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A Delphi Study: Retention of Women in Leadership Positions in Stem Disciplines

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A DELPHI STUDY: RETENTION OF WOMEN

IN LEADERSHIP POSITIONS IN STEM DISCIPLINES

by

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ABSTRACT

A DELPHI STUDY: THE ADVANCEMENT OF WOMEN
IN LEADERSHIP POSITIONS IN STEM DISCIPLINES

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This Delphi study explores barriers and support systems that impact women's professional advancement in STEM disciplines. There were 20 expert panelists who committed to participate in the study and 15 panelists completed the four rounds of the study after attrition. The panelists were selected based on specific criteria including educational background, diversity within STEM disciplines, experience as a former or current female administrator who served at two-year degree offering institutions, leadership and membership within women's advocacy organizations in STEM and related workforce education fields, and depth of knowledge and understanding of the research questions. Through the four rounds of the Delphi study, a consensus was reached among 15 panelists including nine factors supporting advancement and three factors inhibiting advancement for a total of 12 factors that were considered relevant to the research questions based on the mean score of 3.50.

The following factors were identified by the panelists as relevant for supporting advancement: Support Systems, Personal Attributes, Willingness to Advance, Leadership Skills, Curiosity about New Experiences, Role Models, Opportunities for Leadership Roles, Experiences in Undergraduate and Graduate Studies, and Awareness of Institutional Environments; and those for inhibiting advancement: Conflicting Family Obligations, Lack of Compensation, and Personal Concerns. The results of the Delphi study can be used as a conceptual framework to inform administrators and researchers in higher education on the relevant factors concerning organizational climate, institutional policies, and departmental conditions that impact women's advancement or hinder their advancement in STEM fields.

DEDICATION

This dissertation is dedicated to my husband, Harry Luthi, to my daughter, Julia Elise Luthi, to my family and to my mentor, Dr. Dana Burnett. This was only possible due to your support.

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CHAPTER 1

INTRODUCTION

The absence of women in science, technology, engineering, and mathematics (STEM) fields is pervasive and is especially problematic in academic leadership and administrative positions in higher education. Educational professionals have established research agendas to increase understanding of gender inequality in higher education and identify barriers to women's retention in the STEM workforce profession (Britton, 2010; Monroe, Choi, Howell, Lampros, Trejo, & Perez, 2014). Societal efforts to address cultural stereotypes has led to an increase in the number of women who earn advanced degrees, and the underrepresentation of women continues to be addressed through efforts of women's advocacy groups and federal programs that focus on gender equality and broadened participation in STEM (National Research Council, [NCR], 2007). Although the need for a diverse workforce in STEM disciplines is vital for advancement of research and innovation in predominately male STEM occupations, there is still a disproportionate number of men compared to women who advance in STEM careers (Hill, Corbett, & Rose, 2010; Xu 2008).

The National Science Foundation defines STEM as science, technology, engineering, and mathematics that includes a variety of workforce education programs in emerging fields such as biotechnology, nanotechnology, robotics, and mechatronics (NCR, 2017). The dissertation research focuses on experts who have qualifications as scholars and practitioners in STEM and workforce education and have advanced into administrative positions within public higher education two-year institutions. The leadership positions referenced in the study refer to individuals who previously or currently serve as directors, deans, associate vice presidents, or vice presidents within the identified fields. Research outcomes indicate that challenges impacting a woman's decision to advance or remain in leadership positions within STEM include lack of networks, mentors, and advocates (Laursen & Rocque, 2009).

Background

A substantial body of literature explores leadership capacity and leadership efficacy of women in STEM fields with respect to the shortage of women (Settles, Cortina, Malley & Stewart, 2006). Although previous studies have contributed to the understanding of the gender gap, additional research is needed to investigate systemic approaches that would increase representation and promote gender equity in higher education (Bilen-Green, Froelich, & Jacobson, 2008; Bilimoria & Liang, 2012; Stewart, Malley, & LaVaque, 2007). The previous research offers descriptive lists of topics to continue exploring to guide higher education practices within the STEM field and gender inequality (Iskander, Furse, & Bergerson, 2013).

