confidence to continue toward a career in STEM. Additional investigations could be performed to extend the research from this study. An investigation to explore experiences of women in the workplace or at the university based on the chosen STEM field could provide more precise information on where interventions are most needed in middle school or K–12 more generally.

For Women a STEM Degree May Not Mean a STEM Career

Another study could focus on how race informs women's experiences in the K–12 years, through university, and in the workplace. One study could explore reasons why women who receive a STEM degree do not pursue a STEM career. A study investigating the experiences of mothers in the STEM workplace with suggestions for creating a more equitable environment could be pursued. The evidence presented shows girls are influenced as early as 12 years old towards STEM subjects. Though out of the scope of this study, further investigation could determine whether the influence begins even earlier, in elementary school.

Addressing Equity Issues

Findings indicate the need for a greater focus on ensuring women have meaningful academic experiences and leading to successful STEM careers. By utilizing a growth mindset and transformational leadership, educators and education decision makers can reconfigure programming and curriculum to meet the diverse need of the student population to generate more meaningful opportunities for students. Policies to develop social-emotional programs should be implemented in schools to continue addressing gender bias and lack of female leadership in STEM fields. Findings show support, teacher influence, STEM enrichment opportunities, and experiencing women in STEM leadership roles have clear benefits for girls considering STEM as a career in middle school. A more intense focus on these areas fosters equity in education and could offer more girls to one day have the opportunity to become STEM professionals.

Conclusion

The phenomenological study focused on lived middle school experiences of women working in STEM fields. Findings indicate when girls receive the required support of friends, family, and educators, girls build the confidence to continue toward a career in STEM. However, data show despite women receiving STEM degrees, these women are not entering the workforce at the same rate as men (NSB, 2018). A gap remains between the middle school and post-secondary experience.

Participants recommended improving middle school STEM programs by providing enrichment opportunities to capture more girls at an age where studies show girls begin losing interest. Field trips, competitions, after-school programs, and hands-on STEM were specific recommendations to improve conditions and outcomes for girls. Participants also shared the importance of seeing and hearing from women in various STEM fields so girls could begin to learn about and imagine themselves in a variety of STEM careers. School leadership should take on a transformational leadership style with a growth mindset to encourage every stakeholder from parents, students, educators, administration, and the community to participate in building better outcomes for girls.

References

ACT. (2018). *National: The condition of college and career readiness.* https://www.act.org/content/dam/act/unsecured/documents/cccr2018/National-CCCR-2018.pdf

Akaygun, S., & Aslan-Tutak, F. (2016). STEM images revealing STEM conceptions of pre-service chemistry and mathematics teachers. *International Journal of Education in Mathematics, Science and Technology, 4*(1), 56–71. https://doi.org/10.18404/ijemst.44833

Andersen, L. B., Bjørnholt, B., Bro, L. L., & Holm-Petersen, C. (2018). Leadership and motivation: A qualitative study of transformational leadership and public service motivation. *International Review of Administrative Sciences, 84*(4), 675–691. https://doi.org/10.1177/0020852316654747

Anderson, M. (2017). Transformational leadership in education: A review of existing literature. *International Social Science Review, 93*(1), Article 4. https://digitalcommons.northgeorgia.edu/issr/vol93/iss1/4

Bass, B. M. (1985). Leadership: Good, better, best. *Organizational Dynamics, 13*(3), 26–40. https://doi.org/10.1016/0090-2616(85)90028-2

Benson, L. R. (2017). Hidden figures: The American dream and the untold story of the Black women mathematicians who helped win the space race. *Air Power History*, *64*(3), 59–61.

Bevan, M. T. (2014). A method of phenomenological interviewing. *Qualitative Health Research, 24*(1), 136–144. https://doi.org/10.1177/1049732313519710

Bhatt, M., Blakley, J., Mohanty, N., & Payne, R. (2015). *How media shapes perceptions of science and technology for girls and women*. Fem Inc. https://learcenter.org/pdf/femSTEM.pdf

Bian, L., Leslie, S.-J., & Cimpian, A. (2017). Gender stereotypes about intellectual ability emerge early and influence children's interests. *Science, 355*(6323), 389–391. http://doi.org/10.1126/science.aah6524

Blackley, S., Sheffield, R., Maynard, N., Koul, R., & Walker, R. (2017). Makerspace and reflective practice: Advancing preservice teachers in STEM education. *Australian Journal of Teacher Education (Online), 42*(3), 22–37. http://doi.org/10.14221/ajte.2017v42n3.2

Blotnicky, K. A., Franz-Odendaal, T., French, F., & Joy, P. (2018). A study of the correlation between STEM career knowledge, mathematics self-efficacy, career interests, and career activities on the likelihood of pursuing a STEM career among middle school students. *International Journal of STEM Education, 5*(1), 1–15. http://doi.org/10.1186/s40594-018-0118-3

Brassler, M., & Dettmers, J. (2017). How to enhance interdisciplinary competence—interdisciplinary problem-based learning versus interdisciplinary project-based learning. *Interdisciplinary Journal of Problem-Based Learning, 11*(2), Article 12. https://doi.org/10.7771/1541-5015.1686

Bree, R. T., & Gallagher, G. (2016). Using Microsoft Excel to code and thematically analyse qualitative data: A simple, cost-effective approach. *AISHE-J: The All Ireland Journal of*

Teaching and Learning in Higher Education, 8(2), 2811–2819. http://ojs.aishe.org/index.php/aishe-j/article/view/[281]

Brescoll, V. L. (2016). Leading with their hearts? How gender stereotypes of emotion lead to biased evaluations of female leaders. *The Leadership Quarterly, 27*(3), 415–428.

Burns, J. M. (1978). *Leadership.* Harper & Row.

