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An Investigation of Female Leadership Aspirations in STEM Disciplines

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AN INVESTIGATION OF FEMALE LEADERSHIP ASPIRATIONS IN STEM DISCIPLINES

A Dissertation

Submitted to the Graduate Faculty of the University of South Alabama in partial fulfillment of the requirements for the degree of Doctorate in Educational Leadership

by
Melanie R. Cochran
B.S., University of Southern Mississippi, 2012
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May 2022

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This dissertation is dedicated to my baby boy, Theo, who surprised us with his presence mid-way in this academic journey. You are my light and my hope for this world to be a better place. May you read this work one day when it no longer is relevant, but a reminder of how far the world has come.
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ABSTRACT


Women are underrepresented in the majority of STEM disciplines resulting in fewer women to seek STEM leadership positions. Although in the past decade progress has been made to remove gender barriers in STEM in efforts to close the gender gap, one contributing factor to gain more women in STEM disciplines is to increase the number of women in STEM leadership positions (Ramsey et al., 2013; Stearns et al., 2016). This mixed methods study investigated female leadership aspirations in STEM disciplines by analyzing the relationship of leadership aspirations with support systems, barriers, and self-efficacy. Data were collected from 77 participants using a Likert-scale study for quantitative questions and open-ended responses for qualitative questions. Findings indicated that the majority of participants possessed STEM leadership aspirations and held a moderate self-efficacy as well. Parents and teachers were reported as existing support systems; however, the participants indicated a need for more support in their pursuit of leadership positions. The existence of barriers hindering their leadership aspirations was minimal. It is recommended that future research is conducted with a larger population of female students studying STEM disciplines. Increasing the number of participants in more male-dominated STEM fields is also recommended.
CHAPTER I

OVERVIEW OF STUDY

1.1 Introduction

Women hold a minority of STEM (science, technology, engineering, and mathematics) degrees, receiving only 36% of bachelor’s degrees in the field awarded in the United States (American Physical Society, 2018). Furthermore, the less popular STEM disciplines for women such as physics, engineering, and computer science report only 20% of bachelor’s degrees awarded to women in the United States (NSF, 2021).

Additionally, men outnumber women in the majority of leadership positions across STEM disciplines. In 2014, women accounted for 20% of executive, senior officer, and management titles in the United States’ high technological industries (U.S. Equal Employment Opportunity Commission, 2016). In academia, women held 31% of full professorship positions and 27% of college president positions (Johnson, 2016b). The consistent underrepresentation of women in STEM generally, and leadership roles in particular, affects the STEM organizational culture and makes it more challenging for women to break barriers associated with advancement in their profession.

A sense of community and social belonging in any environment encourages a positive self-efficacy which directly impacts an individual’s experience and desire to participate in a particular environment (Tajfel & Turner, 1979). An essential component
to increasing the number of women in committed STEM disciplines lies in cultivating an inviting environment for women to participate in STEM coursework. Key factors such as support systems, role models, and mentors encourage women to choose a career in STEM (Grossman & Porche, 2014; Lawson et al., 2018; Ramsey et al., 2013; Stearns et al., 2016). Recruiting more women to study STEM increases the number of women likely to pursue a STEM leadership position (McCullough, 2019). Increasing the number of women decision-makers within an organization increases the probability of a woman being appointed to a leadership position and potentially to an increased appointed term in their leadership role (Cook & Glass, 2014). These findings suggest that increasing the number of women in STEM workplaces plays a significant role in overcoming social barriers associated with women filling STEM leadership positions.

1.2 Problem statement

Organizations providing more diverse leadership personnel encourage a culture of inclusion and respect for all members within the organization (Gotsis & Grimani, 2016). Government entities, industries, and academic settings benefit from diverse viewpoints sharing new, creative ideas for the advancement of the organization (Fine et al., 2020). The STEM area in academia represents one area currently lacking in female leadership. As noted in the literature, possible reasons for this include lack of positive self-efficacy in females in these fields, lack of existing support systems within STEM environments, and sociocultural barriers for women (Chapple & Ziebland, 2017; Dawson et al., 2015; Lawson et al., 2018; Stearns et al., 2016).
By having more women serve as role models while acting in these leadership positions, the number of women in STEM leadership may increase and thereby increase diversity. These female STEM leadership pioneers may then encourage young girls and women to pursue STEM studies and careers. This dissertation study will address the consistent underrepresentation of women in STEM disciplines resulting in fewer women in STEM leadership positions and the potential solutions to help address this concern.

1.3 Purpose of the study

The purpose of this study was to gain a better understanding of leadership aspirations in female students enrolled in STEM disciplines. The researcher accomplished this goal by investigating perceived STEM self-efficacy and understanding influential experiences, barriers, levels of professional support resulting in decision-making process toward leadership in their STEM field. The researcher sought to gain insight into the role of mentors and role models for students pursuing STEM leadership positions. This study prioritized not only identifying experiences that have influenced interest in STEM leadership, but also explored the existing barriers hindering female opportunities in STEM leadership.

1.4 Rationale and significance

Women in STEM studies score themselves lower on leader effectiveness more often than non-STEM students (Dugan et al., 2013). Significant findings from this study determined positive correlations to leadership self-efficacy when students developed a
sense of belonging in their field, increased interactions among diverse colleagues, and engaged in community service, and off-campus employment (Dugan et al., 2013).

Although widely acknowledged and researched, the topic of underrepresentation of women pursuing STEM fields lacks studies investigating why so few of those women pursue leadership positions. As noted earlier, Gotsis and Grimani (2016) established that a diverse workforce encourages inclusion and respect for all. It is imperative for the future of STEM to understand why so few women in STEM progress to leadership roles. Furthermore, the advancement of women in STEM leadership may help to ensure an encouraging environment for future women to join STEM fields. More female leaders in STEM will create more role models for young female students pursuing STEM degrees. This will ultimately increase the number of potential women leaders in STEM. Figure 1, below, illustrates the cyclic process for increasing the number of women holding STEM leadership roles.
Figure 1. Cyclic Process for Removing the Gender Gap in STEM Leadership.

1.5 Role of the researcher

As an instructor within the STEM field, the researcher actively involves herself with students pursuing STEM degrees. The researcher engaged in this study at her home institution; however, the researcher reported the data objectively and only reflected the participants’ responses. The researcher is considered as part of the setting and participatory in the research action. Steps established to ensure objectivity and anonymity were taken seriously and executed to the best ability of the researcher. Data collected from the students is valuable to the researcher to improve the STEM academic experiences for students at this university. Upon completion of this study, the researcher will partake in creating an action plan to encourage more women in STEM to become leaders in their discipline. The researcher will share findings of this research study with
faculty members and administrators affiliated with the study’s institution.

1.6 Research questions

The following questions guided this mixed methods study in an attempt to better understand influencing factors for female students to aspire to become a leader in STEM:

1. Do female students seeking STEM degrees aspire towards leadership roles in the discipline?
   A. What is the motivation for female students in STEM degree programs to seek leadership roles in the discipline?

2. Do female students feel supported in their STEM leadership interest?

3. Is there a correlation between female STEM student experiences and STEM leadership aspirations?
   A. Is there a correlation between female STEM students’ self-efficacy and STEM leadership aspirations?
   B. Is there a correlation between female STEM students’ support and STEM leadership aspirations?
   C. Is there a correlation between female STEM students’ barriers and STEM leadership aspirations?
1.7 Definitions of terminology

The following list of key terminology provides explanations needed to better understand this study:

- **Aspiration.** Frank (1935) defines aspiration as “the level of future performance in a familiar task which an individual, knowing their level of past performance in that task, explicitly undertakes to reach” (p. 119). For the purpose of this study, aspiration refers to one’s ambition or hope in becoming a leader in STEM.

- **External barriers.** The qualitative portion of the survey to be utilized in this study derives from an existing survey by Nurdiana Gaus (2011). Gaus (2011) categorizes external barriers as “internalized by the organizational system” and “can only be abolished by social and institutional changes” (p. 177).

- **Self-Concept and Self-Efficacy.** Self-Concept refers to a person’s own belief in their capabilities influenced by social environments and interactions with peers (Shavelson et al., 1976). Self-efficacy denotes a person’s own belief in successfully completing a task and influenced by performance outcomes, self-modeling, verbal encouragement and emotional state (Stone, 2018). For this study, consider self-concept and self-efficacy as one component as the literature supports their interconnectedness when studying the underrepresentation of women in STEM.

- **Social Barriers.** Again, as external barriers were utilized in the original survey by Gaus (2011), so were social barriers. Gaus (2011) describes social barriers as “barriers related to domestic conditions of women including social norms in which they live” (p. 177).
• STEM. This is an acronym for Science, Technology, Engineering and Mathematics. Many different college majors fall within one of the four categories of STEM. Names of majors that fall within the realm of STEM may vary depending on the degree-awarding university.

• STEM leader. As defined by the researcher, a STEM leader signifies an individual who has or is currently in an authoritative position in the STEM work environment. In academia, any individual titled as a department chair, or any administrative role would be considered as a STEM leader. In government, business, or industry entities, any individual who holds a supervisory position is considered as a STEM leader.

1.8 Delimitations

The delimiters for the study included restrictions imposed by the researcher. These included:

• The sample for the study was a convenience sample of students declared as STEM majors currently enrolled in STEM courses and active STEM student organizations at the research site. The researcher teaches STEM at the research site where the survey was distributed.

• The sample is further delimited to female students.

1.9 Limitations

By design, this study was limited to a convenience sample of female students studying STEM at a four-year university. The following points list potential limitations
that the researcher may incur (actual limitations of the study will be discussed in Chapter 5 of this study).

- Due to the limited variation in the data sample, the final results and conclusions may not reflect the entire female student STEM population.
- Student absences are unpredictable. At the time of the instrument’s announcement or distribution, the number of students were limited to the number of present students and therefore the number of students available to take the assessment.
- The enrollment rate in STEM courses vary. The semester that the instrument was distributed has potential to be a term with low enrollment.
- Potentially, participants withheld information from the researcher due to personal interactions with the researcher within the research site.
- In an attempt to reassure participants, confidentiality and anonymity was prioritized in the study and addressed through the informed consent document.
- Although students were asked not to take the survey more than once, the possibility for the same student to take the survey more than once may occur. Email addresses were collected at the end of the survey. To avoid this limitation no duplicate email address associated with the survey was considered in the data analysis.
- Additionally, the researcher is a woman in the STEM setting. To the best of the researcher’s ability, all forms of bias were avoided when analyzing data.
1.10 Summary

Chapter I established a problem of practice for this dissertation study - the consistent underrepresentation of female leaders in STEM. To develop a better understanding for the underrepresentation, the researcher investigated female student aspirations for becoming leaders in STEM as well as perceived STEM self-efficacy. Furthermore, the identification of student key experiences, professional support, and barriers recognized by the students for helping or hindering their chances of becoming a leader in STEM were obtained with the intentional benefit for future women in STEM. The researcher presented research questions to focus on understanding leadership aspirations of university students and the impact of sociocultural and personal experiences on these aspirations.
CHAPTER II
LITERATURE REVIEW

2.1 Introduction

The number of bachelor’s degrees awarded to male and female students in the United States reached equilibrium in 1981 (Johnson, 2016a). The most recent data published by the National Center for Education Statistics (NCES) states that for the 2020-2021 school year, women received 57.9% of conferred bachelor’s degrees (U.S. Department of Education, NCES, 2022b). However, women represent a known minority in STEM receiving only 36% of the United States bachelor’s degrees in the STEM field (American Physical Society, 2018). The less popular STEM disciplines for women to study are physics, engineering, and computer science which resulted in approximately 20-25% of bachelor’s degrees awarded to women in 2018 (NSF, 2021).

An additional component pertinent to this study is the current status of women in leadership roles. Women lack representation in leadership positions in the majority of STEM disciplines. In 2014, women accounted for 20% of executive, senior officer, and management titles in the United States high technological industries (U.S. Equal Employment Opportunity Commission, 2016). As of 2016, women held 18% of the Standard and Poor’s (S&P) 1500 board seats (Lukomnik, 2017) and 20.2% of board seats for the Fortune 500 (Deloitte and Alliance for Board Diversity, 2017). In academia,
women held 31% of full professorship positions and 27% of college president positions (Johnson, 2016b).

This literature review begins by examining the advancements of equality in the workplace through the 20th century and the prominent theoretical frameworks in literature during the same time period and, therefore, the theoretical frameworks have guided the research questions for this study. A thorough search of literature is presented to investigate the characteristics and behaviors of successful career women, including successful women in STEM and women in STEM leadership roles. Additionally, common themes are explored associated with female reluctance for STEM academic and career-related decisions. Finally, this literature review will identify common barriers women face in the STEM discipline and empirical evidence that addresses removing these barriers. This literature review aims to provide a background understanding for why so few women pursue STEM and, therefore, why there are so few women in STEM leadership roles.

2.2 Historical background

World War I (WWI), World War II (WWII), and the Cold War created the need for more women to fill roles traditionally held by males in the workplace (Striking Women, n.d.). Women did not have the right to join the military until President Harry S. Truman signed the Women’s Armed Services Integration Act in 1948, meaning only men served in military efforts prior to that year (DeSimone, 2021). While men were heavily recruited for overseas wartime efforts, women filled the vacant job openings in the industry and factories in addition to the new jobs created by the war such as
manufacturing ammunition and uniforms (Research Starters, n.d.). During this period of World Wars and the Cold War, a number of women made significant contributions as scientists, engineers, and mathematicians (Striking Women, n.d.). This section of the literature review includes the historical timeline of women achieving equality in the workplace and advancements in STEM throughout the 20th century.

2.2.1 Women in the workplace

United States war time efforts beginning in the 1910’s lasting through 1980’s created the need for American women to adopt more traditionally masculine roles. WWI marked the first time women aided in non-traditional military work capacities (Women in World War I, 2018). Prior to the United States officially entering WWI, women created organizations and volunteer efforts to aid European countries affected by the war; however, government officials still encouraged women to only act as supporters of military men by keeping to their stereotypical duties of knitting, cooking, cleaning, child-rearing, and homemaking (Schneider & Schneider, 1994; Women in World War I, 2018). Women saw a bigger need to assist more directly in their war efforts and began organizing large volunteer efforts at home in addition to their efforts in Europe (Women in World War I, 2018). Women served as nurses to the wounded soldiers overseas and, on the home front, women took on jobs in industry and jobs vacated by men serving in the war (Schneider & Schneider, 1994). All social classes took part in these efforts. However, upper class women were more likely to be primary originators of large volunteer organizations since they had more time to devote whereas women from the middle and lower class were more likely to take on the jobs left behind by male family members fighting in the war for financial reasons (Women in World War I, 2018).
After WWI, the women’s suffrage movement allowed women the right to vote and provided momentum for women’s equality in both voting and the workplace (Striking Women, n.d.). The establishment of the U.S. Department of Labor Women’s Bureau in 1920 promoted workplace equality by protecting working women especially regarding employment status and pay (United States Department of Labor, n.d.). Although an improvement, this step did not replace the existing mindset of the previously defined roles of the male as provider and the female as homemaker. However, the impact of the Great Depression made it a necessity for women to seek employment for secondary income in the difficult economic times (Hall et al., 2015). Then, in 1941 with the United States entry into WWII, the demand for women in industry increased again, much like in WWI (Hall et al., 2015).

The railroad and airplane companies and manufacturers, as well as smaller supportive companies to these manufacturers, needed personnel to keep up with the demand of the war, so they hired women to do the jobs typically held by men. To support women in these employment opportunities, the federal government assisted with childcare needs (Redman, 2017). Unfortunately, after WWII ended, many women again found themselves unemployed as more men were available for re-employment (Redman, 2017). As a result, American society largely reverted to husbands as the primary providers and wives as the homemakers staying home to raise children (Postwar gender roles and women in American politics, 2007).

During the late 1940’s through the early 1960’s, the United States government encouraged women to maintain their role in the home (MacLean, n.d.). Post-Cold War, working women represented a national security threat as the concern arose for the
decrease in population numbers as a result of war casualties (Cincotta et al., 2003) and, to
combat this population drop, women needed to prioritize having children for future
military services (MacLean, n.d.). According to MacLean (n.d.), mothers were held
responsible for raising boys into idealized images of strong American men as the
American image became a political tool for the United States defense. However, it
became widely known that women were not satisfied with this role (MacLean, n.d.).
Betty Friedan became popular for her publication of the *The Feminine Mystique* which
voiced her opinion of a woman’s right to work (Singer More, 2011). Those who strongly
believed a woman’s natural role takes part in the home for the betterment of the children
and nation opposed this movement of women fighting for equality in the workplace, and
this opposition created a struggle for women to create a role for themselves in the
workplace (MacLean, n.d.).

Throughout the Cold War, women continued to combat the stereotype of
belonging in the home. The 1964 Civil Rights Act stood as a milestone not only for
African Americans but for women as well. This act outlawed discrimination based on
race, color, religion, sex and national origin (Civil Rights Act, 1964). Additionally, in
1972, the Equal Rights Amendment was passed and provided equal legal rights for all
American citizens, and including employment opportunities (History.com Editors, 2021).
This stood as an immense accomplishment for the women’s suffrage movement as the
first proposal of the amendment took place in 1923 (Olson & Mendoza, 2017). These
legal actions by the U.S. Congress legitimized a woman’s place in the workforce
alongside men.
The wars throughout the 20th century provided many opportunities for women to take on the formerly masculine roles in the workplace due to employers’ needs to maintain production (Redman, 2017). Unfortunately, women found themselves falling in and out of employment opportunities as the wars came to an end; nevertheless, the role of women in the workplace became more acceptable as time passed. Figure 2 provides a timeline of significant events that allowed women more recognition and rights in the workplace.

Figure 2. Timeline of Historical Events Concerning Women in the Workplace.
2.2.2 Influential women in STEM history

The Manhattan Project associated with WWII offered employment opportunities for women in the STEM disciplines (Jack, 2009). The Manhattan Project was the secret, American-led program for the development of atomic weapons during WWII (Mullen et al., 2017). Due to the shortage of working personnel, women were recruited to take on jobs at Tennessee Eastman in Oak Ridge (Olwell, 1999) which included isolating enriched uranium for the construction of nuclear bombs for the Manhattan Project (Harris, n.d.; Marshall et al., 2010). Harris (n.d.) stated this team of women became known as the “Calutron Girls” as they made up a critical component in operating the technical instruments for isolating the uranium. The project was considered a governmental top-secret mission, and some of the women were not made aware that they were controlling the mass spectrometers to isolate uranium (Broadhead, 2009). Ultimately, this group of women improved the uranium production rate compared to the male scientists on the same project by utilizing their own processes and procedures (Harris, n.d.; Howes & Herzenberg, 1999). It was not until after the women outperformed their highly educated male scientist counterparts that the facility leaders trusted the women in their performance (Harris, n.d.).