Another dominant discussion in the STEM field is centered on broadening participation of women in STEM and increasing the number of secondary and post-secondary students entering STEM fields. Previous empirical research is focused on factors impacting career persistence and bias that negatively influenced women's progress and participation in STEM (Cech, Rubineau, Silbey, & Serond, 2011). The research on gender inequity in STEM is general and focused on career choice, departmental climate, work/life balance, and collegiality relative to gender differences (Bilimoria, Simy, & Liang, 2008). Further research is needed to confirm the impact specific to barriers at institutions focused on workforce education and core questions surrounding the factors that positively impact female academic professionals' advancement and retention in STEM-related administrative positions.

Men comprise more than half of the workforce in most fields of STEM research, particularly at senior levels. The gender gap is smaller today than it was in the past, giving the impression that there will soon be equal numbers of men and women researchers and that current initiatives to recruit and retain more women are working adequately (NCR, 2007). Shaw and Stanton's (2012) research show women are less likely to progress to senior positions in STEM than men. Gender inequity issues within STEM are contributed to low representation of women in leadership. This can be due to issues such as equivalent achievements by women are not recognized among peers or supervisors or because senior women are less often publicly celebrated as leaders in STEM fields (Stewart, Malley, & LaVaque-Manty, 2007). Sturm (2006) highlights the particular junctures of possible exits within a woman's career that the majority of women choose to leave. For example, women may face extra challenges inside and outside of the workplace as a new mother that impact the pace women progress to leadership positions compared to men (Su, Johnson, & Bozeman, 2014).

Postsecondary institutions, particularly two-year degree offering institutions, provide professional environments that have potential to support or impede the development of women in STEM leadership positions. Two-year institutions are unique compared to other higher educational and professional settings due to the emphasis on the mission to serve the community and provide a skilled labor force through open access opportunities (Mellow & Heelan, 2008). Two-year institutions have dynamic, innovative post-secondary and vocational programs that address regional workforce needs and offer a different workplace climate compared to other private and public institutions in the postsecondary education system (Cohen & Brawer, 2008). As questions concerning workplace climate and institution type continue to be addressed in research, this study explores the specific phenomenon of the organizational culture at two-year institutions that may offer additional programs and networks that focus on a woman's experience of collegiality, equal treatment, and greater job satisfaction and productivity in STEM.

The culture at two-year degree offering institutions can impact the way individuals or a group of individuals identify as members of the institution and the mental framework of the employees in relation to the organization (Schein, 2010). Nationally, approximately 67% of the teaching faculty at community colleges and two-year institutions are part-time and the culture is impacted by the continual adjustments that the institution makes to respond to workforce needs and changes in curricula to address emerging STEM and workforce occupations (Christensen & Larsen, 2008). The type and role of an institution has a strong impact on women's motivation and persistence in a STEM profession and advancement into positions of leadership ([NRC], 2007; Settles et al., 2006).

The political and economic pressure on institutional leadership to increase diversity within the workplace and support the advancement of underrepresented groups have increased awareness of the need for change. Institutional leadership are encouraged to be more inclusive of women in the STEM pipeline. This study is designed to identify factors that contribute to the advancement of women in STEM and workforce education, specifically at two-year degree offering institutions, and barriers that hinder their success in accessing and retaining leadership positions in postsecondary education.

Problem Statement

There is a national movement in community colleges to address equity within STEM fields (NRC, 2007). Central to this movement are issues related to retention and budget stewardship. The purpose of this study is to identify factors that can be used as a conceptual framework for establishing institutional conditions and a work environment across higher education institutions that support women's advancement and retention in administrative positions of leadership related to STEM disciplines and workplace education. This study explored literature related to current institutional strategies and predictors for women's success and retention in STEM disciplines. Such an exploration addresses the gender inequity problem regarding women's advancement in STEM.