Carli, L. L., Alawa, L., Lee, Y., Zhao, B., & Kim, E. (2016). Stereotypes about gender and science: Women≠ scientists. *Psychology of Women Quarterly, 40*(2), 244–260. https://doi.org/10.1177/0361684315622645

Casad, B. J., Hale, P., & Wachs, F. L. (2017). Stereotype threat among girls: Differences by gender identity and math education context. *Psychology of Women Quarterly, 41*(4), 513–529. https://doi.org/10.1177/0361684317711412

Cherlin, A. J. (2016). A happy ending to a half-century of family change?: A happy ending to a half-century of family change? *Population and Development Review, 42*(1), 121–129. https://doi.org/10.1111/j.1728-4457.2016.00111.x

Cheryan, S., Master, A., & Meltzoff, A. N. (2015). Cultural stereotypes as gatekeepers: Increasing girls' interest in computer science and engineering by diversifying stereotypes. *Frontiers in Psychology, 6,* 49. https://doi.org/10.3389/fpsyg.2015.00049

Chiu, A., Price, C. A., & Ovrahim, E. (2015, April 11–14). *Supporting elementary and middle school STEM education at the whole school level: A review of the literature* [Conference session]. NARST 2015 Annual Conference. Chicago, IL, United States. https://www.msichicago.org/fileadmin/assets/educators/science_leadership_initiative/SLI_Lit_Review.pdf

Chowdhury, P. C. (2017). Gender bias in education: Perceptions of masculinity and femininity. *International Education and Research Journal, 3*(5), 253–255. http://ierj.in/journal/index.php/ierj/article/view/919

Clarke, V., & Braun, V. (2014). Thematic analysis. *Qualitative Research, 3,* 1947–1952. https://doi.org/10.1007/978-1-4614-5583-7_311

Collins, K. H. (2018). Confronting color-blind STEM talent development: Toward a contextual model for Black student STEM identity. *Journal of Advanced Academics, 29*(2), 143–168. https://doi.org/10.1177/1932202x18757958

Collins, K. H., Joseph, N. M., & Ford, D. Y. (2020). Missing in action: Gifted black girls in science, technology, engineering, and mathematics. *Gifted Child Today*, *43*(1), 55–63. https://doi.org/10.1177/1076217519880593

Computer Science Degree Hub. (2021). *The 30 most influential computer scientists alive today*. https://www.computersciencedegreehub.com/30-most-influential-computer-scientists-alive-today/

Connor, R. A., & Fiske, S. T. (2019). Not minding the gap: How hostile sexism encourages choice explanations for the gender income gap. *Psychology of Women Quarterly, 43*(1), 22–36. https://doi.org/10.1177/0361684318815468

Conrad, P., Carr, P., Knight, S., Renfrew, M. R., Dunn, M. B., & Pololi, L. (2010). Hierarchy as a barrier to advancement for women in academic medicine. *Journal of Women's Health*, *19*(4), 799-805. http://doi.org/10.1089/jwh.2009.1591

Corbett, C., & Hill, C. (2015). *Solving the equation: The variables for women's success in* *engineering and computing.* American Association of University Women. https://www.aauw.org/app/uploads/2020/03/Solving-the-Equation-report-nsa.pdf

Craig, C., Evans, P., & Stokes, D. (2017). Developing STEM teachers through both informal and formal learning experiences. *Advancing Research and Innovation in STEM of Education of Preservice Teachers in High-Need School Districts.* https://repositorio.grial.eu/handle/grial/919

Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (4th ed.). Boston, MA: Pearson.

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches.* SAGE Publications.

Degol, J. L., Wang, M.-T., Zhang, Y., & Allerton, J. (2018). Do growth mindsets in math benefit females? Identifying pathways between gender, mindset, and motivation. *Journal of Youth and Adolescence.47*(5), 976–990. http://doi.org/10.1007/s10964-017-0739-8

Department of Health and Human Services. (2016, December). *Use of electronic informed consent: Questions and answers guidance for institutional review boards, investigators, and sponsors.* https://www.hhs.gov/ohrp/regulations-and-policy/guidance/use-electronic-informed-consent-questions-and-answers/index.html

Downton, J. V. (1973). *Rebel leadership: Commitment and charisma in the revolutionary process.* Free Press.

Dweck, C. S. (2014). *Mindsets and math/science achievement.* The Opportunity Education: Transforming Mathematics and Science Education for Citizenship and the Global Economy.

https://www.growthmindsetmaths.com/uploads/2/3/7/7/23776169/mindset_and_math_science_achievement_-_nov_2013.pdf

Dweck, C. S. (2016). What having a “growth mindset” actually means. *Harvard Business Review, 13*, 213–226. https://hbr.org/2016/01/what-having-a-growth-mindset-actually-means

Dweck, C. S., & Bempechat, J. (1983). Children's theories of intelligence. In S. G. Paris, G. M. Olsen, & H. W. Stevenson (Eds.), *Learning and motivation in the classroom* (1st ed., 239–256). Routledge.

Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review, 95*(2), 256. https://doi.org/10.1037/0033-295X.95.2.256

Eckman, E. W., Williams, M. A., & Silver-Thorn, M. B. (2016). An integrated model for STEM teacher preparation: The value of a teaching cooperative educational experience. *Journal of STEM Teacher Education, 51*(1), Article 8. https://doi.org/10.30707/JSTE51.1Eckman

El Nagdi, M., Leammukda, F., & Roehrig, G. (2018). Developing identities of STEM teachers at emerging STEM schools. *International Journal of STEM Education*, *5*(1), Article 36. https://doi.org/10.1186/s40594-018-0136-1

English, L. (2016). STEM education K–12: Perspectives on integration. *International Journal of STEM Education, 3*(3), 1–8.

Fiske, S. T. (2017). Prejudices in cultural contexts: Shared stereotypes (gender, age) versus variable stereotypes (race, ethnicity, religion). *Perspectives on Psychological Science, 12*(5), 791–799. https://doi.org/10.1177/1745691617708204

Fiske, S. T. (2018). Stereotype content: Warmth and competence endure. *Current Directions in Psychological Science, 27*(2), 67–73. https://doi.org/10.1177/0963721417738825

Fouad, N. A., Singh, R., Cappaert, K., Chang, W.-H., & Wan, M. (2016). Corrigendum to 'Comparison of women engineers who persist in or depart from engineering.' *Journal of Vocational Behavior*, *92*, 79–93. https://doi.org/10.1016/j.jvb.2016.04.001

Frintner, M. P., Sisk, B., Byrne, B. J., Freed, G. L., Starmer, A. J., & Olson, L. M. (2019). Gender differences in earnings of early- and mid-career pediatricians. *Pediatrics*, *144*(4), Article e20183955. http://doi.org/10.1542/peds.2018-3955

Geiger, A., & Parker, K. (2018, March 15). *For women's history month, a look at gender gains–and gaps–in the U.S.* Pew Research Center. https://www.pewresearch.org/fact-tank/2018/03/15/for-womens-history-month-a-look-at-gender-gains-and-gaps-in-the-u-s/

Girod, S., Fassiotto, M., Grewal, D., Ku, M. C., Sriram, N., Nosek, B. A., & Valantine, H. (2016). Reducing implicit gender leadership bias in academic medicine with an educational intervention. *Academic Medicine, 91*(8), 1143–1150. doi:10.1097/acm.0000000000001099

Greenwald, A. G., & Banaji, M. R. (1995). Implicit social cognition: Attitudes, self-esteem, and stereotypes. *Psychological Review*, *102*(1), 4–27. https://doi.org/10.1037/0033-295x.102.1.4

Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. K. (1998). Measuring individual differences in implicit cognition: The implicit association test. *Journal of Personality and Social Psychology, 74*(6), 1464–1480. https://doi.org/10.1037/0022-3514.74.6.1464

Guzey, S. S., Moore, T. J., Harwell, M., & Moreno, M. (2016). STEM integration in middle school life science: Student learning and attitudes. *Journal of Science Education and Technology*, *25*(4), 550–560. https://doi.org/10.1007/s10956-016-9612-x

Haimovitz, K., & Dweck, C. S. (2017). The origins of children's growth and fixed mindsets: New research and a new proposal. *Child Development*, *88*(6), 1849–1859.