Other missions for WWII required difficult calculations, such as ballistic trajectories. With very little computer technology, people, mostly women, were recruited to complete these complicated calculations for ballistic missiles (Smith, n.d.a). During this time, the first all-electronic computer in America called the Electronic Numerical Integrator and Computer (ENIAC) was invented (Freiberger & Swaine, 2022; Fritz, 1996; Smith, n.d.a). The first digital computer programmers were recruited from the same
group of female mathematicians who completed the hand calculations for the ballistic missiles (Fritz, 1996; Smith, n.d.a). The six women hired by the ENIAC group from the Moore School of Engineering at the University of Pennsylvania were Lila Todd, Kathleen McNulty, Frances Snyder, Betty Jean Jennings, Marlyn Wescoff, and Frances Bilas (Fritz, 1996). These women successfully programmed the computer and developed the language of the computer (Fritz, 1996; Smith, n.d.a). The computer programming and computer language development established by the ENIAC group played a large role in the advancements of computer science (Smith, n.d.a). It was not until decades after the release of the computer that the women received recognition for their contributions (Shaw, 2019; Smith, n.d.a).

Similar to the story of the Calutron Girls, the women at Bletchley Park are accredited for deciphering German communications including decoding Nazi messages encrypted by the German Enigma coding machine (Blewett, 2012; Griffin, 2017). Following these advancements in computer technology by women to defeat the Nazis in WWII (Griffin, 2017; Smith, n.d.a), the United States became involved in the Space Race, an important part of the Cold War. One of the leading mathematicians for NASA’s ‘mission to the moon’ was Katherine Johnson, an African American woman, who calculated the trajectory for the space shuttle (Stofan, n.d.). Out of public view, women completed computations that supported the US’ mission (Smith, n.d.a; Stofan, n.d.). Without these critical calculations, the United States’ lead in the Space Race would have been challenged.
2.3 Theoretical frameworks

This research study will be guided by three interwoven theoretical frameworks. The researcher will examine the underrepresentation of women in STEM leadership positions with respect to the social cognitive theory (Bandura, 1986), the social cognitive career theory (Lent et al., 1994), and the social identity theory (Tajfel & Turner, 1979). The following sections of this literature review explore the details of each theory and how they relate to this study.

2.3.1 Social cognitive theory

The social cognitive theory (SCT) was founded on an agentic standpoint (Bandura, 2018). Bandura (1986) coined the term triadic reciprocal causation to explain the psychosocial functioning of three factors as they influence one another in two directions (Bandura, 1988, 2001, 2018). The three key influential factors that encourage the reproduction of observed behavior include personal, environmental, and behavioral factors (Bandura, 1986, 1988, 2001). Therefore, not only does one’s environment influence their self-directed process but also one’s collective experiences (Bandura, 1989). Characteristics of SCT include developing skills or abilities by mastery modeling, strengthening self-efficacy for better implementation of skills, and increasing one’s self-motivation through goal systems (Bandura, 1988). It is important to note that the SCT entirely rejects the idea that social behaviors define one’s genetic make-up (Bandura, 1999). The SCT provides great insight on how to develop a positive self-efficacy for certain skills as well as how certain skills can be learned through the modeling process (Bandura, 1986). This relates to the proposed study as the literature review will reveal an
underdevelopment of both the female STEM modeling process and positive self-efficacy development in STEM.

2.3.2 Social cognitive career theory

The social cognitive career theory (SCCT) is heavily grounded in social cognitive theory and includes the same three elements of self-efficacy, modeling, and goal outcomes; however, the SCCT was developed for the purpose of unifying cognitive theories as they relate to careers (Lent et al., 1994). Researchers Lent et al. (1994) used Bandura’s (1986) SCT as it is applied to the process of career development in regard to career and academic interests, choosing a career, and outcomes leading to career success and stability. The workings of these elements also relate to particular classifications, such as gender, in organizational structures (Brown & Lent, 2005; Lent et al., 1994).

One defining difference between Bandura’s (1986) SCT and the SCCT (Lent et al., 1994), lies in the application of the elements being a triadic reciprocal causation. Although the SCCT still considers personal, behavioral, and environmental elements linked to psychosocial behaviors, they are not believed to have a main causal pathway (Lent et al., 1994). Instead, different elements have different causal weight at different times (Lent et al., 1994). Additionally, elements were added to the model to incorporate the development of career interests that ultimately lead to academic and vocational decisions and behaviors. Lent et al. (1994) developed the interest development, career/academic choice, and performance models to better understand the career decision making process.

**Interest development.** Exposure to different activities and occupational options influence children and adolescents to pursue particular career paths. Interest development
begins with children showing increased awareness or attention to particular activities. If a child has a positive experience associated with an activity, then it proves more likely that the child will desire to become more involved in similar activities to obtain additional positive experiences (Lent et al., 1994). Through these chosen activities, children build their self-efficacy, personal standards, and outcome expectations for particular tasks or skills used for the activities. As the child develops a positive self-efficacy and experiences positive outcomes from certain activities, an interest develops. The cycle continues and further refines the interests of the child through repeated activities and involvements to further develop their skills and interests. This process shapes a person’s interest starting as a child, developing through adolescence, and further refines through adulthood. For an interest to develop, a person’s environment exposes them to direct, vicarious, and persuasive experiences that build a self-efficacy for certain skills. Likewise, losing interest in an area or activity stems from negative outcomes that lower a person’s self-efficacy for that particular activity or skill (Lent et al., 1994).

**Career/Academic choice.** The SCCT (Lent et al., 1994) model builds on the interest development model. Choosing a career or academic endeavor can be divided into three difference processes (Lent et al., 1994). First, interests develop depending upon activities that lead to positive self-efficacy related to certain skills. These interests then cater to educational and career-related choice goals. Then, actions are taken to pursue certain educational or career pathways (i.e., choosing a college to attend, a major, or technical trade program). And finally, achievements or failures strengthen or weaken self-efficacy or interest in the field. This provides a cycle of feedback that slowly shapes future career decisions and performance (Lent et al., 1994).
Other factors such as outcome expectations, environmental conditions, and self-efficacy hold more weight than interests guiding career and academic decisions (Lent et al., 1994). Only under the most supportive environmental conditions does interest hold more influence over vocational and academic decisions. Social and external barriers may influence final decisions. Cultural expectations and realistic considerations (i.e., financial support or adequate qualifications) may outweigh one’s interest to pursue a certain path (Lent et al., 1994).

**Performance.** The performance model builds on the SCT’s triadic process; however, it also includes the additional cycle of performance achievement and subsequent choices and behaviors. According to Lent et al., (1994), the performance model predicts how to achieve certain levels of success in educational and occupational endeavors and the perseverance needed to overcome obstacles. Self-efficacy with personal goals both directly and indirectly affects performance. Outcome expectations complement self-efficacy as self-efficacy links performance achievements and successive self-efficacy and outcome expectations, or motivation (Lent et al., 1994).

### 2.3.3 Social identity theory

Tajfel (1981) defines social identity as “part of the individuals’ self-concept which derives from their knowledge of their membership of a social group (or groups) together with the value and emotional significance of that membership” (p. 255). Social intergroup experiences develop a positive social identity (Tajfel, 1982). Groups, such as social class, ethnicity, or gender, provide a source of pride and self-confidence which develops into a sense of belonging to these groups in turn creating a social identity (Tajfel & Turner, 1979).
Tajfel and Turner (1979) use the terms *ingroup* and *outgroup* to describe two competing groups. The ingroup refers to the group to which one belongs as a member, and the outgroup refers to any other group that may be seen as a threat or competition. To distinguish between groups, one group may discriminate against the other group. This creates a “positive ingroup distinctiveness” (Tajfel, 1982, p. 24). In fact, groups that appear similar to one another will work harder to establish individuality between the groups. This may include seeking out negative characteristics or behaviors and being more discriminatory of the outgroup to improve the self-image of the member’s ingroup (Tajfel, 1982; Turner et al., 1979; Tajfel & Turner, 1979).

According to Tajfel and Turner (1979), stereotyping characteristics and behaviors for members of particular groups stems from a natural cognitive process related to the human inclination to group things, items, or people together. In doing this, differences between groups and similarities within one group have the tendency to become amplified, hence, the formation of group stereotyping (Tajfel & Turner, 1979). As stated by psychology researchers Tajfel and Turner (1979), the process of cognitive categorization develops through an exercise of constantly assessing the ingroup versus the outgroup. The process goes in a sequence by first developing social categorization, then social identification, and finally, social comparison.

As described by Tajfel and Turner (1979), the first stage of the mental process entails categorizing items, or people, with an identity which creates an assigned generic boundary to describe these items or people within a particular group or social environment (Tajfel & Turner, 1979). This often creates a stereotype. This acknowledgement of a set of characteristics to create a stereotype either develops a sense
of belonging for members who align with that group’s stereotype or a sense of not belonging for those who do not fall in line with the group’s stereotype. This development of belonging or not belonging leads to the social identification stage which develops a sense of identity for members who feel they belong to the group. This creates a sense of comradery between members which promotes self-confidence and a sense of belonging. Once these identities are established, a social comparison between categories or groups then develops to differentiate between the groups. Groups then compare themselves with other groups resulting in a competition between group identities (Tajfel & Turner, 1979).

This study relates to each of the theories discussed through the investigation and consideration of the motivation for women choosing STEM disciplines, the characteristics of women who pursue STEM leadership positions, and, most importantly, how to retain women in STEM disciplines in order to enlarge the applicant pool for women STEM leadership positions. Bandura’s SCT allows insight on how to develop a positive self-efficacy for certain skills as well as how certain skills can be learned through the modeling process. The SCCT (Lent et al., 1994) provides an understanding of the determination for academic and career-related choices. Additionally, the SIT (Tajfel & Turner, 1979) establishes the importance of group identity and sense of belonging, which has proven essential for women’s success in STEM fields as STEM identity fall within a social identity (Barth et al., 2018). The remaining sections of this literature review reveal the importance of all three theories in understanding the reasons behind why so few women choose STEM majors possibly impacting the low number of women who ultimately pursue STEM leadership positions.
2.4 Understanding what makes a successful leader

This literature review aims to explore traits, behaviors and characteristics that commonly describe successful leaders. Behaviors, personalities, qualities, traits and undertakings mark key aspects of leadership essential for understanding how organizations succeed and benefit their investors and participants (Latham, 2014). Latham (2014) acknowledged a gap in research bridging leadership theories. Essential for understanding leadership, one must explore internal perspectives of leaders, their behaviors and activities, organizational environments and outcomes (Latham, 2014). For the purposes of this study, the differences and commonalities between leadership styles of men and women and also women in STEM versus women in other fields have been noted. Successful leaders for this literature review consist of those respected by their colleagues, who make advancements in their organizations or environments and lead effectively overall. This section will first explore the descriptors associated with successful people, women leaders, and women in STEM. Then, the section will discuss several leadership styles before moving on to how others commonly perceive successful leaders in different settings.

2.4.1 Traits, behaviors, and characteristics of successful leaders

Researchers Walker and Aritz (2015) investigated several different cases to identify similar characteristics of a leader with 110 participants who were divided into 22 mixed-gender teams. The study used a simulation of an airplane crash and each group had to agree on a ranking for the necessity of salvaged items from the airplane for the critical purpose of survival. Researchers asked participants in the cases to choose a leader for each of the groups. Once the leaders were chosen, the researchers asked the
participants to express the prominent visible characteristics that influenced their decision. The three common characteristics that emerged were: “(1) Involved others in decision making; (2) Decisive and task oriented; (3) Status conscious and procedural” (Walker & Aritz, 2015, p. 461). A contrasting case involved Walker and Aritz’s (2015) study of communication styles of leaders. The study found that communication styles of being “modest, compassionate, and supportive” and “independent and self-reliant” were not selected as being characteristics of a leader (Walker & Aritz, 2015, p. 459). Although the communication styles and characteristics affiliated with leadership did not relate to gender, participants selected more men than women as the leader of the group. Other studies, such as the one conducted by, found that effective leaders possess common traits, which include acting open, honest and fair when making decisions as well as showing distinguished moral and ethical values (Day et al., 2016). Social interactions and engagements act as critical factors for gauging how peers perceive leaders (Day et al., 2016).

In a world more globally connected than ever before, it is important to consider leaders working with multicultural colleagues. A successful leader possesses characteristics that allow them to relate to many different cultures or races, and welcomes diversity in their personal and professional lives. This allows the leader to have an understanding and awareness of different cultures, thus allowing them to relate to a wider audience (Lisak & Erez, 2015). Riutta and Teodorescu (2014) found the strongest influencer of leadership development for their college student study participants stemmed from pre- and post- college interactions and relationship building with peers belonging to diverse backgrounds.
For men, a power motivation leadership style or leadership motivated by their authoritative stance makes up the most common form of leadership (Hernandez Bark et al., 2016). Power motivation is simply an individual’s motivation for power (Schuh et al., 2014). Schuh et al. (2014) specifically explored the idea of power motivation differences between women and men to further understand the underrepresentation of women in leadership positions. Findings indicated that men consistently reported a higher power motivation score than women. Possessing a higher level of power motivation was also determined as a significant predictor of holding a leadership role. As the researchers had expected, the results of the study determined fewer women acquired leadership positions. Power motivation was determined to facilitate the connection between gender and holding a leadership position (Schuh et al., 2014). The results of this study conclude that the desire to possess an authoritative leadership role differs significantly for each gender.

Hernandez Bark et al. (2016) described a masculine form of leadership as assertive and forceful with a positive self-concept. According to Bear and Babcock (2017) these descriptors facilitate in implementing negotiation tactics. Negotiation is a skill commonly associated with a successful leader. Women more likely underperform in masculine negotiations because negotiations prove incompatible with the female gender roles (Bear & Babcock, 2017). Additionally, Hernandez Bark et al. (2016) suggested that a man who has a natural tendency to desire a leadership role may achieve more leadership positions because of his individual power motivation.

Women leaders. Although this literature review focuses on identifying common traits, skills and behaviors associated with leaders, it is important to note that not all successful female leaders demonstrate these common successful leader descriptors as it
would be an overgeneralization for the female population. Some researchers hesitate to describe women leaders using common traits, skills, and behaviors, as that encourages the development of gender stereotypes in leadership (Bierema, 2016). Bierema (2016) argued that different work environments require different leadership needs and, therefore, must be addressed in that context.

Self-efficacy and internal locus of control serve as common personality traits among women who have achieved a top hierarchical status in their careers (Doubell & Struwig, 2016). Bandura (1977) explored the psychological components of self-efficacy and stated that self-efficacy largely impacts a person’s decisions. People prove less likely to take part in activities that appear threatening and exceed their abilities to complete a task. The higher one’s personal self-efficacy associated with a particular task, the more likely one will pursue the activity (Bandura, 1977). Spector (1988) defined internal locus of control as “a generalized expectancy that rewards, reinforcements or outcomes in life are controlled by one’s own actions” (Spector, 1988, p. 335). Doubell and Struwig (2016) investigated these two personal traits among women in the Americas and South Africa and found that successful women likely possess a strong self-efficacy and internal locus of control.

According to Bear and Babcock (2017), negotiation skills prove important to become a successful leader. Women, when coached or presented with a negotiating experience involving others, increase their likelihood of having equally as good a negotiating experience as men presented with the same situation (Bear & Babcock, 2017). Establishing a sense of authority in settings involving decision making is an essential behavior for successful leadership negotiation tactics.
Both male and female counterparts view women considered successful in a stereotypical male work environment as less likeable and more likely to create an unpleasant work environment (Heilman & Okimoto, 2007; Heilman et al., 2004; Parks-Stamm et al., 2008). According to Faniko et al. (2016), women in supervisory positions think they have more in common with women in similar leadership positions versus women in subordinate positions. Successful women claim to have less in common with women who have chosen to put family first (Faniko et al., 2016). Women in leadership positions rate themselves higher in career obligations and overall masculinity when compared to their subordinates (Faniko et al., 2016).

Moreover, the transformational leadership style is the focus of this literature review as women prove more likely than men to use a transformational leadership style (Bass & Avolio, 1996; Day et al., 2016; Hernandez Bark et al., 2016). As one of the founders of the transformational leadership theory, Bernard Bass considered transformational leaders to be charismatic, inspiring, expressive, encouraging, inspirational, and aware of their colleagues and their contributions to the organization (Bass, 1985; Bass, 1988; Bass & Steidlmeier, 1999). As Bass (1985) stated “transformational leadership is more likely to reflect social values and to emerge in times of distress and change” (p. 154). Bass and Steidlmeier (1999) described transformational leaders as morally ethical while Şahin et al., (2017) described transformational leaders as being positively viewed in regard to motivation, optimism and trusting of their employees. The Şahin et al. (2017) concluded that female leaders hold stronger administrative expectations of employees and demonstrate more transformational leadership than male leaders.
Transformational leadership proved successful for the advancement of organizations and overall effectiveness (Day et al., 2016; Hernandez Bark et al., 2016). However, not all women use transformational leadership as their only leadership style. Typically, leaders use a combination of leadership techniques uniquely created for their organizational needs (Bierema, 2016).

### 2.4.2 Women in STEM

Several studies report significant findings for describing characteristics and life actions that assist in developing women who will succeed in STEM (Grossman & Porche, 2014; Lawson et al., 2018; Ramsey et al., 2013; Robnett & Thoman, 2017; Simon et al., 2017; Stearns et al., 2016). Studies have investigated influences for developing successful women in STEM ranging from adolescent girls to college-aged women (Grossman & Porche, 2014; Lawson et al., 2018; Simon et al., 2017; Stearns et al., 2016). Developing a plan for adolescent girls to be successful in STEM studies serves as an important component for future women being successful in STEM. Students may face gender barriers when pursuing STEM careers (Grossman & Porche, 2014). Grossman and Porche (2014) discovered that adolescent girls find that having support systems, such as family members or public role models, who advocate for overcoming gender discriminating barriers prove more likely to develop the self-confidence needed to study science. Those who pursue STEM degrees more likely perceive science as supportive of gender equality within their field (Grossman & Porche, 2014).

Instructors as support systems make up a large component of women’s success in STEM studies (Lawson et al., 2018; Stearns et al., 2016). According to Stearns et al. (2016), the presence of women actively involved in STEM courses in high school
positively impacts young girls’ desires to pursue STEM experiences. Students taught by female math and science teachers in high school have a higher chance of pursuing a STEM degree and also prove more likely to graduate with a STEM degree as the higher the ratio for female science and math teachers in high school, the more significant the correlation for their female students to graduate from college with a STEM degree (Stearns et al., 2016).

Simon et al. (2017) also investigated the influence of feminine characteristics in those who choose a STEM major. The study applied the Bem sex-role inventory (BSRI) developed by Bem (1974) to study masculine and feminine personality traits of a group of 752 participants. Questions in the survey were related to gender identity, family influences, the value of STEM fields, personal assessments of STEM capabilities, standardized tests achievements, support and preparation for the field. Findings revealed that STEM majors scored lowered on the femininity scale than non-STEM major participants. Additionally, women who scored on the upper end of the femininity scale decreased their odds of majoring in STEM fields; however, the research did not support this to be true for males. The study concluded that masculine and feminine traits work statistically independent from each other, however, they do not serve as “opposite poles on a single gendered personality continuum” (Simon et al., 2017, p. 319).