Research Questions

This research was guided by two specific questions that were addressed through data collection and analysis:

1) What factors have the most impact on women's professional advancement and success in leadership positions within STEM and workforce education-related disciplines at two-year institutions?
2) What factors inhibited women's professional advancement and success in leadership positions within STEM and workforce education-related disciplines at two-year institutions?

Overview of Methods

Because there is limited research that explores the research questions specific to a two-year degree offering institutional environment, an exploratory approach with guidelines on identifying the most important issues related to the research topic was needed. The Delphi method has the ability to obtain opinions and consensus from a diverse group of experts with characteristics designed to offset shortcomings of conventional means of pooling opinions from a group interaction (Dalkey, 1972; Okoli & Pawlowski, 2004; Stitt-Ghodes & Crews, 2004).

Participants. The Delphi method utilizes a panel of selected experts who have knowledge about the research questions being explored (Rohrbaugh, 1979; Stitt-Gohdes & Crews, 2004). The researcher solicited a panel size of up to 20 individuals to ensure there was a minimum number of 10 after attrition (Reid & Nygren, 1988). The target panel size is consistent with Dalkey's (1972) group estimation process in achieving experimental results with small discussion groups. The size relates to the quality of the results generated because the purposive sample requires specific criteria from the panelists regarding their current or former role within administration and leadership positions at a two-year degree offering institutions.

The experts were singled out based on their expertise, experience, knowledge, and skill in offering sound judgement and information processing capability on the factors being explored (Delbecq, Van de Ven, & Gustafson, 1975). The panelists were female and represent diversity of professionals across STEM disciplines. An initial purposive sample of 10 former and current female administrators identified by the researcher were invited to participate in the study based on their qualifications. A snowball sampling technique was used to recruit additional panelists from among their peers based on their understanding of the research questions until the participation of 20 eligible panelists was confirmed for Round 1.

The researcher determined eligibility based on specific criteria including educational background, diversity within STEM disciplines, experience as a former or current female administrator who served at two-year degree offering institutions, leadership and membership within women's advocacy organizations in STEM and related workforce education fields, and depth of knowledge and understanding of the research questions. The researcher requested additional nominations of respected individuals that also meet the criteria within the target group until 20 individuals were identified (Jones & Twiss, 1978; Schmidt, 1997).

Sampling frame. The study consists of four rounds. Round 1 includes the initial collection of data based on the opinion of a minimum of 20 panelists. The panelists were asked to identify two to three factors related to each research questions and to provide examples and context to each factor through a few descriptive sentences. The panelists were sent an introductory letter through email, and then in Round 1 they were asked to choose which two to three factors they felt were most pertinent to address research questions. These data were aggregated to identify commonalities between responses through a review committee who did not participate in the study. In Round 2, the panelists reviewed the list of factors and responded with any additional factors that needed to be added to the list and additional clarifications for the factors described in Round 1. In Round 3, the panelists rated the resulting factors on a Likert-type scale.

At the end of the rating phase, the researcher compiled the list and sent it back to the panelists for reconsideration of agreement or disagreement with the rated items. In this final stage of Round 4, the panelists were asked if they supported the group consensus on the rated factors that were most relevant and if their ratings from Round 3 were valid indicators of relative importance to the factors (Okoli & Pawlowski, 2004). The panelists had the opportunity to change their ratings after reviewing the group responses from Round 3. The panelists were not able to identify the author of each response, but compared their initial rating from Round 3 to the group rating through mean, median, interquartile range, and standard deviation of each factor.

The researcher determined a factor as relevant based on a mean (*M*) score of 3.50 or higher on the 5.0 scale based on Delphi studies that used a similar cut off score as appropriate (Kosloski & Ritz, 2016; Pate, Warnick, & Myers, 2012). The researcher established that consensus was reached for any factors that have an interquartile range (*IQR*) 2.00 or below based on similar studies that used 2.00 as an acceptable cut off to indicate consensus (Childress & Rohodes, 2006; Kosloski & Ritz, 2016). Factors with an *IQR* over 2.00 indicates that consensus has not yet been gained due to the high dispersion of the ratings for each factor.