Hammarberg, K., Kirkman, M., & de Lacey, S. (2016). Qualitative research methods: When to use them and how to judge them. *Human Reproduction*, *31*(3), 498–501.

Hand, S., Rice, L., & Greenlee, E. (2017). Exploring teachers' and students' gender role bias and students' confidence in STEM fields. *Social Psychology of Education*, *20*(4), 929–945.

Henderson, V. L., & Dweck, C. S. (1990). Motivation and achievement. In S. S. Feldman & G. R. Elliott (Eds.), *At the threshold: The developing adolescent* (pp. 308–329). Harvard University Press.

Huang, X., Zhang, J., & Hudson, L. (2019). Impact of math self-efficacy, math anxiety, and growth mindset on math and science career interest for middle school students: The gender moderating effect. *European Journal of Psychology of Education*, *34*(3), 621–640. https://doi.org/10.1007/S10212-018-0403-Z

Hughes, R., & Roberts, K. (2019). The role of STEM self-efficacy on STEM identity for middle school girls after participation in a single-sex informal STEM education program. *International Journal of Gender, Science, and Technology*, *11*(2), 286–311. http://genderandset.open.ac.uk/index.php/genderandset/article/viewFile/549/1061

Husserl, E. (1970). *The crisis of European sciences and transcendental phenomenology: An* *introduction to phenomenological philosophy* (D. Carr, Trans.; 2nd ed.). Northwestern University Press. Original work published in 1936.

Islam, S. I. (2017). Arab women in science, technology, engineering, and mathematics fields: The way forward. *World Journal of Education, 7*(6), Article 12. https://doi.org/10.5430/wje.v7n6p12

Jovanovica, D., & Ciricb, M. (2016). Benefits of transformational leadership in the context of education. *The European Proceedings of Social & Behavioural Sciences EpSBS*, 406–503. https://www.europeanproceedings.com/files/data/article/45/1218/article_45_1218_pdf_100.pdf

Juhn, C., & McCue, K. (2017). Specialization then and now: Marriage, children, and the gender earnings gap across cohorts. *Journal of Economic Perspectives*, *31*(1), 183–204. https://doi.org/10.1257/jep.31.1.183

Kang, H., Calabrese Barton, A., Tan, E., Simpkins, S., Rhee, H., & 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. https://doi.org/10.1002/sce.21492sce.21492

Kelley, T. R., & Knowles, J. G. (2016). A conceptual framework for integrated STEM education. *International Journal of STEM Education*, *3*(1). https://doi.org/10.1186/s40594-016-0046-z

Kerpen, C. (2017, June 21). *How a confidence mindset can help close the gender gap in science, technology, engineering, and math.* Women@Forbes.

https://www.forbes.com/sites/carriekerpen/2017/06/21/how-confidence-mindset-can-help-close-the-gender-gap-in-stem/?sh=671c2fb66708

Kesar, S. (2018). *Closing the STEM gap.* Microsoft. https://query.prod.cms.rt.microsoft.com/cms/api/am/binary/RE1UMWz

Kirwan Institute for the Study of Race and Ethnicity. (2012). *Understanding implicit bias.* https://kirwaninstitute.osu.edu/article/understanding-implicit-bias

Kislyakov, P., Shmeleva, E., & Belyakova, N. (2019). Professional objectives of future STEM specialists. *Advancement in Economics, Business Management, and Research, 79*, 102–105. http://doi.org/10.2991/iscfec-19.2019.27

Korstjens, I., & Moser, A. (2018). Series: Practical guidance to qualitative research. Part 4: trustworthiness and publishing. *European Journal of General Practice, 24*(1), 120–124.

Kuchynka, S. L., Salomon, K., Bosson, J. K., El-Hout, M., Kiebel, E., Cooperman, C., & Toomey, R. (2018). Hostile and benevolent sexism and college women's STEM outcomes. *Psychology of Women Quarterly, 42*(1), 72–87. http://doi.org/10.1177/0361684317741889

Leaper, C. (2015). Do I belong?: Gender, peer groups, and STEM achievement. *International Journal of Gender, Science and Technology, 7*(2), 166–179.

Levitt, H. M., Bamberg, M., Creswell, J. W., Frost, D. M., Josselson, R., & Suárez-Orozco, C. (2018). Journal article reporting standards for qualitative primary, qualitative meta-analytic, and mixed methods research in psychology: The APA publications and communications board task force report. *American Psychological Association*, *73*(1), 26–46. http://doi.org/10.1037/amp0000151

Li, S., & Rincon, R., & Williams, J. C. (2017, June), Climate Control: Gender and Racial Bias in Engineering? Paper presented at 2017 ASEE Annual Conference & Exposition, Columbus, Ohio. 10.18260/1-2—28038

Lub, V. (2015). Validity in qualitative evaluation: Linking purposes, paradigms, and perspectives. *International Journal of Qualitative Methods, 14*(5), Article 160940691562140. https://doi.org/10.1177/1609406915621406

Lucifora, C., Meurs, D., & Villar, E. (2017). *Children, earnings and careers in an internal labor market*. https://www.aiel.it/cms/cms-files/submission/all20170831111248.pdf

Lynn, R. (2019). Reflections on sixty-eight years of research on race and intelligence. *Psych, 1*(1), 123–131. https://doi.org/10.3390/psych1010009

Maguire, M., & Delahunt, B. (2017). Doing a thematic analysis: A practical, step-by-step guide for learning and teaching scholars. *AISHE-J: The All Ireland Journal of Teaching and Learning in Higher Education, 9*(3). http://ojs.aishe.org/aishe/index.php/aishe-j/article/view/335

Makarova, E., Aeschlimann, B., & Herzog, W. (2019). The gender gap in STEM Fields: The impact of the gender stereotype of math and science on secondary students' career aspirations. *Frontiers in Education, 4*. https://doi.org/10.3389/feduc.2019.00060

Meehan, M., Howard, E., & Ní Shúilleabháin, A. (2018, July 3–8). *Students' sense of belonging to mathematics in the secondary-tertiary transition* [Paper presentation]. In PME42 the 42nd Annual Meeting of the International Group for the Psychology of Mathematics Education, Umea Sweden.