Female students entering college declaring STEM majors are more likely to have a positive STEM experience if their school environment supports women in STEM (Lawson et al., 2018; Ramsey et al., 2013). Lawson et al. (2018) specifically investigated the role of professors in creating a positive school environment for women in male-dominated majors. Students who claimed to have personal interactions with professors
and their peers in their core classes were more likely to develop confidence in their STEM abilities (Lawson et al., 2018). Students who have a higher-self-efficacy belief in their mathematics and overall academic performance abilities exemplify one predictor of female students choosing STEM majors (Moakler & Kim, 2014). According to Lawson et al., 2018), student and professor interactions largely impact an increase in self-efficacy and a sense of belonging. Personal attributes of the professors, such as being personable, approachable and positive, create an inviting and encouraging environment for young women to continue pursuing STEM (Lawson et al., 2018). Developing interests and confidence in STEM studies may play an important role in retaining declared STEM majors.

According to Robnett and Thoman (2017), students associated with a higher STEM identity, value, and career commitment prove more likely to have a higher STEM success expectancy. Some highly capable female students could achieve STEM success; however, their own doubt keeps them from having a high STEM success probability (Robnett & Thoman, 2017). The academic environment outside of the classroom and coursework influence these women in developing STEM identity (Ramsey et al., 2013; Robnett & Thoman, 2017). Both STEM identity and STEM value encourage self-confidence in the field. Confident, high-achieving female students in college prove most likely to be successful in STEM compared to other female students; however, fewer women fall into this category than men (Robnett & Thoman, 2017).

Ramsey et al. (2013) studied a university program that created an environment supportive of women in science and engineering. The program titled, “Women in Science and Engineering (WISE),” provided surroundings that encouraged STEM identity,
support and value outside of the classroom in the residential community. Three
environmental influences of WISE that proved statistically significant were: hearing
messages about women in STEM, seeing visible STEM symbols, and having peer role
models in STEM. These components created a self-identity within the STEM field, which
correlated to a positive STEM success outcome (Ramsey et al., 2013).

Once women graduate with a degree in STEM, the next step in understanding a
woman’s accomplishments in STEM is to know how these women achieve success in
their work environment. Researchers Wessel et al. (2015) studied 674 undergraduates
from a large U.S. Midwestern university and analyzed how verbalizing agentic traits and
the existence of gender acknowledgement can influence an interviewee’s hiring decision.
Participants observed mock interviews and answered questions to evaluate the
interviewer’s potential. The participants evaluated the perceived fit of the applicant at the
workplace, professional qualifications, and personal qualifications (Wessel et al., 2015).
Results indicated that when female applicants were applying for a masculine role, the use
of agentic traits (analytical, ambitious, and assertive) in the interview gave them the
advantage of appearing fit for the positions. While when male applicants used communal
traits (compassionate, sensitive, and nurturing), they appeared less fit for the job.
Additionally, the study found that pre-existing negative opinions regarding females was a
large factor for hiring. Gender recognition in the interview led to negative assessments
(Wessel et al., 2015). Knowing how to successfully navigate an interview can be critical
when women attempt to climb their career ladder. Demonstrating agentic traits more
commonly associated with masculine roles potentially creates a positive interview
experience and an effective interviews lead to new opportunities for women to become successful in the STEM work environment (Wessel et al., 2015).

**Leadership aspirations.** Understanding correlations consistent with aspiring leaders creates an essential awareness of who plays a role in becoming a leader. The Career Aspiration Scale Revised (CAS-R) developed by Gregor and O’Brien (2016) serves as one tool to determine career desires and has a component for leadership aspiration. Researchers have utilized this scale to determine who intends to become a future leader and with what traits and characteristics a person intends to utilize to become a future leader. Gregor and O’Brien (2016) studied women’s career aspirations and leadership aspirations for a blend of undergraduate and graduate psychology students. Results of the study concluded that women who prioritized the importance of a career reported to have higher levels of leadership aspirations. Work role salience was described by Gregor and O’Brien (2016) as the relationship of career aspirations and value work as perceived by women. The study showed a positive correlation on achievement motivation and work role salience with women who desired leadership roles. Those who scored high on the education aspiration and achievement aspiration scale were also more likely to score higher on the leadership aspiration scale. Additionally, women who more than likely to desire a leadership role possessed traits such as appreciation for their careers, diligent, competitive and inclined to continue learning within their field. Some results conflict within the study by Gregor and O’Brien (2016) between the relationships of willingness to compromise a career for children and leadership aspirations. Ultimately, Gregor and O’Brien (2016) concluded that for the undergraduate and
graduate psychology major student population studied (N=583), no relationship exists between willingness to compromise a career for children and leadership aspirations.

Gregor and O’Brien (2015) also considered 202 female psychology doctoral students and determined that women who desired leadership positions were also more likely to compromise their careers for their children. Alternatively, some female psychologists adopt a “have it all” way of thinking, meaning that they can act in both a prevalent family role and leadership role (Gregor & O’Brien, 2015, p. 1105). However, those who indicated a strong value for their career and a distinguished work ethic denote the main indicators for women desiring leadership positions in their careers (Gregor & O’Brien, 2015).

Leadership aspirations and gender have also been explored relative to one another. In a study by Fritz and Knippenberg (2016) in which gender roles did not appear as a positively significant predictor of leadership aspiration, however, the researchers did determine leadership self-confidence as a positively significant predictor of leadership aspiration. Fritz and Knippenberg (2016) studied the effects of different organizational climates on men and women and their leadership aspirations. A “Cooperative Interpersonal Climate” (CIC) and a “Cooperative Collective Climate” (CCC) were also considered. The CIC focuses on the supportive relationship between individual colleagues in the organization whereas the CCC emphasizes the supportive relationship between the organization or group as a whole (Fritz & Knippenberg; 2016). The results of the study concluded that women are more likely driven to become leaders from their own self-constructed desire, while men are more likely driven to become leaders from their environmental surroundings. Results from the CCC group were found to be
positively related to leadership aspiration for both men and women; however, there was a stronger correlation for men than women (Fritz & Knippenberg, 2016).

2.4.3 The role of mentoring

Mentoring relates to a relationship between one or more people with the intent of growth and development (Crisp et al., 2017). Mentoring develops between both informal and formal dynamics. Involvements with instructors, family members, peers, and external learning experiences such as internships serve as the main sources for the development of mentoring relationships (Crisp & Alvarado-Young, 2018). Both the mentee and the mentor potentially benefit from mentoring programs (Dziczkowski, 2013; Lin et al., 2016). Students who take part in peer mentorship programs feel as though they develop personal skills and leadership growth (Lin et al., 2016). Mentoring programs and involvement provide several leadership outcomes, such as leadership social responsibility, identity, growth, skills and characteristics (Crisp & Alvarado-Young, 2018).

An important component of mentorship lies in evolving leadership potential into active leadership. A person’s leadership identity must be established before an individual believes in their capability to lead (Priest et al., 2018). Awareness of leadership potential acts as the first stage in the leadership identity development theory founded by Komives et al. (2005). Mentors recognize this leadership potential, make the mentee aware, and then encourage engagement in leadership opportunities (Priest et al., 2018). Once the mentee acknowledges a sense of leadership identity, they then must be guided to acknowledge their responsibility in their own leadership roles (Priest et al., 2018).
Leadership training programs for women interested in pursuing STEM leadership positions in academia have proven to be beneficial for gaining employment opportunities in department chair and dean roles (O’Bannon et al., 2010). Individuals provided with mentorship, administrative training, and leadership training prove very likely to climb the ladder to a leadership position (O’Bannon et al., 2010). A study by O’Bannon et al. (2010) followed 17 female tenured faculty members in a variety of disciplines including biology, biochemistry, chemistry, computer science, economics, engineering, geology, mathematics, physics, political science and technology. All of the 17 women completed a five-year leadership institute that provided mentorship, administrative training, and leadership training. By the end of the leadership institute, 100% of the women secured a leadership position. Although the women who chose to take part in the leadership institute already showed signs of leadership potential and motivation as evidenced by their interest in the program, this study strongly highlighted the importance of mentorship and proper training for promoting successful women in STEM leadership positions (O’Bannon et al., 2010).
2.5 Reasons for women’s reluctance in choosing STEM careers

The issue of consistent underrepresentation of women in STEM degree fields and careers has gained global attention for the importance of diversity in the workplace (Sassler et al., 2017). Researchers actively conduct studies to identify problem areas that lead to fewer women choosing STEM fields as careers. These studies set a backdrop for the process to balance gender representation in the STEM workforce. A thorough review of the literature reveals several common themes, including low self-concept and/or self-efficacy related to STEM, lack of role models and mentors, and the traditional lifestyle and expectations in the home and family life of most women. A discussion of topics which frequently appear in the literature follows.

2.5.1 Self-concept and self-efficacy

Similar factors often influence both self-concept and self-efficacy, especially when investigating reasons why women do not pursue STEM degrees. Self-concept relates to a person’s own belief in their capabilities, and social environments and interactions with peers often shapes one’s self-concept (Shavelson et al., 1976). However, self-efficacy relates to a person’s own belief in successfully completing a task and further develops or depletes by performance outcomes, self-modeling, verbal encouragement and emotional state (Stone, 2018). For this literature review, self-concept and self-efficacy will be explored as one component as the literature supports their intermingled association (Bong & Skaalvik, 2003).

A student’s self-concept influences their decision-making process in choosing areas to study (Else-Quest et al., 2013; Godwin et al., 2016). An individual possessing a negative cognitive belief around a subject, such as math or science, can easily be a
deterred by the subject. Understanding self-concept makes for an essential component in understanding student educational paths (Shavelson et al., 1976). Influences, such as beliefs of success and competition versus collaboration within the workplace, serve as strong predictors of students wanting to pursue a degree in STEM fields (Meyer et al., 2015).

The analysis of surveys and grades serves as one way to measure self-concept. Studies agree that girls tend score lower in self-efficacy and self-concept for STEM related tasks (Else-Quest et al., 2013; Hand et al., 2017). Else-Quest et al. (2013) found that adolescent male students score higher self-concept in math topics than adolescent female students reported math anxiety, lower self-confidence, and lower self-efficacy in the subject than boys serve as influencing factors for a lower self-concept score for female students. Higher self-concept scores for female students positively correlate with math scores (Else-Quest et al., 2013). One’s own perception of one’s abilities to perform well in physics and math makes for a positive indicator in pursuing STEM careers (Godwin et al., 2016; Wang et al., 2017). Additionally, having a greater self-concept in math links to a greater rate of employment in STEM (Wang et al., 2017).

Social surroundings make up an important component in the development of a person’s self-concept. Peers, communities, and family members play a role in developing self-concept (Shavelson et al., 1976). An individual’s social class also acts as another influential factor in self-concept. A 10-year longitudinal study by Archer et al. (2017), investigated the influence of social class and the pursuit of physics studies on 15- and 16-year-old girls. Results indicated that girls in middle or working social classes may hesitate to study physics, and this social status may prevent some girls from engaging in
these studies even if they desire to do so (Archer et al., 2017). Additional research on the same student population and found that students who fell into the upper class category appeared more likely to consider choosing physics (Francis et al., 2017). Although these studies specifically investigated girls pursuing physics degrees, the concept of social class influence relates to other areas within STEM.

Gender stereotypes often form early in life and are influenced by social surroundings. Parents greatly influence gender roles, identities, stereotypes, and biases (Wang & Degol, 2017). Another strong predictor of students choosing STEM majors derives from students having parents in STEM careers (Moakler & Kim, 2014; Sax et al., 2017; Wang et al., 2013). This leads to higher self-efficacy in mathematics and overall academics (Sax et al., 2017; Wang et al., 2013). Expectations associated with gender stereotypes potentially affect girls’ self-efficacy associated with STEM fields (Hand et al., 2017). Developing a belief that students can and will be successful in STEM fields and surrounding young children with a community who supports and engages them in STEM make up critical steps in recruiting more young girls to take interest in pursuing STEM degrees.

A low self-concept of natural abilities in STEM provides another possible reason why women neglect STEM studies. Women are influenced by field-specific ability beliefs from their surrounding community and potentially discourage themselves from pursuing majors they believe require natural talents to be successful (Meyer et al., 2015). Additionally, women prove less likely to perform well on math assessments if they have the impression that STEM fields will never achieve a gender balance (Shaffer et al., 2013). The beliefs that gender balance is not obtainable and that women do not have the
natural skillset to be successful in STEM make it challenging for women to overcome their own self-concepts to pursue STEM work.

When researchers Dugan et al. (2013) investigated leader self-abilities, skills, and leadership potential of women in STEM studies, including participants who were STEM and non-STEM majors, they found that both groups of students had the same leadership potential. However, the study concluded that women in STEM disciplines scored themselves lower on leader effectiveness than non-STEM students (Dugan et al., 2013). Self-efficacy and self-concepts regarding STEM subjects are considered some of the most important factors in choosing STEM degrees (Godwin & Potvin, 2015). Although STEM women tended to score themselves lower on self-leader efficacy, they showed strength in improving their leader efficacy while in school; however, non-STEM majors increased leader efficacy at a faster pace (Dugan et al. 2013). Researchers Dugan et al. (2013) suggested that this is likely due to the highly male-dominated STEM environments.

Furthermore, students make career-related decisions based on their experiences in the classroom and their personal achievement goals for a subject (Jagacinski, 2013). According to Ellis et al. (2015), women prove 1.5 times more likely to leave a mathematically intense field during and after Calculus I than men. Researchers claim that if women were retained during the critical years of taking required fundamental math courses, then the number of women entering the STEM workforce would increase by 75%, which would, in effect, increase the total STEM workforce by 20% (Ellis et al., 2015). Additionally, results from Ellis et al. (2015) indicated that women also proved more likely than men to finish Calculus I with a lower self-confidence in the course than
men. Changing majors outside of STEM serves as the most common reason for students to leave or quit their calculus classes (Ellis et al., 2015).

Jagacinski (2013) studied perceived self-efficacy of first-year engineering students. The study included 117 participants, of which 32% were female. The study found that the female students, who reported lower self-efficacy, generally changed majors. Rather than repeating a course, they opted to enroll in the female-dominated field of psychology. However, male students in the same engineering course who also reported lower self-efficacy enrolled in the same engineering course to be repeated. Women demonstrate becoming discouraged and losing confidence in their STEM skills during their introductory math and engineering courses more often than men (Jagacinski, 2013).

2.5.2 Unique challenges for underrepresented racial minority women in STEM

Black women in particular lack adequate representation in STEM fields. According to the National Science Foundation (NSF), in 2018 Black women earned 8% of Science and Engineering bachelor’s degrees (NSF, 2021). According to Collins et al. (2020), experiences and exposure to STEM education in grade school provide STEM identity and talent development which make up an essential component in establishing and maintaining an interest in STEM careers. Challenges that women of color face in STEM begin in the classroom. Bias and educational institutional discrimination as early as elementary school contributes to the underrepresentation of male and female Black students in the STEM pipeline (Collins et al., 2020). Additionally, African American students are commonly placed on the lower mathematic track when assessed in elementary school (Joseph et al., 2017). This results in fewer opportunities to increase
interest and pursuit in STEM degrees and the necessary advanced mathematical courses for STEM degree preparation (Collins et al., 2020).

According to the U.S. Department of Education, NCES (2022a), Black U.S. citizens earned 8.5% of STEM degrees/certificates for the 2019-2020 academic year. Additionally, of the STEM degrees/certificates awarded to females, 10% were awarded to Black females (U.S. Department of Education, NCES, 2022a). As established by these percentages, there is a need for recruiting and retaining Black women in STEM. Collins et al. (2020) suggested several improvements for educational institutions to implement prior to the start of high school in order to begin developing STEM self-efficacy and stated that “nurturing and solidifying a STEM-scholar identity is a crucial first step in nurturing STEM talent for gifted, Black females” (p. 59). Armstrong and Jovanovic (2017) developed five intersectional facilitators or strategic functional characteristics that support underrepresented racial minority women in STEM at universities:

1. Creating accountable leadership
2. Identifying climate zones
3. Understanding the numbers game
4. Overcoming epistemological hurdles

Creating accountable leadership calls for supportive leaders in their actions and words and are held accountable for outcomes. Identifying climate zones recognizes that every institution functions differently which may require different approaches for intervention and transformation. Additionally, community structures provide opportunities for women in STEM to come together for support. “Understanding the
numbers game” is a phrase coined by researchers Armstrong and Jovanovic (2017) which they define as the “recognition that the small number of individual underrepresented minority women at an institution is not a signal to give up, but rather a sign of particular challenges that require certain reactions” (p. 224). Overcoming epistemological hurdles requires leaders to self-educate on topics associated with transformational improvements and needs at institutions. Promoting community structures is creating an environment where those underrepresented become invested in the need for change in their organization. Having visible leadership personnel to show support for those underrepresented denotes an essential piece of a support system (Armstrong & Jovanovic, 2017).

2.5.3 Lack of role models and mentoring

Mentors and role models play an important role in encouraging individuals to pursue certain career paths. The presence of mentoring programs and active role models can influence a student’s degree choice (Jung et al., 2017). Once committed to a STEM major, mentoring programs can influence students to stay committed to STEM programs which then supports STEM as a field (Dennehy & Dasgupta, 2017). Wang (2012) analyzed data from the Michigan Study of Adolescent Life Transitions longitudinal study which included 3048 sixth-grade students, their teachers, and parents from 124 math classes in 12 public schools over an eight-year period and concluded that positive relationships with math teachers had a strong impact on students to pursue math related careers. The positive influence of role models and mentoring programs appears frequently in the literature for the recruitment of young women soon entering into or
currently enrolled in college and the retention of women in STEM (Wang, 2012).

Introducing young girls to female science and mathematics role models has the potential to increase girls’ self-confidence in the pursuit of studying STEM. However, adolescent girls recall less often than adolescent boys current and/or historical women mathematicians taught in their classroom experience, and both genders acknowledge very few women scientists taught in their classroom experience (Hand et al., 2017). When considering female role models in technology and engineering outside of the classroom, students in technology courses found it difficult to name women in technology but much easier to name men (Jung et al., 2017).

Mentoring programs have been established and implemented in schools and colleges in efforts to encourage students to remain committed to their STEM degrees. A study by Dennehy and Dasgupta (2017) investigated a mentoring program designed for incoming freshmen women pursuing an engineering degree. The study explored different influences of mentors, mentors of the same sex, and mentors of the opposite sex. Results indicated that females who had a female advisor were more likely to feel a sense of belonging in the field, have a higher belief in their abilities, and develop a stronger desire to do well in their studies. As a result, students with like gender mentors were more likely to stay in the program (Dennehy & Dasgupta, 2017).
Zawistowska (2017), analyzed interviews of 20 female students from different STEM majors and found that the presence of role models served as a common contributor among the majority of the female participants and their decision to study STEM. Zawistowska (2017) found that the female study participants’ parents or siblings exemplified the most influential role models for the students. Encouraging support from family for a child’s study within STEM represents a dominant contributing factor for students deciding to study STEM. The identification of family members being significant role models can be attributed to Jung et al.’s (2017) findings that the majority of undergraduate female technology students cannot identify female role models on television or in the media (i.e., newspapers, articles, internet). Studies like these support the increased likelihood of reducing or removing stereotypes when more women visibly represent and support STEM (Riegle-Crumb, & Moore, 2014).