The Delphi method encouraged a group consensus that was free from peer group pressure through the successive rounds of information that was revised and considered in each round. The approach offers flexibility for the group to arrive at a consensus without having to meet each other or be inhibited by one dominate panel member (Ludwig, 1997; Williams & Webb, 1994). The results were based on the judgement of the expert panel and on the multiple rounds of questioning on information related to the issue.

Limitations

Factors that limit this study include the following:

1) This study only examines women in leadership positions in postsecondary education at two-year degree offering institutions to examine a phenomenon specific to the organizational culture within the institution type targeted by the study.
2) STEM and workforce education includes individuals that have accepted positions of leadership based on their scholarship and experience in STEM, as well as individuals who have accepted positions of leadership based on merit and increase of scope of work based on institutional need.
3) The panelists selected for the study only represent postsecondary administrators and leaders who oversee STEM and workforce education programs at institutions that offer two-year degrees.

Assumptions

The following assumptions were made in this study:

1) Panelists view advancement into a leadership position as a positive outcome of their own professional career trajectory.
2) Panelists are aware of the gender inequality within STEM and workforce education academic professions based on relevant literature.

3) Factors that impact women's advancement and success in leadership positions can be determined by experts serving in leadership positions who oversee STEM and workforce education programs.
4) Factors that hinder a women's advancement in leadership positions can be determined by experts serving in leadership positions who oversee STEM and workforce education programs.
5) Panelists are accurately representing themselves with regards to eligibility requirements for this study.

Definitions of Key Terms

- Delphi Method: Creates a group opinion that is free from peer group pressure through the successive rounds of information that is revised and considered in each round. The approach offers flexibility for the group to arrive at a consensus without having to meet each other or be inhibited by one or more dominate panel members (Williams & Webb, 1994).
- Gender Equity: A term that refers to opportunities offered to individuals underrepresented in STEM fields based on their gender. Compensation is made once the experiences, social disadvantages, history and needs of the individuals are considered.
- Gender Inequality: A term that refers to unequal treatment or perceptions of individuals based on their gender.
- Leadership: Leadership positions included in this study are specific to individuals who formally or currently hold administrative roles in a public higher education institution (e.g. dean, assistant vice president, vice president, or equivalent administrative position).
- Professional Advancement and Success: The definition refers to an individual's

professional position or rank, longevity in leadership positions, and engagement in decision-making positions that inform policy within higher education.

- STEM: Science, Technology, Engineering, and Mathematics.
- Two-Year Degree Offering Institutions- Public and private institutions of higher education that offer training and credentials that, generally, take two years to complete. These institutions can include junior colleges, community colleges, trade schools and private institutions that offer Associates of Arts and Associates of Science degrees.
- Workforce Education: Programs that support regional economic needs and industry-growth in emerging advanced technologies, specifically in STEM-related fields. (e.g. engineering technology, cyber security, network systems, information technology, advanced manufacturing, electrical engineering technology, biomedical sciences, biotechnology and nanotechnology, allied health, economics, ect.).

Summary

This study was designed to expand the body of literature regarding equity in STEM viewed through the lens of women's experiences. Following this chapter is an analysis of existing literature related to topics addressed by this study. Chapter 3 is a description of the methods used by this study to answer the research questions posed in the introduction. Chapter 4 is a detailed analysis of the data and Chapter 5 will conclude the study with a discussion of the findings related to the existing literature.

CHAPTER 2

LITERATURE REVIEW

The existing literature related to women in STEM professions reviewed for this study focuses on STEM faculty, STEM professionals in private industry, and STEM administrators who have climbed the ranks in higher education settings as full-time faculty who segue into administrative positions. I will review research that focuses on student behavior in STEM fields at the college level and STEM faculty because these groups are also relevant to the STEM workplace professional. Lee (2012) found that women's motivation to pursue education and career pathways in STEM was influenced by stereotypical images of men in STEM career settings. Cordero, Porter, Israel, and Brown (2010) reinforced that women in STEM fields benefited from positive influences that contradicted the stereotype such as mentors and social networks that highlighted women's abilities in math and science.