https://www.researchgate.net/publication/329844727_Students'_sense_of_belonging_to_mathematics_in_the_secondary-tertiary_transition

Mertler, C. A. (2017). *Action research: Improving schools and empowering educators.* SAGE Publications. https://doi.org/10.4135/9781483396484

Morais Maceira, H. (2017). Economic benefits of gender equality in the EU. *Intereconomics, 52*(3), 178–183. https://doi.org/10.1007/s10272-017-0669-4

Mote, G. (2019, February 26). *How unconscious bias impacts decision making*. Corridor Business. https://corridorbusiness.com/how-unconscious-bias-impacts-decision-making

National Center for Science and Engineering Statistics. (2017). *Women, minorities, and persons with disabilities in science and engineering*. www.nsf.gov/statistics/wmpd/

National Center for Science and Engineering Statistics. (2019). *Women, minorities, and persons with disabilities in science and engineering.* https://ncses.nsf.gov/pubs/nsf19304/

National Science Board. (2018). *Science and engineering indicators 2018*. https://www.nsf.gov/statistics/2018/nsb20181/

Ogle, J. P., Hyllegard, K. H., Rambo-Hernandez, K., & Park, J. (2017). Building middle school girls' self-efficacy, knowledge, and interest in math and science through the integration of fashion and STEM. *Journal of Family & Consumer Sciences*, *109*(4), 33–40. https://doi.org/10.14307/jfcs109.4.33

Okahana, H., & Zhou, E. (2018). *Graduate enrollment and degrees: 2007 to 2017.* https://cgsnet.org/ckfinder/userfiles/files/CGS_GED17_Report.pdf

Olsson, M., & Martiny, S. E. (2018). Does exposure to counterstereotypical role models influence girls' and women's gender stereotypes and career choices? A review of social psychological research. *Frontiers in Psychology, 9*, Article 2264. https://doi.org/10.3389/fpsyg.2018.02264

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

Pearson, G. (2017). National academies piece on integrated STEM. *The Journal of Educational Research, 110*(3), 224–226. https://doi.org/10.1080/00220671.2017.1289781

Plante, I., de la Sablonnière, R., Aronson, J. M., & Théorêt, M. (2013). Gender stereotype endorsement and achievement-related outcomes: The role of competence beliefs and task values. *Contemporary Educational Psychology, 38*(3), 225–235. https://doi.org/10.1016/j.cedpsych.2013.03.004

Prinsley, R., Beavis, A. S., & Clifford-Hordacre, N. (2016). Busting myths about women in STEM. *Office of the Chief Scientist Occasional Paper Series, 13*, 1–4.

Pritlove, C., Juando-Prats, C., Ala-leppilampi Kari, & Parsons, J. A. (2019). The good, the bad, and the ugly of implicit bias. *The Lancet, 393*(10171), 502–504. doi:10.1016/s0140-6736(18)32267-0

Rattan, A., Savani, K., Chugh, D., & Dweck, C. S. (2015). Leveraging mindsets to promote academic achievement: Policy recommendations. *Perspectives on Psychological Science, 10*(6), 721–726. https://doi.org/10.1177/1745691615599383

Régner, I., Thinus-Blanc, C., Netter, A., Schmader, T., & Huguet, P. (2019). Committees with implicit biases promote fewer women when they do not believe gender bias exists. *Nature Human Behaviour, 3*(11), 1171–1179. https://doi.org/10.1038/s41562-019-0686-

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Reinking, A., & Martin, B. (2018). The gender gap in STEM fields: Theories, movements, and ideas to engage girls in STEM. *Journal of New Approaches in Educational Research. 2018, 7*(2): 148–153. https://doi.org/10.7821/naer.2018.7.271

Rice, L., & Barth, J. M. (2017). A tale of two gender roles: The effects of implicit and explicit gender role traditionalism and occupational stereotype on hiring decisions. *Gender Issues, 34*(1), 86–102. https://doi.org/10.7821/naer.2018.7.271

Rodenbusch, S. E., Hernandez, P. R., Simmons, S. L., & Dolan, E. L. (2016). Early engagement in course-based research increases graduation rates and completion of science, engineering, and mathematics degrees. *CBE—Life Sciences Education*, *15*(2), Article 20. http://doi.org/10.1187/cbe.16-03-0117

Roy, J. (2019). *Engineering by the numbers.* American Society for Engineering Education. https://www.asee.org/documents/papers-and-publications/publications/college-profiles/2018-Engineering-by-Numbers-Engineering-Statistics-UPDATED-15-July-2019.pdf

Savaria, M. C., & Monteiro, K. A. (2017). A critical discourse analysis of engineering course syllabi and recommendations for increasing engagement among women in STEM. *Journal of STEM Education: Innovations and Research*, *18*(1) 92–97.

Schmidt, M., & Fulton, L. (2016). Transforming a traditional inquiry-based science unit into a STEM unit for elementary preservice teachers: a view from the trenches. *Journal of Science Education and Technology, 25*(2), 302–315. https://doi.org/10.1007/s10956-015-9594-0

Schuster, C., & Martiny, S. E. (2017). Not feeling good in STEM: Effects of stereotype activation and anticipated effect on women's career aspirations. *Sex Roles, 76*(1–2), 40–55. http://doi.org/10.1007/s11199-016-0665-3

Selimbegović, L., Karabegović, M., Blažev, M., & Burušić, 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. https://doi.org/10.1002/pits.22296

Sharma, G. (2017). Pros and cons of different sampling techniques. *International Journal of Applied Research, 3*(7), 749–752.

Song, J., Zuo, B., Wen, F., & Yan, L. (2017). Math-gender stereotypes and career intentions: An application of expectancy–value theory. *British Journal of Guidance & Counselling, 45*(3), 328–340. https://doi.org/10.1080/03069885.2017.1283680

Spearman, C. (1904). "General intelligence," objectively determined and measured. *The American Journal of Psychology, 15*(2), 201–293. http://doi.org/10.2307/1412107

Spencer, S. J., Logel, C., & Davies, P. G. (2016). Stereotype threat. *Annual Review of Psychology, 67,* 415–437. https://doi.org/10.1146/annurev-psych-073115-103235

Steiber, N., Berghammer, C., & Haas, B. (2016). Contextualizing the education effect on women's employment: A cross-national comparative analysis, *Journal of Marriage and Family, 78*(1), 246–261. https://doi.org/10.1111/jomf.12256

Steinke, J. (2017). Adolescent girls' STEM identity formation and media images of STEM professionals: Considering the influence of contextual Cues. *Frontiers in Psychology, 8*. https://doi.org/10.3389/fpsyg.2017.00716