2.5.4 Lifestyle

The lifestyle of STEM employees is a frequent topic in the literature when investigating the recruitment of women in STEM studies. Studies suggest that women and girls acknowledge that a STEM career does not fall into the most flexible of careers for family obligations (Bamberger, 2014; Hughes et al., 2017; Weisgram & Diekman, 2017). In one study, 15-year-old girls acknowledged the amount of time required to be a committed scientist could interfere with family responsibilities (Bamberger, 2014). Additionally, Shapiro et al. (2015), noted that eight times as many middle school girls as middle school boys projected taking a brief period of time off to commit to raising a family. When Weisgram and Diekman (2017) assessed both males and females, they found that beliefs about science careers supporting family goals decreased as the
participants aged from middle school to college. However, those under the impression that STEM careers permit a positive family life were more likely to agree that careers in STEM can support family goals (Weisgram & Diekman, 2017). Lifestyle values and/or work-family balance preferences offer potential explanations as to why women are consistently underrepresented in STEM fields, especially those with a heavy mathematical emphasis such as physics, computer science, and engineering (Wang & Degol, 2017).

Part of a STEM career stereotype involves a lack of support of communal experiences (Steinberg & Diekman, 2017). Researchers Steinberg and Diekman (2017) considered communal experiences as interactions with or helping others with group projects, extracurricular activities, meeting with mentors, serving as mentors or volunteering. Women prefer a lifestyle where they commit to a career that involves working with or helping others (Diekman et al., 2015; Steinberg & Diekman, 2017). Women more often than men have communal goals they wish to incorporate in their lifestyle (Diekman et al., 2015; Diekman et al., 2017; Steinberg & Diekman, 2017). A study which examined middle school girls’ and boys’ career aspirations also found young middle school girls have goals of “making the world a better place” and “helping others” (Shapiro et al., 2015, p. 11). STEM career settings appear incompatible with fulfilling communal goal needs, but the path to earning a STEM degree may not support communal goals either (Diekman et al., 2015). Diekman et al. (2017) suggested that participation in activities that fulfill communal goals, such as student organizations or family interactions, may take away from the time needed to dedicate to STEM courses. Noncommunal STEM career stereotypes are ubiquitous; however, educational
experiences that promote STEM and congruent communal goals may help reduce the stereotype and encourage a greater interest to pursue STEM disciplines and careers (Fuesting et al., 2017).

A 2017 study by Steinberg and Diekman supported the idea that non-STEM students typically view STEM careers as independent experiences and non-supportive of communal goals. However, active involvement in communal experiences can develop positive attitudes towards STEM and promote communal opportunities within STEM. The study determined that highlighting experiences that directly benefit society allowed participants to develop a positive outlook on STEM and the community, therefore, encouraging a wider audience who find working in STEM a rewarding experience. Thus, framing STEM fields as having communal affordances offers a possible recruitment tool for encouraging women to pursue STEM disciplines (Steinberg & Diekman, 2017).

Both young adolescent girls and college-aged women acknowledge the significant amount of time necessary to dedicate to STEM careers. To compensate for the long work hours, research participants suggest that STEM workplaces must be flexible for women with family in order for more women to consider a career in STEM (Wang & Degol, 2017; Xu, 2015). Additionally, Fathima et al. (2020) identified childcare responsibilities as a challenge perceived by female scientists. The presence of childcare support, whether it be informally by family members or formally by childcare services, provides a coping strategy for women in STEM (Fathima et al., 2020).

2.6 Barriers

Women in STEM face different social and external barriers than men that can
discourage them to pursue a STEM degree or a STEM leadership position. This literature review expounded on several common hurdles that women must overcome to succeed in the STEM environment. Gender discrimination and stereotype threat, mentoring, and overall support for women in STEM offer three areas of improvement to attempt to close the gender gap in STEM. A study by McClelland and Holland (2015) surveyed 26 STEM department chairs and five deans at one large public university and found that the participants acknowledged personal responsibility for increasing the number of women in their department. Additionally, department leaders viewed themselves accountable for diversifying the departments (McClelland & Holland, 2015). Participants considered themselves as part of the solution to closing the gender gap and not part of the problem for the consistent underrepresentation of women in STEM (McClelland & Holland, 2015).

Manfredi (2017) suggested positive action in recruitment and promotion to be taken in higher education institutions to bring awareness to the gender gap in the consistent underrepresentation of women in leadership roles. Positive action is a political term used in Europe, and Manfredi (2017) specifically discussed positive action as used in the United Kingdom. The University of Cambridge (n.d.) defines positive action as “a range of measures allowed under the Equality Act 2010 which can be lawfully taken to encourage and train people from underrepresented groups to help them overcome disadvantages in competing with other applicants” (para. 1). An active positive involvement by all members in STEM will assist in removing the barriers facing women in STEM.
In efforts to close the gender gap in STEM, Manfredi (2017) suggested creating a repetitive cycle of setting targets, recruiting and promoting women in STEM fields, reexamining the judge of merit, and developing an all-encompassing idea of success in the STEM environment. STEM recruitment and retention in undergraduate studies serves as an essential part of developing a pool of eligible women to compete in career-oriented STEM leadership roles. The literature suggests developing support systems for women in STEM in addition to mentorship programs and addressing the gender stereotype to create an encouraging atmosphere for young women to choose STEM careers (Grossman & Porche, 2014; Lawson et al., 2018; Stearns et al., 2016). These developments can extend to the workplace to inspire potential leaders in the STEM work environment.

2.6.1 Gender discrimination and stereotypes

Gender stereotyping within STEM fields emerges in early educational settings (Barth et al., 2018; Blažev et al., 2017; Grossman & Porche, 2014; Shapiro et al., 2015). Men, more often than women, appear to have more qualities associated with scientists (Carli et al., 2016; Miller et al., 2015). One influential source of gender stereotypes is in television broadcasts and newspaper articles (Puchner et al., 2015). These media types influence children to assign gender roles to occupations which include representing males as scientists and mathematicians more often than females (Puchner et al., 2015). Additionally, scientists generally demonstrate more agentic behaviors which lend to stereotypically male attributes versus communal behaviors which lend to stereotypically female attributes (Carli et al., 2016). Carli et al., (2016) defined agency to refer “to people striving to be independent, to control their environment, and to assert and expand themselves” and defined community to refer “to a person’s striving to be part of a
community, to establish close relationships with others, and to subordinate individual needs to the needs of other people” (p. 248). In general, STEM course work and employment opportunities appear to have more agentic goals often associated with independence and assertiveness for themselves rather than communal goals often associated with the desire to work and help others with moral obligations and fairness for all involved (Carli et al., 2016). This presents a problem, as women prove less likely to complete studies in areas that do not align with their gender role (Stout et al., 2016).

Gender stereotyping of STEM fields with male characteristics or traits appears more often in STEM fields with a lower representation of women in the field (Carli et al., 2016; Miller et al., 2015). Oftentimes, women do not seem capable of succeeding as scientists due to gender stereotyping (Carli et al., 2016).

Everyday interactions with society have the potential to influence perceptions of an organization, group, or membership. Women in STEM leadership positions acknowledge the presence of stereotyping and implicit bias in the STEM disciplines and in STEM leadership positions (Chapple & Ziebland, 2017; Cundiff & Vescio, 2016). Stereotyping and implicit bias in STEM disciplines develop microaggressions. Microaggression is defined as “a comment or action that subtly and often unconsciously or unintentionally expresses a prejudiced attitude toward a member of a marginalized group” (Merriam-Webster, n.d.). Experiencing microaggressions associated with gender does correlate to STEM success (Grossman & Porche, 2014).

In a study by Grossman and Porche (2014), researchers interviewed high school girls and boys to investigate everyday interactions that lead to the discrimination and gender stereotyping in STEM disciplines. The microaggressions associated with power
appeared within the participants’ responses. According to the study, 29% of the girls viewed a man’s power motivation, or one’s motivation for power (Schuh, et al., 2014) as guarding his status in the field. Of the 53 participants, 57% identified negative societal beliefs and assumptions related to the success of women in STEM settings. Overall, female students more commonly than male students reported gender discriminatory microaggressions associated with power, societal stereotypes and assumptions. These gender roles associated females with domestic responsibilities and the thought of women having a limited capacity for success in STEM environments. Although these microaggressions associated with gender and STEM fields appeared often within the study, Grossman and Porche (2014) do perceive the active movement to provide family and educational support for school-aged girls as hope for these microaggressions to slowly dissipate. Participants acknowledged progress in removing gender barriers, and 28% of the participants believed that no barriers existed between gender and STEM success (Grossman & Porche, 2014).

Leslie et al. (2015) tested the field specific ability beliefs hypothesis which is the idea that women are underrepresented in STEM fields due to the cultural stereotype that women lack the skill to compete with men in these fields. The study included 1820 participants from STEM, social science, and humanities disciplines. A questionnaire was distributed to the participants and analyzed quantitatively. The scores showed that the higher the participants ranked a field on valued giftedness these fields corresponded to predominately male areas of study. The study also investigated the correlation of intensity of workloads and women in the field. The study found that job demands were not the reason for the underrepresentation of women in STEM fields (Leslie et al., 2015)
which conflicts with the belief that STEM careers may interfere with a woman’s role in the family (Bamberger, 2014; Hughes et al., 2017; Weisgram & Diekman, 2017.

2.6.2 Social justice and the removal of barriers

The consistent underrepresentation of women in STEM can be considered a social justice issue. The Center for Economic and Social Justice (2019), defined social justice as follows:

Social justice encompasses economic justice. Social justice is the virtue which guides us in creating those organized human interactions we call institutions. In turn, social institutions, when justly organized, provide us with access to what is good for the person, both individually and in our associations with others. Social justice also imposes on each of us a personal responsibility to collaborate with others, at whatever level of the “Common Good” in which we participate, to design and continually perfect our institutions as tools for personal and social development (para. 3).

There are laws in place, such as Title IX of the Education Amendments Act of 1972 (Hill et al., 2010) and Title VII of the Civil Rights Act of 1964 (Civil Rights Act, 1964), to prevent sexual discrimination in the workplace and in education programs that receive federal funding. However, these laws do not address disproportionate gender participation in the workplace and educational institutions. These laws allow regulation of organizations, however, an organizational interest and emphasis to create a more equal opportunity must exist to develop climates where women and men of comparable talents experience an equal opportunity to succeed in the STEM workforce (Hill et al., 2010).
Integrating social justice practices in career developments supports the removal of barriers in the workplace (Arthur et al., 2013).

Identifying barriers women face while pursuing STEM careers bolsters the understanding of what must be done to remove those barriers. A few key themes integrated into the daily lives of young women can aid in combatting gender discrimination and gender stereotypes as discussed in this section of the literature review. The focus of supporting and mentoring young women in STEM plays a vital role in removing the gender stereotype. The lack of support and mentoring for women in STEM presents another potential barrier (Chapple & Ziebland, 2017; Dawson et al., 2015); however, for this literature review, these categories will be associated with removing barriers. The following sections will be divided into supporting women in STEM, mentoring women in STEM, and other tactics to remove gender bias in STEM disciplines.

**Supporting women in STEM.** Developing and providing support systems for young girls as they think about their career choices serves an essential role in encouraging girls to pursue STEM careers. Grossman and Porche (2014) determined that science aspirations positively correlate with an understanding that a support system exists for girls and women in science. Girls and boys acknowledge the need for support systems to beat gender stereotypes in the STEM environment. Family members and educators make up primary support systems (Grossman & Porche, 2014).

Educators as supporters play an important role in combating the gender stereotype in STEM disciplines (Grossman & Porche, 2014; Lawson et al., 2018; Stearns et al., 2016). Acknowledging existing barriers to STEM success and coping methods to combat
those barriers provide examples of how teachers can assist in supporting young girls in
the fight against gender stereotyping (Grossman & Porche, 2014). Additionally, in the
college setting, women prove more likely to complete STEM courses successfully if the
course has lower agentic descriptors (Stout et al., 2016). Course agentic descriptors,
according to Stout et al. (2016) are courses that lend themselves to goal affordances such
as “independence, power, recognition, self-direction, and self-promotion” (p. 493).
Encouraging students to overcome gender stereotypes and addressing agentic behaviors
both create supportive structures that promote an increase in the number of women
studying STEM disciplines.

Gender stereotyping emerges strongly in young children (Barth et al., 2018;
Blažev et al., 2017; Grossman & Porche, 2014; Shapiro et al., 2015). Female-oriented
organizations and groups such as the Girl Scouts act as strong influencers in the
development of career aspirations in young girls (Shapiro et al., 2015). Shapiro et al.,
(2015) determined that girls who participate in Girls Scouts are more likely to choose a
STEM career than girls who do not participate in Girl Scouts. This suggests that
confidence boosting interactions with young girls and boys in gender-specific groups can
assist in closing the gender gap in STEM disciplines (Shapiro et al., 2015).

Creating a supportive work environment for women in leadership positions marks
an influential factor in encouraging more women to pursue leadership positions in the
STEM workforce. Fritz and Knippenberg (2016) determined women to have a higher
leadership aspiration in cooperative interpersonal climates (CIC) and cooperative
collective climates (CCC). Organizations supporting and encouraging CIC and CCC
environments by incorporating team organization and team building create an atmosphere
for social relationships between members of the organization of different hierarchal status (Fritz & Knippenberg, 2016).

Faculty members at the Illinois Mathematics and Science Academy (IMSA) investigated the common occurrence of female students consistently outnumbered by male students in advanced physics, modern physics, calculus-based physics, engineering and electronics classes (Hinterlong et al., 2014). According to Hinterlong et al. (2014), female students expressed interest in a new engineering course but then digressed after the first year. Male students claimed they enjoyed physics classes and considered them to be fun and a tangible way of thinking while female students lacked enthusiasm for the courses and considered them an intangible way of thinking. Faculty members made small changes in the classroom, invited women guest speakers in casual settings, incorporated more team projects in engineering, and aligned projects to the school’s mission to “ignite and nurture creative, ethical, scientific minds that advance the human condition, through a system distinguished by profound questions, collaborative relationships, personalized experiential learning, global networking, generative use of technology and pioneering outreach” (p. 24). The school saw a constant decrease in female enrollment for the engineering course from 2004-2009 prior to the changes; however, after the new implementations, the female engineering enrollment increased from 18% in 2008-2009 school year to 45% in the 2012-2013 school year (Hinterlong et al., 2014).

Other efforts, like IMSA’s, have been established within the educational setting to support women in STEM. Students who have a weakness in calculus feel threatened by this barrier for STEM success (Carver et al., 2017). More specifically, women prove
more insecure about their calculus abilities as they are more likely than men to leave STEM fields requiring calculus after only calculus I (Ellis et al., 2015). Cleveland State University developed a program titled “Operation STEM” or “Op-STEM” that supports students who struggle with calculus. The program exposed students to peer mentorship and additional calculus lessons. The students had access to this program during their freshman year as a cohort. The results from Carver et al. (2017) indicated that with a significant form of support (i.e., tutoring and mentorship) provided by the Op-STEM program resulted in a significantly higher calculus I pass rate than students who did not participate in the Op-STEM program (Carver et al., 2017).

**Mentoring women leaders.** The visibility of women in STEM-related roles and careers greatly influences young women studying in the STEM field (Ramsey et al., 2013; Stearns et al., 2016). Relationships with advisors have shown to be effective in increasing the number of women math and science teachers in secondary education systems. In turn, the increase of women math and science teachers also effectively increases the number of young women who choose a STEM path in college. Additionally, policies and organizations that focused on retaining women who declare STEM majors in college make up a critical component in closing the gender gap (Stearns et al., 2016). Organizations such as Women in Science and Engineering (WISE), created at the University of Michigan, provided students with the opportunity to interact with more women in their field. WISE mentors, in conjunction with the presence of peer role models and a community of other women studying in their field, increased the students’ sense of belonging in the STEM environment. Creating a welcoming environment for
women studying STEM in college has the potential to greatly impact their educational endeavors by developing an identity associated with STEM (Ramsey et al., 2013).

Peer mentoring programs proved successful in retaining students in lower-level STEM courses (Carver et al., 2017). Additionally, peer mentoring programs support self-efficacy views of women in engineering (Dennehy & Dasgupta, 2017). Low self-efficacy scores represent a consistent problem for women within STEM. A longitudinal study by Dennehy and Dasgupta (2017) found that women who take part in peer mentoring programs are very likely to maintain their level of self-efficacy in engineering, while those women who do not take part in peer mentoring programs show signs of decreasing their level of self-efficacy in engineering. The visibility of female mentors provided a sense of belonging in the field, defying the gender stereotype (Dennehy & Dasgupta, 2017).

Mentorship benefits more than just those women training to become a STEM representative. Women working in STEM fields also benefit from mentorship. Researchers Thomas et al. (2014), formed mentoring groups for female STEM faculty members. The majority of the members agreed that they personally benefited from participating in small group sessions, while approximately 50-75% claimed they benefitted from the small groups on a professional level. The retention of women in STEM disciplines critically supports the advancement of gender equality in the field. Mentoring groups prove to be a successful form of encouragement for women in STEM by strengthening their work environment to support them in their occupational endeavors. (Thomas et al., 2014).
Gaining access to mentors within STEM fields makes up one priority for removing the lack of mentorship as a barrier for women in STEM. Online mentoring programs, such as CareerWISE, offer women the psychosocial form of mentoring without the need for finding a physical mentor. Dawson et al. (2015) studied the effects of the CareerWISE program on college women declared as STEM majors which provides online mentoring in modular form that includes videos of professional women in STEM sharing their stories and challenges and advice for overcoming gender stereotypes in the field. Other tools found in the CareerWISE modules include interactive simulations for students to train in communicating effectively in gender discriminatory conversations (Dawson et al., 2015). The intention of the CareerWISE program aims to “increase women’s resilience, problem-solving, coping, and communication skills” (Dawson et al., 2015, p. 59). Evidence from the study suggests that the online program, CareerWISE, can decrease the risk affiliated with the lack of mentorship and a common unwelcoming atmosphere that women often experience in the STEM discipline (Dawson et al., 2015).

**Addressing gender stereotypes.** The presence and visibility of more women in active STEM roles assists in battling gender stereotypes in STEM disciplines (Ramsey et al., 2013; Riegle-Crumb & Moore, 2014; Stearns et al., 2016). Riegle-Crumb and Moore (2014) analyzed data from the National Longitudinal Study of Adolescent Health to determine the influence of communities on young girls making STEM career decisions and found a pattern based on students who enroll in high school physics classes. They found a correlation between higher numbers of women in STEM in the community and higher numbers of girls enrolled in high school physics classes. The researchers noted
that the gender ratio in high school physics courses was greater in the Midwest than in the Western United States. The study predicted that when 7% of women in the community held a STEM career, the predicted probability of girls taking high schools physics courses exceeded the probability of boys taking high school physics (0.27 vs. 0.25) (Riegle-Crumb & Moore, 2014). This is a specific example of community support combating gender stereotype in STEM disciplines.

Another example of community involvement minimizing the threat of gender stereotype shows up in the example of the Women in Science and Engineering (WISE) program as mentioned previously in the Women in STEM section of this literature review. Ramsey et al. (2013) studied the WISE program at the University of Michigan which provided a source for mentorship for freshman women in science and engineering fields. WISE members lived in the same on-campus housing building and invited women in the STEM field to lead discussions and talks to the students to provide examples of successful women in STEM (Ramey et al., 2013). Being exposed to and surrounded by more women in STEM on a daily basis allowed students to see successful women in STEM who contradict the gender stereotype of the field. Results from the studies by Riegle-Crumb and Moore (2014) and Ramsey et al. (2013) suggested that when more women visibly represent STEM, the greater the chance of removing the stereotype threat in the community.