Stout, J. G., Grunberg, V. A., & Ito, T. A. (2016). Gender roles and stereotypes about science careers help explain women and men's science pursuits. *Sex Roles, 75*(9–10), 490–499. https://doi.org/10.1007/s11199-016-0647-5

Suarta, I. M., Suwintana, I. K., Sudhana, I. F. P., & Hariyanti, N. K. D. (2017). Employability skills required by the 21st century workplace: A literature review of labor market demand. *Advances in Social Science, Education, and Humanities Research, 102*, 337–342. https://doi.org/10.2991/ictvt-17.2017.58

Theofanidis, D., & Fountouki, A. (2019). Limitations and delimitations in the research process. *Preoperative Nursing, 7*(3), 155–162. https://doi.org/10.5281/ZENODO.2552022

Thibaut, L., Ceuppens, S., De Loof, H., De Meester, J., Goovaerts, L., Struyf, A., Boeve-de Pauw, J., Dehaene, W., Deprez, J., De Cock, M., Hellinckx, L., Knipprath, H., Langie, G., Struyven, K., Van de Velde, D., Van Petegem, P., & Depaepe, F. (2018). Integrated STEM education: A systematic review of instructional practices in secondary education. *European Journal of STEM Education, 3*(1), 2. https://doi.org/10.20897/ejsteme/85525

Ufnar, J. A., & Shepherd, V. L. (2020). The magic in the classroom: A twenty-year sustained scientist in the classroom partnership program. *The Journal of STEM Outreach, 3*(3), 1-15 . https://doi.org/10.15695/jstem/v3i3.06

United States Bureau of Labor Statistics. (2018). *Labor force statistics from the current population survey: Employed persons by detailed occupation, sex, race, and Hispanic or Latino ethnicity.* https://www.bls.gov/cps/cpsaat11.htm

United States Department of Education. (2018, June 28). *U.S. Department of Education fulfills administration promise to invest $200 Million in STEM education*.https://southernmarylandchronicle.com/2018/11/10/u-s-department-of-education-fulfills-administration-promise-to-invest-200-million-in-stem-education/

Vagle, M. D. (2018). *Crafting Phenomenological Research.* Routledge. https://doi.org/10.4324/9781315173474

Van Bavel, J., & Klesment, M. (2017). Educational pairings, motherhood, and women's relative earnings in Europe. *Demography. 54*(6), 2331–2349. https://doi.org/10.1007/s13524-017-0621-z

Van Bavel, J., Schwartz, C. R., & Esteve, A. (2018). The reversal of the gender gap in education and its consequences for family life. *Annual Review of Sociology, 44*(1), 341–360. https://doi.org/10.1146/annurev-soc-073117-041215

Wang, M., & Degol, J. L. (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. https://doi.org/10.1007/s10648-015-9355-x

Warren, S., Goodman, M., Horton, R., & Bynum, N. (2016). Stemming the tide: The presentation of women scientists in CSI. *International Journal of Gender, Science, and Technology, 8*, 360–381.

Weisgram, E., & Diekman, A. (2015). Family-friendly STEM: Perspectives on recruiting and retaining women in STEM Fields. *International Journal of Gender, Science, and Technology, (8)*1, 38–45. https://doi.org/10.3390/socsci6020061

Weitekamp, M. A. (2015). ‘We’re physicists’: Gender, genre and the image of scientists in the Big Bang Theory. *The Journal of Popular Television, 3*(1), 75–92. https://doi.org/10.1386/jptv.3.1.75_1

Wells, J. G. (2019). STEM education: *The potential of technology education* [Conference session]. 95th Mississippi Valley Technology Teacher Education, St. Louis, MO, United States. https://vtechworks.lib.vt.edu/bitstream/handle/10919/93963/Wells_Ch10_STEM-Potential-of-TechEd-2019YrBk.pdf?sequence=1&isAllowed=y

The White House Office of Science and Technology Policy. (2018). *Summary of the 2018 White House state-federal STEM education summit.* https://trumpwhitehouse.archives.gov/wp-content/uploads/2018/06/Summary-of-the-2018-White-House-State-Federal-STEM-Education-Summit.pdf

Xu, Y. J. (2017). Attrition of women in STEM: Examining job/major congruence in the career choices of college graduates. *Journal of Career Development, 44*(1), 3–19. https://doi.org/10.1177/0894845316633787

Yıldırım, B., & Sevi, M. (2016). Examination of the effects of STEM education integrated as a part of science, technology, society and environment courses. *Journal of Human Sciences, 13*(3), 3684–3695. https://doi.org/10.14687/jhs.v13i3.3876

Yoder, B. L. (2018). *Engineering by the numbers*. American Society for Engineering Education. https://www.asee.org/documents/papers-and-publications/publications/college-profiles/16Profile-Front-Section.pdf

Appendix A

LinkedIn Participant Recruitment Ad

Want to make a real difference for girls to become women in STEM?

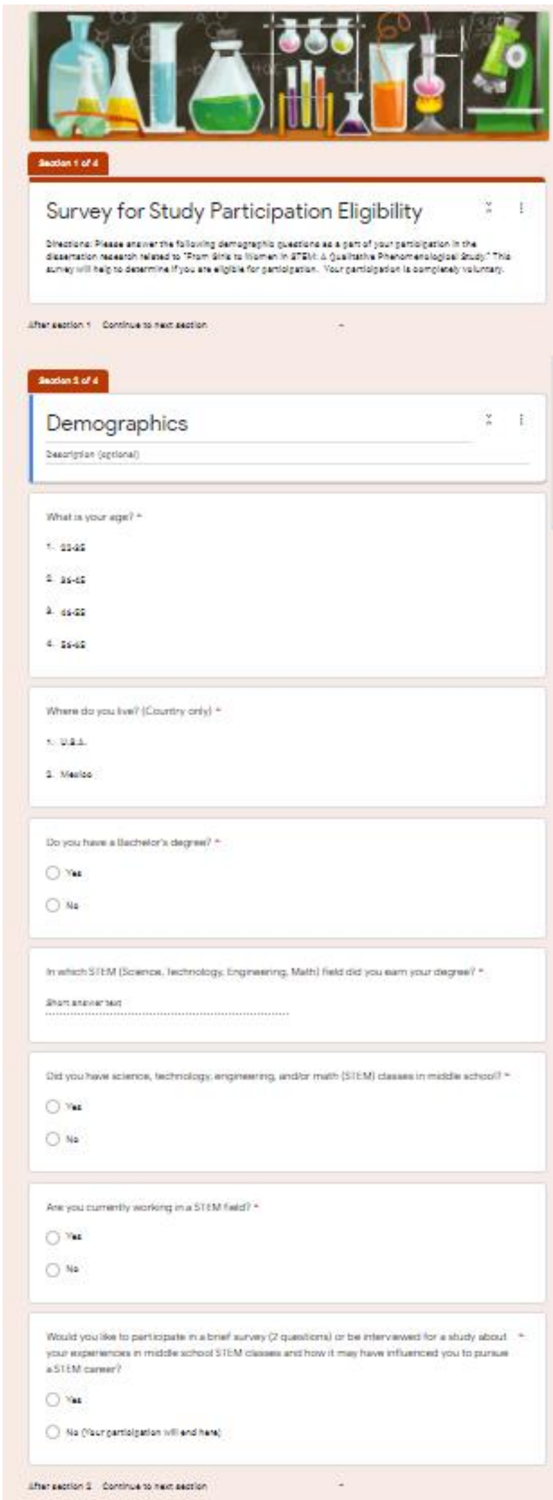
Are you a female professional currently working in a STEM field, hold at least a Bachelors's degree in a STEM field, between the ages of 22-65, and living in the USA or Mexico?

Great! You may be able to make a real difference for women and girls in STEM by participating in a research study. Take this quick survey and find out!

https://forms[redacted]

Appendix B

Participant Demographics



Section 1 of 4

Survey for Study Participation Eligibility

Directions: Please answer the following demographic questions as a part of your participation in the dissertation research related to "From Girls to Women in STEM: A Qualitative Phenomenological Study." This survey will help to determine if you are eligible for participation. Your participation is completely voluntary.

After section 1 Continue to next section

Section 2 of 4

Demographics

Description (optional)

What is your age? *

1. 25-35
2. 35-45
3. 45-55
4. 55-65

Where do you live? (Country only) *

1. U.S.A.
2. Mexico

Do you have a Bachelor's degree? *

- Yes
- No

In which STEM (Science, Technology, Engineering, Math) field did you earn your degree? *

Short answer text

Did you have science, technology, engineering, and/or math (STEM) classes in middle school? *

- Yes
- No

Are you currently working in a STEM field? *

- Yes
- No

Would you like to participate in a brief survey (2 questions) or be interviewed for a study about your experiences in middle school STEM classes and how it may have influenced you to pursue a STEM career? *

- Yes
- No (Your participation will end here)

After section 2 Continue to next section

Directions: Please answer the following demographic questions as a part of your participation in the dissertation research related to "From Girls to Women in STEM: A Qualitative Phenomenological Study."

1. What is your full name?
2. What is your age?
3. Where do you live? (country)
4. Do you have a bachelor's degree?
5. In which STEM field did you earn your degree?

Appendix C

Informed Consent

Section 3 of 4

Informed Consent

My name is Virginia Pantella and I am a doctoral candidate at the American College of Education (ACE). Every research study requires the informed consent of participants by law. Information gathered in this survey and/or interview will be used for my dissertation research related to "From Girls to Women in STEM: A Qualitative Phenomenological Study." The purpose of the phenomenological qualitative study will be to evaluate your experience of middle school STEM classes and how they may have impacted your decision to become a STEM professional. Please affirm your understanding of each statement below. At the end of the form, you will be asked whether you would like to participate in the two-question survey ONLY or also like to participate in an interview.

Voluntary Participation - Your participation in this research is entirely voluntary. It is your choice whether or not to participate. If you choose not to participate, it will have no bearing on your job or work-related relationships or situations. If you choose to participate and then decide later you do not wish to participate, you will not be punished in any way. *

- [ ] I understand

Procedures - I am asking you to help me learn more about the value of STEM education in middle school and its influence on women pursuing STEM careers. If you choose to participate, you will first complete a survey at the end of which you will be asked to participate in a private 60-minute interview. After the interview, you will be asked to review a transcript of your interview for accuracy. You will be able to contact me if you wish to ask questions or to clarify any of your previous statements. *

- [ ] I understand

Duration - The research takes place over a one- to two-month period. During this time, I will interview you one time for a period of 60 minutes. If clarification is needed you may be contacted by phone, video call app, or email. *

- [ ] I understand

Risks- I am asking you to share personal and confidential information, and you may feel uncomfortable talking about some of the topics. You do not have to answer any question or take part in the discussion if you do not wish to do so. You do not have to give any reason for not responding to any question. Benefits - While there will be no direct financial benefit to you, your participation is likely to help us find out more about the value of STEM education for girls in middle school and its influence on women pursuing STEM careers. *

☐ I understand

Reimbursements - There will be no monetary reimbursements for participation in this research study. You will be thanked for your participation and you will be able to learn from the findings of the study as to how your thoughts and opinions related to other participants. *

☐ I understand

Confidentiality - I will not share information about you or anything you say to anyone outside of the research study. The information I collect will be kept in a locked file cabinet or on a password protected computer only known to the principal investigator. Any information about you will have a number on it instead of your name. Only I will know your number and I will secure the information. Information will be retained securely for a minimum of 3 years after the completion of the study in accordance with the Code of Federal Regulations (CFR) 46.115 which specifies how IRB records should be handled. *

☐ I understand

Sharing the Results - Each participant will receive a summary of the research findings. I hope to publish the results in my doctoral dissertation so other interested people may learn from the research. *

☐ I understand

Right to Refuse or Withdraw - Any and all participation in this study is voluntary and includes the right to withdraw at any time. *

☐ I understand

…b

Who to Contact - If you have any questions, you can ask them now or later. You may contact me, Virginia Pantella, Principal Investigator, at this email address, [redacted] My telephone number is [redacted]. This research plan has been reviewed and approved by the Institutional Review Board of the American College of Education. This is a committee whose role is to make sure the research participants are protected from harm. If you wish to ask questions of this group, email IRB@ace.edu *

☐ I understand

Certificate of Consent -I am conducting this research in a respectful and responsible manner. My goal is to observe the experiences you have or have had with STEM education in middle school and its influence on your choice to become a STEM professional. It is important to gather information on the impact of STEM education on this education level so that important adjustments can be made to curriculum that would best prepare students, especially girls, to follow through on STEM careers. *

☐ I understand

Please write any questions you may have about this study and/or participation below. *

Long answer text

I have read the information about this study. I have had the opportunity to ask questions about the study, and any questions have been answered to my satisfaction. I consent voluntarily to be a participant in this study. *