Manfredi (2017) suggested that positive action can defeat gender bias and stereotypes. Recognizing times at which gender bias and stereotypes are established offers one critical insight into address these issues. Stereotypes can hamper the acknowledgement of such discernment when they actively occur within an organization.
People prove more likely to acknowledge gender discrimination as the main cause of the gender gap in leadership roles more so than in STEM occupations. This suggests that addressing gender discrimination and stereotype issues within an organization should be handled differently depending on the situation (Cundiff & Vescio, 2016). However, as Cundiff and Vescio (2016) concluded from their research, educating peers and colleagues about gender differences occurring due to social factors and not biological factors, as well as not fixed to one particular gender, can potentially positively shift gender bias within the workplace.

Another cause for gender stereotyping relates to the media (Puchner et al., 2015). Teaching students to analyze hidden messages within media displays and to acknowledge gender discrimination within media potentially alleviates gender stereotyping. Critical Media Literacy (CML) curriculum involves teaching students, typically in grade school, not only to analyze media (i.e., television, newspapers, articles, etc.) outputs for the portrayal of stereotypical messages and discrimination of social groups, but to also identify these biases in the media for themselves (Puchner et al., 2015). Incorporating CML curriculum within educational institutions provided a source for acknowledging gender bias and stereotype within media outlets (Puchner et al., 2015). A constant exposure and education of counter-stereotypical relations suggests a path towards gender equality (Miller et al., 2015; Shapiro et al., 2015). As Cundiff and Vescio (2016) found, the acknowledgement of discrimination and stereotype offers one step towards eradicating the gender stereotype threat.
2.7 Summary

Equality for women in the workplace greatly improved throughout the 20th century. The presence of working women during WWI, WWII, and the Cold War assisted in evolving the woman’s role from strictly homemaker to provider (Striking Women, n.d.). The STEM field benefited from women in the 20th century as they proved critical in advancing the United States in computer programming and mathematical computations (Smith, n.d.a; Striking Women, n.d.). The demand for more working personnel resulted in a more diverse STEM work environment that proved to be beneficial for production and promoted creative thinking and problem solving.

Social cognitive theory (Bandura, 1986), social cognitive career theory (Lent et al., 1994), and the social identity theory (Tajfel & Turner, 1979) took prominence over other existing theoretical frameworks for understanding the underrepresentation of women in STEM. Empirical evidence suggests that these theoretical frameworks provide evidence that supports reasoning for the lack of women pursuing STEM disciplines and leadership roles. For this reason, these three theoretical frameworks were used to guide the research questions in this study. One common theme of these theoretical frameworks is the idea of self-efficacy. A positive self-efficacy proves essential for social, academic, and career decision making processes in STEM (Else-Quest et al., 2013; Godwin et al. 2016; Godwin & Potvin, 2015; Wang et al., 2017). Additionally, identifying with a group, such as STEM, is important for being successful in that particular group. The SCT (Bandura, 1986), SCCT (Lent et al., 1994), and the SIT Tajfel & Turner, 1979) help in understanding the importance of social belonging and positive self-efficacy in STEM to recruit and maintain the number of women in the field.
In addition to positive self-efficacy, women also need support systems, role models, and mentors to be successful in STEM fields. The review of literature revealed the importance of positive relationships for women to choose STEM disciplines and for the retention of women in STEM (Dennehy & Dasgupta, 2017; Wang, 2012, Zawistowska, 2017). Providing experiences for women to interact with other women in STEM helps create the necessary support system (Wang, 2012). Mentoring and training programs have been successful at maintaining women in STEM (Dennehy & Dasgupta, 2017; Wang et al., 2013) as well as developing and encouraging leadership aspirations (Crisp & Alvarado-Young, 2018; Lin et al., 2016; O’Bannon et al., 2010).

A positive self-efficacy (Doubell & Struwig, 2016) and honesty (Day et al., 2016) make up descriptors for successful leaders. Acceptance of cultural diversity also represents an important indicator for a successful leader (Lisak & Erez, 2015; Riutta & Teodorescu, 2014). Women leaders commonly exhibit qualities of assertiveness as well as having a strong internal locus of control (Doubell & Struwig, 2016). Successful women are often described as being determined and adaptable to accommodate any situation’s needs. Oftentimes, women demonstrate qualities associated with a transformational leadership style (Bass & Avolio, 1996; Day et al., 2016; Hernandez Bark et al., 2016; Şahin et al., 2017).

It was evident in the literature review that removing the gender stereotype threat for women in STEM makes up a critical component of encouraging more women to pursue the discipline. Establishing support systems in the educational setting during childhood helps establish a positive self-concept (Else-Quest et al., 2013; Hand et al., 2017). Removing barriers, such as gender discrimination and stereotypes, appears
possible through mentorship and support systems as well as bringing awareness of these barriers to society (Grossman & Porche, 2014; Lawson et al., 2018; Stearns et al., 2016). Supportive efforts such as developing mentoring programs and training programs provide encouragement and a positive self-efficacy for women to be successful in STEM disciplines and leadership roles (Dennehy & Dasgupta, 2017; Lawson et al., 2018; Ramsey et al., 2013).
CHAPTER III

METHODOLOGY

3.1 Introduction

The researcher for this study utilized a participatory action research model to frame a mixed methods study. The focus of the study was to understand leadership interests and aspirations of female students pursuing STEM undergraduate and graduate degrees for future STEM leadership positions. Knowledge gained from the literature review helped link leadership aspirations to the following: social and external barriers the students perceived as helping or hindering their chances of becoming a leader, self-efficacy, past STEM experiences, and professional support (i.e., role models, peers and/or mentors). The purpose of this study was to gain a better understanding regarding leadership aspirations of female students enrolled in STEM disciplines by understanding perceived STEM self-efficacy and influential experiences, barriers, professional support, and lack of support which then influence their decision-making process toward filling leadership positions in their field.

Along with investigating leadership aspirations, perceived STEM self-efficacy, and barriers viewed as obstacles for female STEM discipline students, the researcher sought to gain insight into the role of mentoring and role models for students pursuing STEM leadership positions. Role models are considered influential persons in the
students’ lives who have interacted with these students and who are not necessarily public figures. Role models include, but are not limited to, parents and teachers involved in STEM. Interactions with role models and mentors in addition to other experiences that shape students’ desires to lead in their field were also of interest to the researcher.

For this mixed methods design, quantitative and qualitative data were collected using an online survey instrument (Appendix A). The survey included questions about leadership aspirations, potential barriers hindering future leadership opportunities, and past experiences with role models and mentors. Qualitative data were collected using open-ended questions that requested participants to discuss specific experiences involving role model, mentor, and peer relationships that encouraged or hindered their leadership aspirations. The replies to the open-ended questions provided support for the quantitative responses with regard to specific experiences that influenced leadership aspirations. This chapter presents the research questions and an overview of the research design, setting, participants, instruments, quantitative data, qualitative data, procedure, and data analysis.

### 3.2 Research questions

Prior to dissertation study, the researcher conducted a pilot study the spring of 2018. The pilot study allowed the researcher to determine necessary modifications for the study. The pilot study details, results, and improvements to be made to the dissertation study are identified and discussed in Appendix B. After the pilot study, the researcher modified and strengthened the research questions to current form. The
questions that the researcher developed were answered through an integrated quantitative and qualitative data analysis, as follows:

1. Do female students seeking STEM degrees aspire towards leadership roles in the discipline?
   A. What is the motivation for female students in STEM degree programs to seek leadership roles in the discipline?

2. Do female students feel supported in their STEM leadership interest?

3. Is there a correlation between female STEM student experiences and STEM leadership aspirations?
   A. Is there a correlation between female STEM students’ self-efficacy and STEM leadership aspirations?
   B. Is there a correlation between female STEM students’ support and STEM leadership aspirations?
   C. Is there a correlation between female STEM students’ barriers and STEM leadership aspirations?

3.3 Research design

The researcher utilized a participatory action research (PAR) model. PAR is often used by scholars who are interested in change in the community with the purpose of achieving social justice for underrepresented groups or individuals (Lake & Wendland, 2018). Lake & Wendland (2018) defined PAR as “the attempt to collaboratively generate knowledge (i.e., as a participatory process) for the purpose of both using that knowledge (i.e., acting upon it) and sharing potentially valuable lessons with others (i.e.,
disseminating the findings)” (p. 12). PAR addresses the challenges for those in disadvantaged positions such as the subject of this research involving women in STEM leadership positions.

A mixed methods parallel design was utilized to collect and analyze data for answering the research questions. As explained by Creswell et al. (2003), a mixed methods research design “involves the integration of the data at one or more stages in the process of research” (p. 165). By integrating both quantitative and qualitative data in this mixed methods research study, the researcher gained a comprehensive understanding for the study’s findings (Mulisa, 2021). The researcher merged quantitative and qualitative data by comparison and consensus of qualitative themes with quantitative results. The study was primarily quantitative with qualitative support of quantitative findings. The quantitative portion of this study used a cross-sectional, descriptive, and correlational design. The quantitative and qualitative data were distributed on one survey which included questions answered on a 6-point scaled instrument and open-ended questions. Barriers, support, and self-efficacy make up the independent variables for this study. Leadership aspiration serves as the dependent variable as it is the measured outcome the researcher is interested in determining from the independent variables.

### 3.3.1 Setting

The researcher selected participants from a public university in a southern state. The university has a student population of approximately 15,000, and of those students, 9,050 are undergraduates (U.S. Department of Education, NCES, n.d.). At the time the study was conducted, the percentage of female students enrolled at the university was 60.8%, and the percentage of male students was 39.2% (U.S. Department of Education,
Minority students made up 39.9% of the student population and the student to faculty ratio was 17 students to 1 faculty member (U.S. Department of Education, NCES, n.d.). The university offers all levels of degrees including bachelors, master’s and doctoral degrees as well as post-baccalaureate certificates. The following are undergraduate and graduate STEM majors of interest offered by the university at which the research was conducted: chemical engineering, chemistry, civil engineering, computer engineering, computer science, electrical engineering, geography, geology, information systems, information technology, mathematics-statistics, mechanical engineering, meteorology, and physics. Additionally, the university offers graduate programs in Information Systems-CIS and Systems Engineering.

For Spring 2021, the percentage of female undergraduate students with a declared STEM major in the College of Arts and Sciences (including biology, chemistry, geographic information systems, geography, geology, marine conservation, marine science, mathematics-statistics, meteorology, physics, and psychology majors) was 67.59% (Anonymous, 2021). For Spring 2021, the percentage of female undergraduate students with a declared STEM major in the School of Computing (including computer science, information systems, and information technology majors) was 18.27% (Anonymous, 2021). For Spring 2021, the percentage of female undergraduate students with a declared STEM major in the College of Engineering (including chemical, civil, computer, electrical, and mechanical engineering majors) was 18.20%. For Spring 2021, the percentage of female graduate students in the College of Arts and Sciences was 59.96%, for the College of Allied Health was 87.50%, for the College of Engineering was 22.83%, and for the School of Computing was 35.95% (Anonymous, 2021). See Table 1.
for the research setting student population statistics for the majors listed for each college as previously mentioned.

Table 1. Research Setting STEM Student Population within Different Colleges

<table>
<thead>
<tr>
<th>College</th>
<th>Percent Female</th>
<th>Percent Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>College of Allied Health</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undergraduate</td>
<td>75.04%</td>
<td>24.80%</td>
</tr>
<tr>
<td>Graduate</td>
<td>87.50%</td>
<td>12.50%</td>
</tr>
<tr>
<td>College of Arts and Science</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undergraduate</td>
<td>67.59%</td>
<td>32.4%</td>
</tr>
<tr>
<td>Graduate</td>
<td>59.96%</td>
<td>43.04%</td>
</tr>
<tr>
<td>College of Engineering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undergraduate</td>
<td>21.70%</td>
<td>77.96%</td>
</tr>
<tr>
<td>Graduate</td>
<td>22.83%</td>
<td>77.17%</td>
</tr>
<tr>
<td>School of Computing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undergraduate</td>
<td>18.22%</td>
<td>81.78%</td>
</tr>
<tr>
<td>Graduate</td>
<td>35.95%</td>
<td>64.05%</td>
</tr>
</tbody>
</table>

3.4 Study participants

The sample of students used for this study consisted of a convenience sample of students from the institution at which the researcher is employed. Participants included undergraduate and graduate female students with a declared STEM major. The researcher encouraged participation in the study via various forms of contact. The forms of research participation outreach included emailing colleagues in the researcher’s department with an Institutional Review Board (IRB) approved email to distribute to current students with an invitation to voluntarily participate, sending the researcher’s previously enrolled and currently enrolled students an IRB approved email with an invitation to voluntarily participate, sending an IRB approved email to the researcher’s department’s female
student majors with an invitation to voluntarily participate, and advertising twice in the researcher’s home institution’s mass email system (see Appendix C). The researcher will reference the “research site” as a pseudonym associated with the institution. Individual participants names were not gathered and therefore will not be stated when reporting the results of the study to ensure anonymity.

There were 140 surveys submitted with complete and partial responses. Incomplete responses were not considered in the analysis, so the total sample size included 76 participants. See Table 2 for detailed information about the quantitative participant demographics. Data were collected from participants 18 years of age or older. This participation age requirement prevented the need for parental consent as would typically be required by IRB. Additionally, appropriate research protocols were instituted when working with this population which include informed consent and IRB approval (see Appendices D and E).
Table 2. Women in STEM Research Participant Demographics for Quantitative Data

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Percentage of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>100%</td>
</tr>
<tr>
<td>Age (Years)</td>
<td></td>
</tr>
<tr>
<td>18-22</td>
<td>86%</td>
</tr>
<tr>
<td>23-27</td>
<td>9%</td>
</tr>
<tr>
<td>Over 27 years</td>
<td>5%</td>
</tr>
<tr>
<td>Major</td>
<td></td>
</tr>
<tr>
<td>Biochemistry</td>
<td>&lt; 2%</td>
</tr>
<tr>
<td>Biology</td>
<td>21%</td>
</tr>
<tr>
<td>Biomedical Sciences</td>
<td>20%</td>
</tr>
<tr>
<td>Brain and Behavioral Sciences</td>
<td>&lt; 2%</td>
</tr>
<tr>
<td>Chemistry</td>
<td>9%</td>
</tr>
<tr>
<td>Communication Sciences and Disorders</td>
<td>&lt; 2%</td>
</tr>
<tr>
<td>Computer Science</td>
<td>7%</td>
</tr>
<tr>
<td>Engineering</td>
<td>21%</td>
</tr>
<tr>
<td>Exercise Science</td>
<td>4%</td>
</tr>
<tr>
<td>Geography</td>
<td>&lt; 2%</td>
</tr>
<tr>
<td>Healthcare Sciences</td>
<td>3%</td>
</tr>
<tr>
<td>Information Technology</td>
<td>3%</td>
</tr>
<tr>
<td>Marine Science</td>
<td>&lt; 2%</td>
</tr>
<tr>
<td>Mathematics</td>
<td>3%</td>
</tr>
<tr>
<td>Meteorology</td>
<td>3%</td>
</tr>
<tr>
<td>Psychology</td>
<td>4%</td>
</tr>
<tr>
<td>Other</td>
<td>3%</td>
</tr>
<tr>
<td>Official School Year</td>
<td></td>
</tr>
<tr>
<td>Freshman</td>
<td>8%</td>
</tr>
<tr>
<td>Sophomore</td>
<td>20%</td>
</tr>
<tr>
<td>Junior</td>
<td>33%</td>
</tr>
<tr>
<td>Senior</td>
<td>27%</td>
</tr>
<tr>
<td>Graduate</td>
<td>12%</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>8%</td>
</tr>
<tr>
<td>Asian-Eastern</td>
<td>8%</td>
</tr>
<tr>
<td>Asian-Indian</td>
<td>&lt; 2%</td>
</tr>
<tr>
<td>Hispanic</td>
<td>7%</td>
</tr>
<tr>
<td>Middle Eastern</td>
<td>&lt; 2%</td>
</tr>
<tr>
<td>Native American &amp; White/Caucasian</td>
<td>&lt; 2%</td>
</tr>
<tr>
<td>White/Caucasian</td>
<td>60%</td>
</tr>
<tr>
<td>Prefer Not to Answer</td>
<td>&lt; 3%</td>
</tr>
<tr>
<td>Other</td>
<td>4%</td>
</tr>
</tbody>
</table>
It is important to note that participants in this study were anticipated to be traditional students. Traditional students are considered to be students enrolled as full-time college students directly after high school graduation. Therefore, this student population may not yet have experienced employment opportunities in STEM careers. These students are likely still developing their career intentions, including the pursuit of leadership positions.

### 3.5 Instrumentation

The survey instrument used in this study consisted of a questionnaire with 19 questions scored on a 6-point scale, five open-ended questions, and six demographic questions (See Appendix A). The quantitative questions were modified from the instrument developed by Gaus (2011) titled “Women in School Leadership” questionnaire (see Appendix F). Details about the original survey and alteration of the instrument are discussed in the following section. The original author of the survey granted permission to the researcher to use and/or adapt the survey (see Appendix G). The structure of the questionnaire has remained the same; therefore, validity and reliability remain unchanged. The original questionnaire was validated using quantitative methodology (Gaus, 2011).

Before completing the electronic survey, students were asked to verify that they were 18 years of age or older. For students who responded that they were less than 18 years of age, the survey thanked the participants for their time and ended. For participants who met the age requirement, their demographic information, education year, and
declared majors were requested at the end of the survey after the qualitative portion of the questionnaire.

### 3.5.1 Quantitative data

The quantitative portion of the questionnaire derived from a questionnaire first implemented in Makassar, Indonesia, to study factors that deter female educators from pursuing principal and superintendent leadership positions (Gaus, 2011). Because the original survey was created to answer questions about holding a leadership position as a school principal or superintendent, alterations were needed to fit the current research (Gaus, 2011). The alterations to the questionnaire included the modification of wording to reflect future STEM leadership positions instead of school principal or superintendent leadership positions. The original questions created were validated using a structured quantitative data analysis method (Gaus, 2011); however, when the researcher requested specific reliability and validity scores for the original instrument, Gaus responded that she no longer had the scores (see Appendix H). All responses for the quantitative questions were recorded on a 6-point scale ranging from 1 (strongly disagree) to 6 (strongly agree). The quantitative portion of the questionnaire included questions concerning participants’ aspirations of becoming a leader in STEM, the influence of professional development opportunities in developing the hope of becoming a leader, and social and external barriers that pose potential threats to becoming a successful leader in STEM. See Table 3 for corresponding research questions to each item number on the survey.
Table 3. Links Between Research Questions and Questionnaire for Women in STEM

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Item Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Do female students seeking STEM degrees aspire towards leadership roles in the discipline?</td>
<td>1, 2, 20</td>
</tr>
<tr>
<td>A. What is the motivation for female students in STEM degree programs to seek leadership roles in the discipline?</td>
<td>20</td>
</tr>
<tr>
<td>2. Do female students feel supported in their STEM leadership interest?</td>
<td>22</td>
</tr>
<tr>
<td>3. Is there a correlation between female STEM student experiences and STEM leadership aspirations?</td>
<td>23, 24</td>
</tr>
<tr>
<td>A. Is there a correlation between female STEM students’ self-efficacy and STEM leadership aspirations?</td>
<td>1, 2, 21</td>
</tr>
<tr>
<td>B. Is there a correlation between female STEM students’ support and STEM leadership aspirations?</td>
<td>5-8, 18, 19, 21</td>
</tr>
<tr>
<td>C. Is there a correlation between female STEM students’ barriers and STEM leadership aspirations?</td>
<td>5-8, 21</td>
</tr>
</tbody>
</table>

3.5.2 Qualitative data

The qualitative portion of the questionnaire included four open-ended questions at the end of the scaled questions. The researcher created the four open-ended questions which were not part of Gaus’ (2011) original survey questions. These questions can be found in Appendix A at the end of the survey.

The qualitative questions were informed by the researcher’s literature review. The qualitative portion of the questionnaire includes open-ended questions to reflect a phenomenological approach. In 1999, Welman and Kruger suggested that phenomenology is “concern with understanding social and psychological phenomena
from the perspectives of people involved” (p. 189). As such, the qualitative portion of this study focused on student experiences and why they have or have not decided to pursue leadership positions. The open-ended questions were designed to have the participant to report on STEM self-efficacy and experiences, including those with role models and mentors, which have shaped their desire/pursuit, or lack thereof, for leadership positions in future STEM careers. Reported experiences were also analyzed for potential barriers that have hindered participants’ STEM leadership aspirations.

3.6 Procedures

After receiving approval by the University’s Institutional Review Board (see Appendix E) students were informed of the questionnaire by several means. One form of contact included an announcement in the university daily newsletter which is emailed to all student email accounts. Additionally, the researcher solicited participation in the study by directly emailing female students enrolled in introductory calculus-based and trigonometry-based physics I and II courses at the time the survey was conducted as well as female students enrolled in these same courses three years prior to the survey distribution. The researcher also emailed other STEM faculty requesting they encourage students to participate in the study. The faculty were asked to iterate participants were allowed to take the survey one time. Participants were given the option to be included in a drawing for a $25 Amazon gift card. If the participants selected that they wanted to be included in the drawing, then the participants were directed to a new, one-question survey that was not linked to original questionnaire responses to provide contact information (a valid email address). There were no duplicate email addresses provided by participants.
It is important to note that the researcher and fellow colleagues advertised the questionnaire to current students; however, it was stressed in the email that the main questionnaire responses were anonymous and participation was voluntary. Voluntary participation was reemphasized in the consent form at the beginning of the questionnaire to reassure the students that they were not required to participate for class records. After the responses were collected and email addresses voluntarily provided if desired for the gift card drawing, the researcher did not review the addresses for student names or affiliations.

The researcher teaches students enrolled in undergraduate physics laboratories, including Algebra/Trigonometry-based and Calculus-based Physics I and II laboratory courses. This data collection method included female participants from female students in pre-medical majors and other non-STEM majors; however, data were only analyzed for female students declaring a STEM major or pursuing a STEM undergraduate or graduate degree. STEM majors were considered to be the majors stated in the research design of this chapter. There were no male respondents in the data collection.

The researcher met confidentiality protocol for the protection of human subjects. Confidentiality can be defined as the “treatment of information that an individual has disclosed in a relationship of trust and with the expectation that it will not be divulged to others without permission in ways that are inconsistent with the understanding of the original disclosure” (University of California Irvine Office of Research, 2021, para. 8). Data were collected using Qualtrics survey software and survey responses were stored within Qualtrics in a password protected electronic format. The survey utilized Qualtrics Anonymize Response setting so that there was no record of any personal information, and
all contact association was removed from the original survey responses. With this method, no identifying information including IP address or location data were collected. The questionnaires were open and available to participants for a two-week period. After the two-week period, the researcher closed the survey.

After qualitative data were collected, the extent to which results are plausible, credible, consistent, and trustworthy was determined though verification strategies. These strategies included ensuring coherence between the research question and components of the method, utilizing an appropriate sample, collecting and analyzing data concurrently, thinking theoretically, and moving from a micro perspective of the data to a macro conceptual/theoretical understanding (Morse et al., 2002).

### 3.7 Data analysis

**Quantitative.** Data gathered via Qualtrics were imported to the IBM Statistical Package for the Social Sciences (SPSS) Statistics (2015, v. X), and analyzed based on the response to each individual question of the questionnaire. The researcher first determined the characteristics of the distribution of scores by calculating the mean, median, mode, range, and standard deviations of the raw data.

A bivariate correlation analysis on three variables was conducted to test the predictive qualities of female students who aspire to become a leader in STEM. For this type of analysis, independent and dependent variables were established. With established independent and dependent variables, the researcher determined the strength between the variables and the predictive power of the independent variables on the dependent variable (Urdan, 2017). The independent variables consisted of barriers, support, and self-
efficacy. The dependent variable was leadership aspiration. The variable names were determined to align with the terminology commonly found in the researcher’s literature review. In addition to the correlation analysis, descriptive statistics were also obtained for the variables.

**Qualitative.** The data from the open-ended portion of the survey, collected in Qualtrics was imported to a Microsoft Word document, organized by responses for each question then analyzed using a manual coding process. Coding qualitative data typically uses a word or short phrase that accurately depicts the essence of the language-based or visual data (Saldaña, 2013). The descriptive coding method was used by the researcher. Descriptive coding is also known as “topic coding” because it is a coding process that assigns a word or short phrases to a topic of a passage of qualitative data (Saldaña, 2013, p. 88). Tesch (1990) states that “it is important that these [codes] are identifications of the topic, not abbreviations of the content. The topic is what is talked or written about. The content is the substance of the message” (p. 119). In addition to establishing coding themes for response topics, direct quotations from the participant responses were used to provide a descriptive understanding of the data in support of proper interpretation. The codes and their frequencies were used to analyze and interpret with the intention to better understand young, aspiring female leaders in STEM. The analyses of both quantitative and qualitative data were integrated to further understand the research questions.

**3.8 Summary**

The purpose of this study was to gain a better understanding regarding leadership aspirations of female students enrolled in STEM disciplines by understanding perceived
STEM self-efficacy and influential experiences, barriers, professional support, and/or lack of support leading to their decision-making process toward leadership in their field. The researcher distributed questionnaires to students at the researcher’s home institution. Qualtrics software was utilized to distribute the survey and assisted in analyzing the data. SPSS software was incorporated for further statistical analysis of the data. The researcher was part of the research setting; however, the researcher took measures to remain objective in the analysis and interpretation of the data collected. Improvements upon the pilot study included incorporating open-ended questions at the end of the questionnaire to be analyzed qualitatively, transitioning the paper questionnaire to an electronic form, using Qualtrics software to distribute to the participants, increasing the sample size for the study, and only analyzing results from female participants. This study was conducted as a dissertation in practice and the results of this study are intended to be used for encouraging, improving and promoting gender equality in STEM leadership.
CHAPTER IV

PRESENTATION OF DATA

4.1 Introduction

In this chapter, information regarding the quality of data and an analysis of the quantitative and qualitative data is provided. The quantitative data analysis included a bivariate correlation analysis and descriptive statistics for the established variables of barriers, support, and self-efficacy as they contribute to STEM leadership aspirations. The qualitative data analysis used descriptive coding method to establish themes provided by the participants in the open-ended responses on the survey. In all, this chapter presents the missing data, reliability, normality, and the integrated quantitative and qualitative analysis from the data acquired from the survey instrument.

4.2 Missing data

A total of 140 participants responded to the survey. Thirty-one respondents agreed to consent and verified their age, but did not complete the remainder of the questions, and thus, were not considered in the dataset. Twenty-four students did not answer gender or major questions at the end of the survey; therefore, could not be considered for interpretation. When asked about their gender, one respondent indicated “non-binary” and one other indicated “prefer not to answer.” These two participants were removed
from the data set due to the subject of the study being women in STEM. Six respondents did not meet the major requirement as they declared a medicine, nursing, international studies or physician assistant major, and, therefore, were not considered in the dataset. There was one false data entry that was not considered in the data set. In total, 64 participants were removed, and 76 participants were retained for analysis.

The researcher reviewed participant responses considered for the quantitative analysis portion of the survey to determine the overall percentage of missing data. For the 19 items considered for quantitative analysis, there were two questions unanswered by two different participants. For overall item responses, 0.14% of data was missing. The researcher retained the responses from the two participants considering the low overall percentage of missing data.

4.3 Reliability

The researcher utilized internal consistency reliability for the quantitative data in this study. Internal consistency reliability is used when several items on the same survey are consistent with the same topic (e.g., barriers, leadership aspiration, support, self-efficacy). The interrelationship of the items for the same topic allows researchers to understand if the items on the survey are truly representative of the established topic (Henson, 2001). A higher correlation assumes that the topic of interest has been consistently measured, meaning that the scores are reliable (Henson, 2001).

A Cronbach alpha reliability greater than .700 is considered acceptable reliability (Urdan, 2017). An exploratory factor analysis (EFA) was conducted on the data.
considered for each of the four variables. The defined four variables were leadership aspiration, support, barriers, and self-efficacy.

Originally, nine items (questions 9-17) from the survey were considered for analysis of the barriers variable. After conducting an EFA, one of the items was removed from the barriers analysis because the item pertained to awareness of barriers instead of the actual impact of the barrier on leadership aspiration which is the interest of the research study. The Cronbach alpha reliability supported this removal. An EFA was conducted on the remaining eight items (questions 10-17) considered for measuring barriers. After a visual inspection of the scree plot, two factors were suggested for the barrier measure. The researcher reviewed the questions and clearly distinguished the two-factor solution. The two factors were determined to be personal/family barriers and cultural barriers. The internal consistency reliability for the four items in the personal/family barrier factor was acceptable with a Cronbach alpha reliability of $\alpha = .813$ (Urdan, 2017). The internal consistency reliability for the four items in the cultural barrier factor was also acceptable with a Cronbach alpha reliability of $\alpha = .811$ (Urdan, 2017). The internal consistency reliability for all eight items considered in the barriers variables was acceptable with a Cronbach alpha reliability of $\alpha = .747$ (Urdan, 2017).

A total of five items (questions 5, 6, 8, 18, and 19) were considered for analysis of the support variable. Questions 18 and 19 were reverse coded due to the nature of the wording in the questions. An EFA was conducted on the five items considered for measuring support. After a visual inspection of the scree plot, two factors were suggested for the support measure. The researcher reviewed the questions and clearly distinguished the two-factor solution. The two factors were determined to be access to support and
desire for support. The internal consistency reliability for the three items in the access to support factor was acceptable with a Cronbach alpha reliability of $\alpha = .840$ (Urdan, 2017). The internal consistency reliability for the two items in the desire for support factor was below acceptable with a Cronbach alpha reliability of $\alpha = .518$ (Urdan, 2017). The internal consistency reliability for all five items considered in the support variable was just below acceptable with a Cronbach alpha reliability of $\alpha = .694$ (Urdan, 2017).

One item (question 21) was considered for the self-efficacy variable. The one item was a sliding scale question where participants answered by rating their response from 0-100 by dragging a sliding bar and stopping on their best answer. Originally, there were two items (questions 3 and 21) that measured self-efficacy; however, one item was discarded. There is no Cronbach alpha for this variable since there was one item scored.

Two items (questions 1 and 2) were considered for analysis of the leadership aspirations variable. An EFA was conducted on the two items considered for measuring leadership aspirations. After a visual inspection of the scree plot, one factor was suggested for the leadership aspirations measure. The internal consistency reliability for the two items in the leadership aspirations was below acceptable with a Cronbach alpha reliability of $\alpha = .646$ (Urdan, 2017).

### 4.4 Normality

Univariate normality was tested for variables representing total barriers, cultural barrier, personal/family barrier, total support, access to support, desire for support, self-efficacy, and leadership aspirations. The distribution of scores for all eight variables
showed no substantial deviation from normality; however, skewness is discussed when appropriate to research question responses in the following section.

4.5 Quantitative data analysis

The following section provides the analytical findings for the research questions answered by quantitative analysis. Data corresponding to each research question are presented in sequential order. A discussion of results and findings will be presented in the following chapter.

4.5.1 Research question 3

Research question 3A asked, “Is there relationship between female STEM students’ self-efficacy and STEM leadership aspirations?” A bivariate correlation analysis revealed a statistically significant moderate correlation between the self-efficacy and total aspirations measures. The correlation coefficients are presented in Table 4. The correlation between the two variables was $r = .566$ ($p < .01$). The coefficient of determination ($r^2 = .320$) indicates that there is a moderate effect size in the relationship between the self-efficacy and total aspirations measures. This finding suggests that as STEM students’ report of self-efficacy rises so does their report of aspirations to leadership roles.

Research question 3B asked, “Is there a correlation between female STEM students’ support and STEM leadership aspirations?” Likewise, for question 5B, a bivariate correlation analysis revealed a statistically significant moderate positive correlation between the total support and total aspirations measures. The correlation coefficients are presented in Table 4. The correlation between the two variables was $r =$
.574 (p < .01). The coefficient of determination ($r^2 = .327$) indicates that there is a moderate effect size in the relationship between the total support and total aspirations measures. This finding suggests that as STEM students’ report of receiving support rises so does their report of their own aspirations towards leadership roles.

Research question 3C asked, “Is there a correlation between female STEM students’ barriers and STEM leadership aspirations?” A bivariate correlation analysis revealed no statistically significant correlation between the total barriers and total aspirations measures. The total barriers variable was constructed by both personal/family barriers and cultural barriers variables from study participants. The correlation coefficients are presented in Table 4. The correlation between the two variables was $r = - .155$ (p = .181) and was not statistically significant.

Table 4. SPSS Correlation Analysis

<table>
<thead>
<tr>
<th></th>
<th>Total Aspiration</th>
<th>Total Support</th>
<th>Self-Efficacy</th>
<th>Total Barriers</th>
<th>Mean (SD)</th>
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<tbody>
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<td>Total Aspiration</td>
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<tr>
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<td>1.00</td>
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<tr>
<td>Total Barriers</td>
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<td>-.350**</td>
<td>-.233</td>
<td>1.00</td>
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<td>(.881)</td>
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</tbody>
</table>

Note. IBM Statistical Package for the Social Sciences (SPSS)

** p < .01
4.6 Qualitative data analysis

The following section provides the findings for the research questions answered by qualitative analysis. The open-ended questions answered at the end of the questionnaire were coded for themes and direct quotes from the participants were provided to support themes found in the responses. The research questions with their supporting data are presented in sequential order. A discussion of results and findings will be presented in the following chapter.

4.6.1 Research question 1

Research question 1 asked “Do female students seeking STEM degrees aspire towards leadership roles in the discipline?” An overwhelming majority of participants shared that they do aspire to become a leader in STEM. Very few participants clearly stated that they do not aspire to become a leader in STEM due to the lack of general interest in being a leader. The second most common response was that participants were unsure about their leadership aspirations. Participants’ reasons for their hesitancy included “lack of confidence,” “a lot of pressure,” and “typical expectations and time commitments that make having a family hard.”

Research question 1A asked, “What is the motivation for female students in STEM degree programs to seek leadership roles in the discipline?” Survey question number 20 included “Please explain why you would or would not like to hold a leadership position in the STEM workforce.” The coding process revealed the themes addressing this question to be “Promote Gender Equality” “Community Impact” and “Future Role Model.”
The theme of “Promote Gender Equality” was the most frequently stated reason for seeking future leadership roles in their disciplines. Participants acknowledged the lack of women in STEM leadership and their desire to increase the female representation in STEM leadership. One participant stated that she is, “aware of the lack of female representation but wants to actively find ways to change that,” and another participant stated she desired to “break the stigma of women not being able to do certain things.” Several participants expressed the need for more women in STEM leadership roles. One participant shared that, “women’s voices are not heard in the STEM field. By having more female STEM leaders, we can ensure that the female population of STEM is heard.”

The second theme that emerged was “Community Impact.” One participant stated that a leadership role in STEM would allow her to “positively impact people and contribute to society.” A couple of participants stated that they would be able to make a “positive impact” or “make a difference” in the community. Another participant stated that she wanted to “share her hardships” with those who shared similar struggles as her so that they can learn from each other.

The third theme and final theme that surfaced was the desire to become a “Future Role Model.” Several participants explicitly stated their desire to be a “role model” or mentor” to the future generation. One participant stated she wanted to “serve as an example and role model.” Another participant shared that she "enjoys teaching others and making things better for them” while another expressed her interest in “being a part of mentoring the younger generation.”

4.6.2 Research question 2

Research question 2 asked, “Do female students feel supported in their STEM
leadership interest? This question was addressed in the quantitative portion of the results but is also supported by qualitative responses from Question 22 on the survey. The majority of respondents stated “yes” to feeling supported in their STEM leadership interest with 34 “yes” responses and 17 “No” responses. The coding process revealed themes that many students who desired a leadership role in STEM felt supported by “Parents,” “Teachers,” and “Role Models.” The theme of “Parents” was the most frequently stated form of support stated by the participants. Participants reported being “encouraged,” “supported,” and “pushed” by their parents to pursue a STEM leadership position. Other participants reported having parents in the STEM field which influenced their interest in pursuing a leadership position in STEM.

The second theme that emerged was “Teachers.” A majority of the participants who mentioned “teachers” also described them as “mentors” in their statements. Some of the participants specifically stated the discipline of the teacher that influenced their interest in pursuing a leadership position in STEM. Some of the teachers mentioned were high school chemistry teachers, a biology professor, and female STEM professors in general. One participant stated that, “seeing how passionate my female STEM professors are with the field they are in makes me inspired.” Another participant included that her instructor discussed “how to break barriers for yourself” and created a “very welcoming and safe place for uncomfortable but important discussions.”

The third theme that surfaced was “Role Models.” Several of the participants mentioned that there were “role models” that influenced their interest in STEM leadership. The overwhelming majority of participants who stated, “role models” influenced their decision generically claimed, “other women in STEM” or “no one
particular person.” However, one participant specifically stated political leader Alexandria Ocasio-Cortez having inspired her as she is “unapologetically outspoken and confident with her prominent leadership role.”

4.6.3 Research question 3

Research question 3 asked, “Is there a correlation between female STEM student experiences and STEM leadership aspirations?” This question was supported by the qualitative responses from Questions 23 and 24 on the survey. The coding process revealed themes of “Mentorship,” “Disciplinary Interaction,” and “Gender Stereotyping.” Experiences positively influencing STEM leadership aspirations were associated with “Mentorship,” and “Disciplinary Interaction.” Experiences negatively influencing STEM leadership aspirations were associated with “Gender Stereotyping.” The most common theme was “Discipline Interaction” which includes participant responses for shadowing, attending conferences and attending guest lectures. One participant recalled listening to a woman in STEM speaker who inspired from her life story of “hardships” that got her where she is today. Another participant recalled her “desire to become a leader in STEM happened at a conference where she saw others doing what [she] wanted to do.”