☐ I voluntarily consent

What is your first name? *

Short answer text

What is your last name? *

Short answer text

What is your email address? *

Short answer text

What is your phone number? *

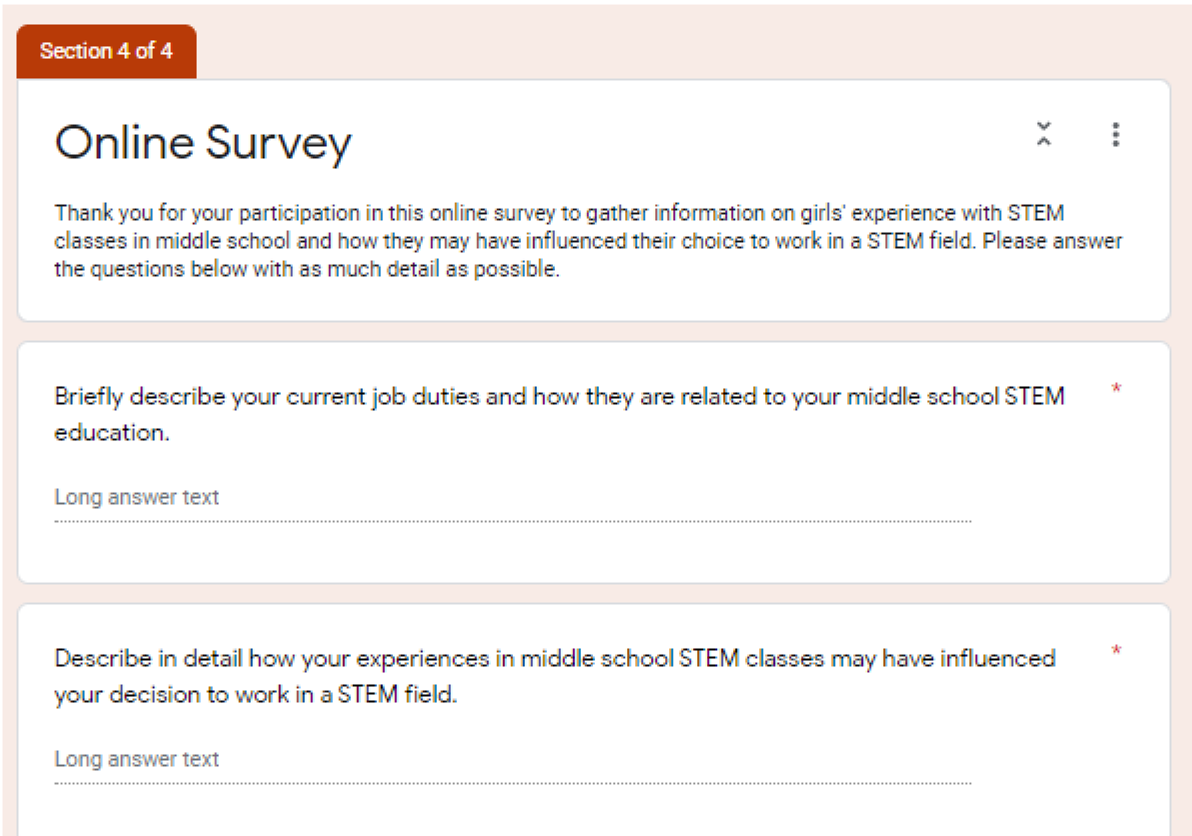
Short answer text

I would like to participate in (select only one): *

- [ ] ONLY Survey - (Two questions)
- [ ] BOTH Survey AND Interview

Appendix D

Online Questionnaire



Section 4 of 4

Online Survey

Thank you for your participation in this online survey to gather information on girls' experience with STEM classes in middle school and how they may have influenced their choice to work in a STEM field. Please answer the questions below with as much detail as possible.

Briefly describe your current job duties and how they are related to your middle school STEM education. *

Long answer text

Describe in detail how your experiences in middle school STEM classes may have influenced your decision to work in a STEM field. *

Long answer text

Appendix E

Interview Protocol

Project: From Girls to Women in STEM: A Study of Middle School STEM Experiences

Time of Interview: ____

Date of Interview: ____

Location: ____

Interviewer: ____

Interviewee: ____

Thank you for consenting to participate in the research study by answering some questions about your middle school STEM education experiences and how they influenced you to pursue a STEM career. I would like to audio and video record the interview so the study can be as accurate and efficient as possible. You may request the audio/video recorder be turned off at any point during the interview.

Questions the participants will be asked include:

1. What Science, Technology, Engineering and Math Classes did you have in grades 6-8, often known as middle school?

2. Which was your favorite STEM class and why?

3. Now think about the classes you chose to take in high school. How were they influenced by any of the STEM classes you took in middle school?

4. How early did you think about pursuing a STEM career? What specific situation stands out in your decision to pursue this education and career?

5. How were you supported by friends, family, and academia when choosing to pursue a STEM career?

6. What supports, or resources would you recommend for STEM education in middle school to encourage more girls to enter STEM fields?

7. What unique pressures associated with being female did you find, if any, in pursuit of your education and/or degree? How did you overcome or deal with this pressure?

8. What additional reflections or information you would like to share before we end the interview?

Appendix F

SME Invitation and Feedback

Email Request to Dr. Watermeyer and all subject matter experts:

Virginia Pantella <[redacted]@gmail.com>
to richard.watermeyer

Mon, May 25, 2:38 PM (1 day ago)

Dear Dr. Watermeyer,

I am a doctoral student in STEM Education Leadership at the American College of Education. My school requires 5 subject matter experts to validate our research instruments for dissertation proposals. Based on your extensive research on STEM education, I would highly value a review by your expert eyes.

Would you please review the attached survey and interview questions for my proposed research study? The study is entitled, From Girls to Women in STEM: A Phenomenological Study. It will examine the experiences of women when they were in middle school STEM classes as well as how that time may have influenced their decision to become women in STEM.

Thank you for any feedback you can provide.

____

Regards,
Virginia Pantella
American College of Education
Doctoral Candidate, STEM Ed. Leadership
[redacted]@gmail.com

- **Response from Dr. Watermeyer:**

Richard Watermeyer
to me

5:00 PM (53 minutes ago)

Hello Virginia
Thanks for getting in contact and what an interesting arrangement. Have you yet spoken with your supervisor in respect of this schedule? There are ethical aspects to consider related especially to your request for personal information. Your preamble would also really need to explicitly communicate to participants their rights - anonymity, voluntary participation, right to withdraw without consequence etc. Interesting that you're opting interview over survey. The questions themselves are okay. Ask yourself will they provide the most rigorous data set to answer your core RQs.
Good luck,
Richard

Richard Watermeyer
Professor of Higher Education
School of Education
University of Bristol
Helen Wodehouse Building
[redacted]

- **Response from Dr. Jane Stout:**

Jane Stout
to me

11:58 AM (5 hours ago)

Hi Virginia,

Thank you for the additional information. In light of this, I believe the instruments are appropriate.