The second theme that emerged was “Mentorship.” Participants stated teachers from high school supported their decision in pursuing a STEM leadership position. One student stated that her teacher “saw potential” in her during her participation on the high school robotics team. Other mentors were stated to have “inspired” the participants in their classrooms. One participant stated that one professor “showed me her work and I was in awe of it and fell in love with the field.”
The third theme that surfaced negatively was “Gender Stereotyping.” One participant stated that she would “not be considered as an equal on a team because it is assumed from my gender that I know less and cannot contribute nearly as much.” Additionally, another participant reported “being rejected from superiors because of the way [she] looks.” One participant described events that specifically happened to her as a college engineering student. She stated that “it was common for my engineering assignments to be stolen and trashed by the male students in my class. Although I always kept the top score in the class, I was not treated the same way as my male peers in any of my STEM classes…Anything I experienced negatively…I use to drive myself.”

4.7 Summary

This chapter presented the reliability, normality, and validity of the data in addition to the quantitative and qualitative findings associated with the research questions. The quantitative portion of the study indicated that the majority of participants aspire to become a leader in their STEM field. The qualitative portion of the study revealed themes associated with their experiences that positively and negatively influenced their decision to pursue a STEM leadership position. Those themes were determined to be “Parents,” “Teachers,” “Role Models,” “Mentorship,” “Disciplinary Interaction,” and “Gender Stereotyping.” Additionally, the qualitative portion of the study revealed themes associated with STEM leadership aspiration which included “Promote Gender Equality” “Community Impact” and “Future Role Model.” Further discussion and limitations of the results will be discussed in Chapter V.
CHAPTER V

CONCLUSIONS

5.1 Introduction

This chapter presents further discussion of the findings stated in Chapter IV and conclusions association with each research question in the study. The discussion integrates the literature review presented in Chapter II as it pertains to the study findings. Additionally, this chapter addresses the limitations presented in the study and recommendations for future research.

5.2 Discussion and conclusions

The purpose of this study was to gain a better understanding of leadership aspirations in female students enrolled in STEM disciplines by investigating perceived STEM self-efficacy and understanding influential experiences, barriers and support. Lack of support, support systems, and awareness of support programs were also explored through the study. Additionally, the study aimed to identify student experiences that shaped a desire to pursue a STEM leadership position. The research findings also provided insight into the motivation behind female students in STEM seeking leadership roles in their discipline. In the following sections of this chapter, the researcher presents the findings for this mixed methods research design. The researcher discusses the results
as they directly relate to the research questions for this study. The quantitative data provided insight to overall leadership aspirations and influential factors, while the qualitative data provided support and specific experiences, support systems, and motivational factors that shaped participant self-efficacy and leadership aspirations.

5.2.1 Leadership aspirations

Research question 1 asked “Do female students seeking STEM degrees aspire towards leadership roles in the discipline?” Items on the survey to answer this question considered participants who have plans to pursue leadership positions in the future and participants currently pursuing leadership positions. Overall, the research study revealed that very few participants lacked a general interest in becoming a leader in STEM disciplines. The vast majority of participants indicated having future plans to pursue a leadership position and, although still a majority, there were slightly fewer participants who indicated that they are currently pursuing a leadership position in STEM. The qualitative portion of the survey supported the quantitative results as the majority of participants stated having STEM leadership aspirations. Very few participants stated that they lacked general interest in becoming STEM leaders. The findings agree with research by Fritz and Knippenberg (2016) who found that gender roles are not a positively significant predictor of leadership aspiration. According to Gregor and O’Brien (2016), the findings also suggest that the participants are focused on their careers, competitive, and are inclined to continue learning within their field.

5.2.2 Leadership aspirations and motivation

Research question 1A asked, “What is the motivation for female students in STEM degree programs to seek leadership roles in the discipline?” Common themes for
motivation were “Promote Gender Equality,” “Community Impact” and “Future Role Model” with “Promote Gender Equality” being the most common response. These results align with research findings that women desire communal goals for their work life (Diekman et al., 2017; Diekman et al., 2015; Steinberg & Diekman, 2017). Additional research by Shapiro et al. (2015) established that adolescent girls desire careers that positively benefit society. The results suggest that participants’ desire to narrow the gender gap and become influential leaders in STEM disciplines developed from an awareness of the shortage of women in STEM disciplines.

5.2.3 Leadership aspirations and support

Research question 2 asked, “Do female students feel supported in their STEM leadership interest?” The total support variable took into consideration both access to support and desire for support in pursuing a leadership position in STEM responses from study participants. The study found that the majority of participants indicated a moderately strong disagreement in feeling supported in their STEM leadership interest. The study revealed that the majority of participants indicated a moderately strong need for access to support in their STEM leadership interest. Although the responses from the Likert-scale portion of the survey indicated the need for more support in STEM leadership interest, the qualitative portion of the survey provided details on current support systems associated with experiences which included parents, teachers and role models. Parents made up the most popular form of support indicated in this study which aligns with researchers Grossman and Porche’s findings (2014). Family members and educators make up primary support systems for developing female science aspirations (Grossman & Porche, 2014). These somewhat conflicting findings from the survey
indicate that although the participants have support systems in place for their career in STEM, they more specifically lack support for pursuing a STEM leadership position.

The study revealed that a majority of participants indicated a moderately strong desire for more support in their STEM leadership interest. This aligns with research findings that support and mentoring for women in STEM is limited and presents itself as a potential barrier (Chapple & Ziebland, 2017; Dawson et al., 2015). Collectively, the results for total support which included access to support and desire for support, indicate that participants desire more support than they currently receive.

Additionally, research question 3B asked, “Is there a correlation between female STEM students’ support and STEM leadership aspirations?” The analysis revealed a moderate correlation between the total support and total aspirations measures. Prior research suggests that science aspirations positively correlate with an understanding that a support system exists for girls and women in science (Grossman & Porche, 2014). Educators as supporters play an important role in combating the gender stereotype in STEM disciplines (Lawson et al., 2018; Grossman & Porche, 2014; Stearns et al., 2016). Although participants acknowledged support systems in qualitative responses, the quantitative portion of the study suggests a desire for more support. Since parents, teachers, and role models were often mentioned as support systems, other forms of support such as gender-focused STEM programs and other organizational support systems within the discipline may be lacking. Mentoring programs prove effective in retaining women in STEM disciplines (Carver et al., 2017; Thomas et al., 2014), increasing self-efficacy (Dennehy & Dasgupta, 2017), and developing a STEM identity (Dennehy & Dasgupta, 2017; Ramsey et al., 2013; Robnett & Thoman, 2017).
5.2.4 Leadership aspirations and self-efficacy

One sliding scale item on the survey collected the responses for participant confidence in taking on a leadership role. Respondents rated their self-efficacy level from 0-100 where a low confidence level is a 0 and a high confidence level is 100. The participants had an overall moderately strong self-efficacy score. Bandura’s (1977) psychological study of self-efficacy and the large impact of self-efficacy on personal decisions support this study’s findings. Women tend to score themselves lower on self-efficacy scales for STEM related tasks than men (Else-Quest et al., 2013; Hand et al., 2017) which explains the more moderate scores provided by the participants. Additionally, many participants responded in the qualitative portion that parents in STEM provided support for pursuing a STEM degree. Having parents in STEM careers increases one’s self-efficacy in mathematics and overall academics needed to be successful in STEM disciplines (Sax et al., 2017; Wang et al., 2013). An explanation for the average self-efficacy score for this study being on the higher end of a moderate score may be explained by the participants having active parents in STEM.

Moreover, research question 3A asked, “Is there a correlation between female STEM students’ self-efficacy and STEM leadership aspirations?” A bivariate correlation analysis revealed a moderate correlation between the self-efficacy and total aspirations measures. As established, the majority of participants in this study responded that they aspire to become a leader in their STEM discipline. Considering Bandura’s (1977) study, the higher level of self-efficacy means participants view themselves as capable and confident in their abilities to become a leader in their STEM discipline. Research by
Fritz and Knippenberg (2016) did determine leadership self-confidence or self-efficacy as a positively significant predictor of leadership. These findings agree with the current study. Additionally, self-efficacy is a common personality trait among women in experienced leadership positions (Doubell & Struwig, 2016). In summary, in order to pursue and become a leader in STEM disciplines, one requires a strong self-efficacy.

5.2.5 Leadership aspirations and barriers

Female students in STEM reported few barriers regarding their decision to become a leader in their field. The total barriers variable took into consideration both personal/family barriers and cultural barriers variables from study participants. The study found that a majority of participants indicated that barriers did not impact their decision-making process of becoming a leader in STEM. When analyzing the barriers variable in subcategories of cultural and personal/family, the study determined a majority of participants indicated that their cultural barriers did not impact their decision-making process of becoming a leader in STEM and a gross majority of participants indicated that personal/family barriers did not impact their decision-making process of becoming a leader in STEM. The quantitative responses from the study suggest that the participants may not have encountered such barriers in their fields due to the participant age range and lack of experience working in the field. The literature review revealed that women with experience in STEM leadership positions acknowledged the presence of stereotyping and implicit bias in their STEM leadership roles and in STEM fields in general (Chapple & Ziebland, 2017; Cundiff & Vescio, 2016). To encounter stereotyping and implicit bias in leadership roles, one must have or had experience in a leadership role. Additionally, research question 3C asked, “Is there a correlation between female
STEM students’ barriers and STEM leadership aspirations?” The analysis revealed no statistically significant correlation between the total barriers and total aspirations measures.

These findings conflict with previous research for women in STEM disciplines. Gender stereotyping within STEM fields emerges in early educational settings (Barth et al., 2018; Blažev et al., 2017; Grossman & Porche, 2014; Shapiro et al., 2015). Men, more often than women, appear to have more qualities associated with scientists (Carli et al., 2016; Miller et al., 2015). The reportedly low presence of barriers by study participants is logical for this study’s participant pool of women in STEM who have already declared a STEM major and indicated leadership aspirations in their field. The responses from this study suggest that either the participants overcame existing barriers to reach the point of studying in a STEM discipline or that with this age group of participants there has been progress in removing gender barriers. Research by Grossman and Porche (2014) acknowledged that although gender discriminatory microaggressions associated with power, societal stereotypes, and assumptions were identified in their research participants, female study participants acknowledged the progress made in recent years in removing gender barriers within the STEM field and suggested hope for the microaggressions to slowly dissolve.

Although the majority of participants indicated a low presence of gender discriminatory barriers, some participants indicated that they were unsure about their leadership aspirations. The undecided participants indicated in their qualitative responses the presence of potential barriers. Reasoning for their hesitancy included responses regarding low confidence in their abilities to lead, the amount of responsibility and
amount of time to commit to the position which could potentially take away from their
time with family. Women in STEM leadership positions acknowledge the presence of
stereotyping and implicit bias in the STEM disciplines and in STEM leadership positions
(Chapple & Ziebland, 2017; Cundiff & Vescio, 2016). These responses echo research
findings by Grossman and Porche (2014) that found gender roles associated with the
domestic responsibilities of women limited women in their success in STEM
environments.

5.2.6 Leadership aspirations and experiences

Research question 3 asked, “Is there a correlation between female STEM student
experiences and STEM leadership aspirations?” Apparent themes that emerged for
student experiences inspiring STEM leadership goals included “Mentorship,”
“Disciplinary Interaction,” and “Gender Stereotyping” where the first two themes denote
positive influences and the latter a negative influence. “Disciplinary Interaction”
appeared as the most common theme which included participant responses regarding job
shadowing, attending conferences and attending guest lectures. However, for these
“Disciplinary Interactions” to occur, one might assume that a mentor guided them to
these opportunities. Crisp et al. (2017) explained mentorship as the relationship between
one or more people with the intent of growth and education for the mentee. Participants
commonly used the word “mentor” in their responses associated with teachers or parents
which aligns with Crisp and Alvarado-Young’s (2018) understanding for the most
common forms of mentorship. Mentorship plays an active role in a person’s degree
choice (Jung et al., 2017) and commitment to STEM programs once a STEM major is
declared (Dennehy & Dasgupta, 2017). The presence of women in STEM-related roles
and careers facilitates opportunities for mentorship which greatly influence young women studying in the STEM field (Ramsey et al., 2013; Stearns et al., 2016). Grossman and Porche (2014) stated that support systems such as family members and role models who challenge gender stereotypes may help women develop self-confidence to seek science degrees. Additionally, the results of participant leadership aspirations and mentorship align with recent research of mentoring experiences and the influence on leadership outcomes including leadership identity, skills and characteristics (Crisp & Alvarado-Young, 2018). Overall, the study participants indicated strong parental support and exposure to role models in STEM that shaped their desire to pursue a STEM leadership position.

5.3 Limitations

Several limitations exist in this study which are necessary to address. First, the survey was distributed during the time COVID-19 pandemic precautions were in place. This means that traditional in-person classes were offered as a blended format or strictly online format. This created the need for advertising the survey strictly in an electronic format by email (either personal, class announcement on a course site, or institution mass email system) and did not allow the survey to be advertised in person to students attending class or student organizational meetings. Advertising the survey strictly by electronic means may have affected the number of students who received the email and therefore the number of students available to take the survey. A second limitation is due to the fact this study was a convenience sample that only collected data from a single institution rather than multiple institutions. As such, the generalizability of results to the
entire female student STEM population may be limited. As with any study involving potentially sensitive information when the researcher has or had personal interactions with the students as their instructor, another limitation involves the possibility of participants not being honest or withholding information. A fourth limitation is that due to the target study age range and convenience sample chosen, participants were limited to those who had already chosen to pursue a degree in STEM and therefore had potentially overcome barriers as anticipated and discussed in the literature review. Next, a fifth limitation is due to missing demographic information for some quantitative responses. Because there were no demographics to correspond with the responses, this data was not used in the analysis. Finally, the sixth limitation is the restricted number of participants who completed the survey from STEM fields with a minority of women such as chemistry, engineering, physics, computer science, etc. Due to the nature of this population being a minority group, there were fewer women to advertise to and complete the survey than more gender-balanced STEM fields. The data included fields where women do not necessarily represent a minority in their field such as biology or biomedical sciences. This limitation again created a generalizability of results that may not reflect STEM fields with a male majority population.

5.4 Recommendations for future research

Several recommendations for future research would enhance this study’s findings. The first recommendation would be to adjust the survey instrument to include more survey questions corresponding to each of the defined variables and confirm validity and reliability prior to distributing the survey. In this study, during the analysis of data,
subcategories to the barriers, support, and aspirations variables became apparent. Increasing the number of questions for each variable would significantly increase the validity and reliability of the survey instrument. Other adjustments to the survey instrument include moving the demographic questions to the beginning of the survey. Due to missing demographic information, fewer participants could be included in the analyzed data. Several respondents answered the quantitative portion of the survey but then ended the survey once reaching the qualitative portion of the survey and never answered the demographic questions that followed. This meant that the quantitative responses missing demographic information could not be included in the analysis.

In addition, a longitudinal study over the course of five-to-ten-year period after graduation would make it possible to investigate whether the students who participated in the study achieved their goals of becoming a STEM leader. Insight on experiences and relationships established during college years as well as once employed in the field could benefit researchers in understanding how they achieved or did not achieve the goal of becoming a leader in the field. The experiences have potential to inform activities or programs to support more women in STEM achieve their goal of becoming a leader.

Next, although the study provided results from women from several different STEM disciplines, future research would benefit from narrowing the participant pool to women studying STEM disciplines with a severe underrepresentation of women. Redirecting the target of the research to STEM fields holding a true female minority would provide a better understanding as to what factors influence those women to become a leader in their field and therefore increase the number of female role models in their field. Research may also benefit from comparing leadership aspirations from
female participants in more balanced gender STEM fields (e.g., psychology, biology, biomedical sciences, etc.) with female participants in imbalanced gender STEM fields (e.g., physics, chemistry, engineering, etc.).

Finally, future research would benefit from analyzing demographic data collected from participant responses. Analyzing ethnicity, declared major(s), and/or age groups may be beneficial in understanding the variation in leadership aspirations for different groups of participants. Insight from this type of analysis has potential to inform and develop support systems for the groups lacking STEM leadership aspirations and also give greater insight about those groups that indicate a strong STEM leadership aspiration.

5.5 Summary

Chapter V briefly restated significant findings from the study as discussed in detail in Chapter IV. A discussion of the findings was included and connected, compared, and contrasted with the literature presented in Chapter II. The findings determined that the majority of participants in this study have plans to pursue or are currently pursuing a leadership position in their STEM discipline. Literature supports that this most likely stems from their communal career aspirations and desire to increase the representation of women in STEM disciplines. Barriers were not heavily perceived by the participants as obstacles to obtain a STEM leadership position. A reasonable explanation for this is that, in this study, the participants were declared STEM majors and previously minimized the existence of barriers to already establish an interest in a STEM leadership position. In addition to a discussion of the study’s findings, limitations of the
current study and future research suggestions for further understanding female STEM leadership aspirations were also discussed.
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*Rosie the Riveters discovered a wartime California dream.*


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APPENDICES

Appendix A: A Questionnaire for Women in STEM

After reviewing the linked Consent Form, please select your choice below. By selecting "I Agree" below, you agree to the following:

1. I have read the above information contained in the Consent form.
2. I voluntarily agree to participate.
3. I am 18 years of age or older.
4. I am currently a STEM major at the University of South Alabama.

☐ I Agree (1)

☐ I do not agree (2)

Please check one of the following that describes your age:

☐ I am 18 years of age or older (1)

☐ I am NOT 18 years of age or older (2)
Q1 In the future, I would be interested in a promotion to a STEM leadership position.

- Strongly Disagree (1)
- Disagree (2)
- Slightly Disagree (3)
- Slightly Agree (4)
- Agree (5)
- Strongly Agree (6)
Q2 I am actively pursuing a STEM leadership position.

- Strongly Disagree (1)
- Disagree (2)
- Slightly Disagree (3)
- Slightly Agree (4)
- Agree (5)
- Strongly Agree (6)

Q3 I believe I am suited to become a STEM leader.

- Strongly Disagree (1)
- Disagree (2)
- Slightly Disagree (3)
- Slightly Agree (4)
- Agree (5)
- Strongly Agree (6)

Q4 The steps I need to take to be successful in a bid for STEM leadership positions are clear to me.

- Strongly Disagree (1)
- Disagree (2)
- Slightly Disagree (3)
Q5 There are ample opportunities for me to receive professional development training that would prepare me for leadership positions.

- Strongly Disagree (1)
- Disagree (2)
- Slightly Disagree (3)
- Slightly Agree (4)
- Agree (5)
- Strongly Agree (6)

Q6 I would be interested in receiving additional professional development training to prepare for leadership positions.

- Strongly Disagree (1)
- Disagree (2)
- Slightly Disagree (3)
- Slightly Agree (4)
- Agree (5)
- Strongly Agree (6)
Q7 I am aware of what I would have to do to become a STEM leader.

- Strongly Disagree (1)
- Disagree (2)
- Slightly Disagree (3)
- Slightly Agree (4)
- Agree (5)
- Strongly Agree (6)

Q8 Having a mentor would be beneficial for me in helping me to pursue my leadership aspirations.

- Strongly Disagree (1)
- Disagree (2)
- Slightly Disagree (3)
- Slightly Agree (4)
- Agree (5)
- Strongly Agree (6)

Q9 I am aware of barriers or obstacles that could stand in the way of me becoming a leader in STEM.