Best,
Jane

- **Response from Dr. Harriet Mosatche:**

Harriet Mosatche [redacted]
to me

Tue, May 26, 7:27 PM (2 days ago)

Dear Virginia,

You are researching a very important topic with significant implications for education. I am suggesting the following changes in your instruments:

Appendix C: 1) Leave out the term "phenomenological" since many respondents will not understand it and therefore might bias their answers.
2) Change question #6 to the following: Briefly describe your current job duties and how they are related to your middle school STEM education.
3) Leave out the term "lived" in the question that asks about being interviewed.

Appendix B: 1) Question #2: Ask only about "your favorite STEM class." Otherwise, you might get multiple answers, which will be difficult to analyze.
2) Question #3: Revise the wording of the second sentence in the following way: ...How were they influenced by ...
3) Question #4: What specific situation stands out...
4) Question #7: Change wording to something like the following: What unique pressures associated with being female...
5) Question #8: Change wording to:...What additional reflections or information... (By asking in that way, you are more likely to get additional information from respondents.)

Wishing you the best as you move ahead in your research,
Harriet

- **Response from Dr. Rachel Sheffield:**

Rachel Sheffield
to me
7:32 AM (52 minutes ago)

Hi Virginia

Thank you for the opportunity to review your tools it will be an interesting study and I think this will add to the literature in the area through your dissertation.

The interview questions were for the most part very positive and I wondered if you had considered if there were any challenges that they felt they experienced and also in Q7 Did you feel any unique pressures that you would associate with being female in pursuit of your education and/or degree? If so, how did that impact you? How did you overcome or deal with this pressure

Just a thought with the demographics questions 4. Do you have a bachelor's degree? Might be better to ask what qualification the person has and which are in STEM related?

I think that what you have asked will give you an interesting view and it would be interesting to consider the lens of identify and how their education shaped their STEM identity

Congratulations on your study and best wishes

Rachel

Dr.Rachel Sheffield
PhD. Curtin Academy Fellow, HERSDA Fellow, SHEA Fellow
Chair of Curtin Academy
Associate Professor Science Education | School of Education
Faculty of Humanities
Curtin University

Follow-up email to all reviewers for a <u>review of revisions:</u>

Review of Revisions to Research Intruments Inbox ×

Virginia Pantella [redacted]gmail.com>
to me, bcc: Harriet, bcc: Jane, bcc: Richard, bcc: Rachel.Sheffield
8:13 AM (8 minutes ago)

Good day everyone!

I want to thank you so much again for your review of my research instruments for my dissertation proposal, "From Girls to Women in Science: A Qualitative Phenomenological Study." I have received excellent feedback to improve my questions and I would like everyone to give it another look to make sure you are all in agreement with the changes. I have <u>highlighted and changes</u> in the document to make it as easy as possible for you to consider, understanding your busy schedules. If you were able to <u>get it back to me today</u>, that would be very much appreciated.

Again, thank you so much for your help! I look forward to hearing from you soon.

____

Regards,
Virginia Pantella
American College of Education
Doctoral Candidate, STEM Ed. Leadership
[redacted]@gmail.com

- **Response from Dr. Rachel Sheffield:**

Rachel Sheffield 8:17 AM (8 minutes ago)
to me

Hi Virginia

I agree and good luck with your further studies

Rachel
Dr.Rachel Sheffield
PhD. Curtin Academy Fellow, HERSDA Fellow, SHEA Fellow
Chair of Curtin Academy
Associate Professor Science Education | School of Education
Faculty of Humanities
Curtin University
Tel | [redacted]
Email [redacted]
Web | [redacted]

- **Response from Dr. Jane Stout**:

Jane Stout 9:32 AM (0 minutes ago)
to me

Hi Virginia,

I approve your changes.

Best,
Jane

- **Response from Dr. Harriet Mosatche:**
  N/A since she proposed the revisions

- **Response from Dr. Nataly Chesky:**

Virginia Pantella [redacted]@gmail.com> 10:39 AM (6 minutes ago)
to Nataly

Hello Dr. Chesky,

A collection of other reviewers have already made some edits to improve the way my questions are asked. Would you be able to approve those as is? I have highlighted the changes in the document to make it as easy as possible for you to consider, understanding your busy schedule. If you were able to get it back to me today, that would be very much appreciated.

Again, thank you so much for your help! I look forward to hearing from you soon.

____
Regards,
Virginia Pantella
American College of Education
Doctoral Candidate, STEM Ed. Leadership
[redacted]@gmail.com

Nataly Chesky 10:44 AM (4 minutes ago)
to me

Hello Virginia,

I approve of your interview questions. Yes, there will be plenty of time to further investigate these area, once you complete your dissertation.

Good Luck!
Nataly

Nataly Z. Chesky, Ed.D.
Associate Professor, Department of Teaching & Learning
Coordinator, Master of Science in Teaching Program
State University of New York at New Paltz
800 Hawk Drive
New Paltz, NY 12561-2443
Office: Old Main 218D
Pho[redacted]
Ema[redacted]

Appendix G

Study Welcome Email

Dear __________,

Congratulations! Based on your answers in the google form, you are qualified to participate in my doctoral study, "From Girls to Women in STEM: A Qualitative Phenomenological Study." This study will investigate how your middle school STEM classes may have influenced you to become a woman in STEM. Many of you are aware that women continue to be chronically underrepresented in many STEM fields, particularly in Computer Science and Engineering. This study intends to fill a gap in the literature by understanding why based on your lived experiences.

There will be a total of 15 qualified participants selected for this study. To simplify scheduling, I've created a form in which you can choose a time to be interviewed. Just click here [redacted] and fill out the form. The one-on-one interview should run ***no more than 60 minutes*** and will be conducted via ***zoom or google meets/hangouts*** as a recorded video conference.

However, should I need to contact you for additional information or clarification, I will reach out. Furthermore, you are welcome to contact me at [redacted] if you should have questions. Additionally, all participants will have the opportunity to check their responses for accuracy from a transcript I will produce from our interview. Your privacy will be protected at all times according to the terms of the study. You will be given a participant number and your name will not be disclosed. In other words, the study will be published using data from "numbered participants." You should feel comfortable and open to share. If at any time you do not, please let me know.

I am very excited to get to know each of you and work with you in this investigation. Please let me know if you have any questions along the way, and I'll be happy to answer them. Thank you again!

Warm regards,
Virginia Pantella
American College of Education
Ed.D. Candidate, STEM Ed. Leadership
[redacted]

Scheduling form: https://form.jotform.com/[redacted]

Appendix H

Rejection Email

Dear ________,

Due to an overwhelming number of participants, I have already found a sufficient population for my study.

Thank you for your willingness to participate. I will reach out if there are future studies that you may want to be a part of.

Regards,
Virginia Pantella