- Strongly Disagree (1)
- Disagree (2)
- Slightly Disagree (3)
Q10 The cultural expectation that women will not assume leadership positions has affected me and helps explains why I will not be pursuing a STEM leadership position.

Q11 In my American culture, I would have to be brave to break the social expectations if I were to apply for a STEM leadership position.
Q12 In my American culture, there would be sanctions if I were to break these social rules and applied for leadership positions.

- Strongly Disagree (1)
- Disagree (2)
- Slightly Disagree (3)
- Slightly Agree (4)
- Agree (5)
- Strongly Agree (6)

Q13 My current or future family responsibilities and expectations discourage me from pursuing future leadership positions.

- Strongly Disagree (1)
- Disagree (2)
- Slightly Disagree (3)
- Slightly Agree (4)
- Agree (5)
- Strongly Agree (6)

Q14 The lack of support from my domestic partner discourages me from pursuing future leadership positions.

- Strongly Disagree (1)
- Disagree (2)
Q15 My current or future family responsibilities for childcare discourage me from pursuing future leadership positions.
Q16 My extended family responsibilities discourage me from pursuing future leadership positions.

- Strongly Disagree (1)
- Disagree (2)
- Slightly Disagree (3)
- Slightly Agree (4)
- Agree (5)
- Strongly Agree (6)

Q17 Society's view of women as unsuitable for leadership discourages me in pursuing my leadership aspirations.

- Strongly Disagree (1)
- Disagree (2)
- Slightly Disagree (3)
- Slightly Agree (4)
- Agree (5)
- Strongly Agree (6)
Q18 The educational system's lack of support for leadership discourage me in pursuing my leadership aspirations.

- Strongly Disagree (1)
- Disagree (2)
- Slightly Disagree (3)
- Slightly Agree (4)
- Agree (5)
- Strongly Agree (6)

Q19 Lack of encouragement from my superiors discourages me in pursuing my leadership aspirations.

- Strongly Disagree (1)
- Disagree (2)
- Slightly Disagree (3)
- Slightly Agree (4)
- Agree (5)
- Strongly Agree (6)

Q20 Do you aspire to become a leader in STEM? Please explain why you would or would not like to hold a leadership position in the STEM workforce. Include any past experiences that have impacted your career decisions.
Q21 Please select a number to indicate your confidence in taking on a leadership role.

<table>
<thead>
<tr>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
<th>100</th>
</tr>
</thead>
</table>

Confidence (Low is 0 High is 100) ()

Q22 If you are interested in pursuing a leadership position in STEM, has this desire been driven by an influential peer, role model, or mentor (i.e., parent, teacher, public figure, etc.)? If so, please describe how this person was influential.

________________________________________________

Q23 Do you recall any experiences that have influenced your aspiration to become a leader in STEM? If so, please state and/or describe the experience/experiences.

_______________________________________________

Q24 If you do not aspire to become a leader in STEM, do you recall any negative experiences that have influenced your lack of aspiration? If so, please state and/or describe the experience/experiences.

_______________________________________________
Q25 Please indicate your declared major(s) by checking all that apply:

☐ Engineering (1)
☐ Mathematics (2)
☐ Physics (3)
☐ Biomedical Sciences (4)
☐ Chemistry (5)
☐ Biology (6)
☐ Biochemistry (7)
☐ Other (8) ______________________________

Q26 Please indicate your gender by checking one of the following:

☐ Male (1)
☐ Female (2)
☐ Other (3) ______________________________
☐ Prefer not to answer (4)
Q27 Please indicate your official year in school by checking one of the following:

○ Freshman (1)
○ Sophomore (2)
○ Junior (3)
○ Senior (4)
○ Graduate (5)

Q33 What is your ethnic background?

○ White/Caucasian (1)
○ Asian-Eastern (2)
○ Asian-Indian (3)
○ Hispanic (4)
○ African American (5)
○ Other (6) ________________________________________________
○ Prefer not to answer (7)
Q35 What is your age?

- 18-22 years (1)
- 23-27 years (2)
- Over 27 years (3)
- Prefer not to answer (4)

Q28 I am a student at the University of South Alabama.

- True (1)
- False (2)

Q32 Would you like to be considered in a drawing for a $25 Amazon gift card? If "yes" is selected, you will be redirected to a new single question survey to collect your email address with no attachment to your responses in this main survey.

- Yes (1)
- No (2)
Appendix B: The Pilot Study

The instrument used in the pilot study was a questionnaire composed of 21 questions. The questionnaire was a modified version of Nurdiana Gaus’ “Women in School Leadership” questionnaire (Gaus, 2011). The original survey was created to answer questions in regard to holding a principal position. The questions were modified to reflect future STEM leadership positions as being the subject of interest. The original questions created by Gaus were validated using quantitative data analysis methods (Gaus, 2011). All responses for the questions were recorded on a 6-point scale ranging from 1 (strongly disagree) to 6 (strongly agree). The end of the questionnaire collected information about the students’ demographics.

The intention for the pilot study was to provide an initial assessment for the instrument. The responses were reviewed for participant clarity and as an aside for their responses. The data was analyzed based on the response to each individual question of the questionnaire. The pilot study had 15 participants of which nine were female and six were male.

An independent samples t-test was conducted in SPSS to compare leadership aspirations of men and women who participated in the survey. Statistically significant responses were identified in question two concerning the act of pursuing a STEM leadership position for men ($M=4.83$, $SD=2.04$) and women ($M=2.67$, $SD=.866$), $t(13)=2.86$, $p=.013$, $d=1.06$, in question three concerning the belief of being suited to become a STEM leader ($M=5.17$, $SD=1.602$) and women ($M=3.67$, $SD=1.0$), $t(13)=2.25$, $p=.043$, $d=.936$, and in question five concerning opportunities for receiving professional
development training preparation for leadership positions for men \( (M=5.33, SD = .516) \) and women \( (M=4.0, SD=1.12) \), \( t(13)=3.11, p=.009, d=2.58 \). There was not a statistically significant difference in the remaining questions or subcategories for men and women.

Drawing from the results of the pilot study, male students are more likely to be actively pursuing a STEM leadership position during their undergraduate years. However, this does not suggest that female students are not interested in eventually being promoted to STEM leadership positions as men and women both reported such interest. There were similar findings regarding social and external barriers of female and male students in that there were none keeping them from holding a position in STEM leadership. Cultural expectations and family responsibilities, which can oftentimes be thought of as barriers, were not recognized by the students of either gender to be a problem for becoming a leader in STEM fields. Findings suggested that male students are more likely to believe that they are suited for becoming a leader in STEM. Males were also more likely to report that they knew of opportunities for receiving professional development training in preparation for leadership positions in STEM. This suggests that female students may not be presented with opportunities by their superiors for leadership advancements in their field.

Overall, the pilot study was successful and there was no confusion in the survey reported by the students; however, the researcher decided to make minor changes and improvements regarding conduction and the collection of data based on lessons learned. These modifications to the dissertation study included a change of procedure to utilize Qualtrics online survey software for the distribution of questionnaires electronically, the
addition of four open-ended questions at the end of the survey to provide a qualitative
data set for the study, collection of data from students who are 18 years of age or older,
collection of data only from women with declared STEM major at the university,
 omission of a duplicate question, slight modifications in survey question wording, and
 revisions to research questions. The pilot study included both male and female
 participants; however, the dissertation study will only include the analysis of female
 participants. This shift is due to the researcher’s interest in understanding leadership
 aspirations for female students only and not the comparison of female to male student
 aspirations.
Appendix C: Emails Distributed for Advertisement

**Daily Digest Advertisement**

ATTENTION-ALL FEMALE STEM STUDENTS!! Your help is needed to gain insight into the leadership aspirations of women in STEM disciplines. If you are willing to participate in a 5-10 minute anonymous survey, please click on the following survey link: LEADERSHIP ASPIRATIONS OF WOMEN IN STEM DISCIPLINES.

For your participation, (if you choose to register) you will be entered into a drawing for an AMAZON GIFT CARD. But HURRY, the survey will close in two weeks! (Winner of the gift card will be notified via registered email address.)

The likelihood of being chosen is dependent on the number of participants and it is expected that 100 questionnaires will be completed. The drawing will be conducted in the University Commons Building in the presence of Dr. Wanda Maulding-Green on April 30, 2021.

**Email**

Hello,

Below you will find a link inviting you to participate in a questionnaire for my dissertation research study, which focuses on leadership aspirations of undergraduate and graduate women in declared STEM disciplines. Please take a moment to complete the anonymous, 5-10 minute survey or pass it along to a female studying STEM at USA. The link to the survey LEADERSHIP ASPIRATIONS OF WOMEN IN STEM DISCIPLINES will be accessible for two weeks. My goal is to obtain responses from over 100 students at USA so that we can better understand our future in STEM leadership!

After completing the survey, you have the option to enter your email address for a chance to win a $25 Amazon gift card for the completion of the questionnaire. The likelihood of being chosen is dependent on the number of participants and it is expected that 100 questionnaires will be completed. The drawing will be conducted in the University Commons Building in the presence of Dr. Wanda Maulding-Green on April 30, 2021. You will be contacted by email if you were randomly selected.

Thank you in advance for helping me along in my academic endeavors!

Sincerely,

Melanie Cochran
Educational Leadership Doctoral Candidate
Appendix D: Consent Form

Consent

You are invited to voluntarily participate in a research project to gain a better understanding of leadership aspirations in female students enrolled in STEM disciplines at [university name]. This will take no longer than 10 minutes to complete. Participation will remain anonymous and no identifying data will be collected.

Project Title: An Investigation of Female Leadership Aspirations in STEM Disciplines
Principal Investigator: Melanie Cochran
Educational Leadership Doctoral Candidate
Contact Information: melaniebrady2@gmail.com
Advisor: Dr. Wanda Maulding-Green
Associate Professor of Educational Leadership

How Participants Will Be Selected:

All participants who are 18 years of age or older and identify as female will be included in this study.

Procedure:

Students are asked to participate by answering questions on the linked survey. There is no cost for taking the survey. You have the right to refuse to answer any questions that you do not wish to complete and/or answer.

Potential Benefits and Risks:

There may be no personal benefit from your participation but the information gained by doing this research may help others in the future. This study may have potential to shed light on why there are fewer women in STEM leadership positions.

The risks of harm and discomfort from participation are no more than would be experienced in daily life. The possible risks or discomforts of the study are minimal. As with taking any survey, you may feel uncomfortable or embarrassed answering personal survey questions. Other risks include loss of confidentiality, burden of time, and/or discomfort of sensitive questions.

Confidentiality:

Data will be collected using Qualtrics survey software and your survey responses will be stored within Qualtrics in a password protected electronic format. This study is anonymous. The survey utilizes Qualtrics Anonymize Response setting so that there will be no record of any personal information and all contact association will be removed from the original survey responses. With this method, no identifying information including IP address or location data will be collected. The researcher will use pseudonyms for names associated with the institution and participant (if provided by the participant in a response) when reporting the results of the study to ensure anonymity.

Incentive:

You will have the option to be included in a drawing if you choose to supply your email address at the end of the questionnaire. If you choose to provide your email address, you will be directed to a new, one question survey that will not be linked to your original responses on the questionnaire. You will be included in a drawing of $25 by Amazon gift card for the completion of the questionnaire. The likelihood of being chosen is dependent on the number of participants and it is expected that 100 questionnaires will be completed. The drawing will be conducted in the University Commons Building in the presence of Dr. Wanda Maulding-Green on April 30, 2021. You will be contacted by email if you have been selected.
Appendix E: IRB Approval

INSTITUTIONAL REVIEW BOARD
March 28, 2021

Principal Investigator: Melanie Cochran
IRB # and Title: IRB PROTOCOL: 21-050

[1553731-1] Ed.D. Dissertation - AN INVESTIGATION OF FEMALE
LEADERSHIP ASPIRATIONS IN STEM DISCIPLINES

Status: APPROVED  Review Type: Exempt Review
Approval Date: March 26, 2021  Submission Type: New Project
Initial Approval: March 26, 2021  Expiration Date: 

Review Category: 45 CFR 46.104 (d)(2): Research that only includes interaction involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior (including visual or auditory recording):

ii. Any disclosure of the human subjects' responses outside of the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation

This panel, operating under the authority of the DHHS Office for Human Research and Protection, assurance number FWA 000061692, and IRB Database #00000286 or #00011574, has reviewed the submitted materials for the following:

1. Protection of the rights and the welfare of human subjects involved.
2. The methods used to secure and the appropriateness of informed consent.
3. The risk and potential benefits to the subject.

The regulations require that the investigator not initiate any changes in the research without prior IRB approval, except where necessary to eliminate immediate hazards to the human subjects, and that all problems involving risks and adverse events be reported to the IRB immediately!

Subsequent supporting documents that have been approved will be stamped with an IRB approval and expiration date (if applicable) on every page. Copies of the supporting documents must be utilized with the current IRB approval stamp unless consent has been waived.

Notes:
Appendix F: Gaus Original Survey

WOMEN AND SCHOOL LEADERSHIPS:
Factors Deterring Female Teachers from Holding Principal Positions at Elementary Schools in Makassar

1. What is your current position?
2. Are you working in your area of specialization?
3. What grade are you teaching?
4. I am satisfied with my current position as a teacher/a principal
5. I would be interested in a promotion to be a principal/a superintendent
6. I am actively pursuing to be a principal/a superintendent
7. I believe that I would be suited to become a principal
8. The step I need to take to be successful in a bid for the principal position are clear to me
9. There ample opportunities for me to receive professional development training that would prepare me for leadership positions.
10. I would be interested in receiving additional professional development training to prepare me for leadership positions in my school.
11. I am aware of what I would have to do to become a principal
12. Having a mentor would be very helpful for me in helping me to pursue my leadership aspirations.
13. I am aware of any barriers or obstacles that could stand in the way of me becoming a principal.
14. Cultural expectation that women will not assume leadership positions has affected me and helps explain why I have not pursued the principal position.
15. I would have to brave to break the social expectations of me if i were to apply for a principal position.
16. There would be sanctions if I were to break these social rules and apply for leadership aspirations.
17. I would need more family support for me if I were to pursue becoming a principal.
18. Having a mentor would be very helpful in helping me to pursue my leadership aspirations.
19. I realize that paying some amount of money would give a better chance of being selected as a principal.
20. The social barriers to do with my domestic situations discouraged me from pursuing my leadership positions.
21. The social barriers to do with my lack of support from my domestic partner discouraged me from pursuing my leadership positions.
22. The social barriers to do with my family responsibilities for child care discouraged me from pursuing my leadership positions.
23. The social barriers to do with my extended family responsibilities discouraged me from pursuing my leadership positions.
24. The external barriers to do with the society’s view of women as unsuitable for leadership discouraged me in pursuing my leadership aspirations.
25. The external barriers to do with the system’s lack of support for leadership discouraged me in pursuing my leadership aspirations.
26. The external barriers to do with the lack of encouragement from my superordinates discouraged me in pursuing my leadership aspirations.
27. The external barriers to do with my school system itself discouraged me in pursuing my leadership aspirations.
28. Could you please describe the things you believe you would have to do to become a principal in your school system?
29. Could you please describe any kinds of sanction you could receive if you pursued the principalship?
30. Given the present situation in your school system, how likely is that you could be successful in achieving a principal position if you were to pursue
31. Please describe the reasons for your response in question 29?
32. In what way do you think the recruitment process should be revised?
33. Could you please describe what kind of discrimination you may face if you were to pursue a principal position.
34. What changes in the recruitment for principal process would you like to see in the future?
35. What advice would you give to women who wish to be a principal? What should they do and how should they prepare?
36. Could you please describe factors that contributed to your success in becoming a principal in your school system?
37. In what ways do you think the recruitment process should be revised?
38. Please share your advice to any women who wish to be a principal. What should they do and what should they prepare.
39. If I did plan and develop your career to prepare for the principalship.
40. What were the most influential experiences in your success at gaining a principal position?
Appendix G: Survey Instrument Permission

On Sat, Jun 16, 2018 at 9:54 PM, Nurdiana Gaus <nurdiana.gaus@gmail.com> wrote:
Dear Ms. Cochran,

Thank you very much for your email informing me about your interest in using the survey for your doctoral dissertation. It is with my pleasure to allow you to use it with several adjustment you made to your subject-women in STEM.

I would also appreciate your acknowledgement of me as being the creator of this survey and hope your research project will run smoothly and you will gain a great success for the completion of your study.

Best wishes,

Nurdiana Gaus

Dr. Gaus,

I am currently an Educational Leadership doctoral student at the University of South Alabama writing my dissertation tentatively titled "The Underrepresentation of Women in STEM Leadership Roles." I am also a full-time faculty member in the physics department at the same university.

I came across your article "Women and school leaderships: Factors deterring female teachers from holding principal positions at elementary schools in Makassar" published in the Advancing Women in Leadership. After reading your article, my interests for understanding deterring agents for women becoming leaders in STEM is very similar to your interest women in principal positions. I am very interested in adopting a few questions in your questionnaire provided in the appendix of your article. I will like to inform you that I will have to revise the questions so that they relate to my subject-women in STEM rather than women in principal positions. I have attached a copy of how my questionnaire would be written to better suit my target participants.

If given permission to use your survey, I will acknowledge you as being the creator of the original survey, I will use this survey only for my research study and will not sell or use it with any compensated or curriculum development activities, and I will send you my research study and any publications that may come from it to your attention.

If you have any questions prior to providing an answer, please feel free to contact me. I will be happy to answer all questions that you may have about my dissertation.
I hope that you will consider allowing me to use your survey for my dissertation purposes.

Sincerely,

Melanie Cochran
Appendix H: Gaus Validity Score Request

From: Nurdiana Gaus <nurdiana.gaus@gmail.com>
Date: Sun, Nov 3, 2019 at 12:16 AM
Subject: Re: Survey instrument permission request from Women and school leaderships: Factors deterring female teachers from holding principal positions at elementary schools in Makassar
To: Melanie Cochran <melaniebrady@southalabama.edu>

Hello Ms. Cochran

Thank you for your email. With regard to your request, I regret to let you know that unfortunately, I do not longer have them at hand now. Do apologize. I wish you all the best for your PhD study.

Best

Nurdiana Gaus

Pada tanggal Sab, 2 Nov 2019 pukul 00.48 Melanie Cochran <melaniebrady@southalabama.edu> menulis:
Hello Dr. Gaus,

I am using your questionnaire from your article "Women and school leaderships: Factors deterring female teachers from holding principal positions at elementary schools in Makassar" published in the Advancing Women in Leadership for my dissertation study. I was hoping to report the reliability and validity of your instrument as you state the "data validation methods included methodological structure of quantitative data." Do you have these statistics for the quantitative data or specifics about the methods used?

Thank you,

Melanie Cochran
BIOGRAPHICAL SKETCH

Name of Author: Melanie R. Cochran

Graduate and Undergraduate School Attended:

University of Southern Mississippi, Hattiesburg, Mississippi

University of South Alabama, Mobile, Alabama

Degrees Awarded:

Bachelor of Science in Physics, Mathematics Minor, 2012, Hattiesburg, Mississippi

Master of Science in Physics, 2014, Hattiesburg, Mississippi

Doctor of Education in Education Leadership, 2022, Mobile, Alabama