A dominant discussion in the STEM field is centered on the underrepresentation of women in academic STEM fields and problems related to organizational climate including structure, policies, and practices (Settles et al., 2006). Lack of representation has historically been considered a result of cultural stereotype threat and the belief that activities related to STEM and workforce education were predominately characterized by one gender group (NRC, 2007). The empirical research is focused on factors impacting career persistence and bias that has negatively influenced women's progress and participation in STEM (Cech et al., 2011; Iskander, Gore, Furse, & Bergerson, 2013). For example, men are more readily associated with higher ranked positions with in STEM disciplines and knowledge of the cultural stereotypes can steer women away from pursuing upward mobility in a STEM leadership due to perceived limitations in gender differences (Hill et al., 2010; West & Curtis, 2006).

The research about gender inequity in STEM highlights how cultural stereotypes can affect workplace climate and job satisfaction for women in higher education. Similar studies have focused on career choice relative to gender differences (Walters & McNeely, 2010; Xu, 2008). Further research is needed to confirm the impact specific to institutional barriers at two-year colleges and core questions surrounding the factors that positively impact academic professionals' advancement and retention in leadership positions in STEM fields and factors that hinder their advancement to administrative leadership positions (Ambrose, Dunkle, Lazarus, Nair & Harkus, 1997). The literature review will examine variables that support and impede the development of women in STEM leadership positions including the STEM pipeline, stereotype threat, societal gender bias, culture change in academia, the role of the institution, policy review and reform in higher education, and barriers to self-efficacy and motivation.

STEM Pipeline

STEM professionals. Women in STEM fields (e.g., Biology, Chemistry, Physics, Engineering, Computer Information Systems, Technology, Mathematics) and workforce education can experience obstacles related to career growth without an equitable workplace. Early stereotypes in STEM include workplace recognition, culture barriers, career fit, self-efficacy and social system bias (Ambrose et al., 1997). The research of Glass and Minnotte (2010) highlight that women may advance into leadership positions within industry and academics, yet they have less perceived recognition and significance in their influence as a leader. Federally-funded programs and women's advocacy groups have sought to bring equity into the workplace and encourage best practices for institutions to recruit and retain women in the STEM professions. Federally-funded programs and research initiatives including ADVANCE, WISE, RAISE and Beyond Bias and Barriers address cross-cutting issues related to gender equity in higher education and receive funding through agencies such as National Science Foundation and the National Academy of Science (Laursen & Rocque, 2009; Lincoln, Pincus, Koster, & Leboy, 2012).

The grant program Advance addresses institutional changes needed to combat underrepresentation and gender inequities of women in higher education and in the STEM workforce (Fine & Sheridan, 2006). The program encourages institutional conversations and a call to action regarding departmental climate issues and inclusion in research (Laursen & Rocque, 2009). It is essential that our academic institutions promote the educational and professional success of all people without regard to sex, race, or ethnicity. So that our scientists and engineers can realize their greatest potential, our academic institutions must be held accountable and provide evidence that women and men receive equitable opportunities, resources, and support (Broder, 1993).

Leader efficacy. Dugan, Fath, Howes, Lavelle, and Polanin (2013) conducted a study focusing on 14,698 women from 86 institutions within higher education in the United States. The results from the research indicated women in STEM majors reported the same levels of leadership capacity as their non-STEM peers. However, the undergraduate students participating in the survey demonstrated significantly lower levels of leader efficacy at the end of their senior year compared to other women in non-STEM majors. Although college women in STEM majors report the same levels of leadership capacity, the results showed consistent indicators of psychological barriers and low participation rates in student organizations and learning communities.

Furthermore, the rate of leader efficacy among women in STEM majors increased at a consistently lower rate from freshman to senior year (Dugan et al., 2013). Institutions have made great strides to build inclusion in administrative positions and create equal opportunity for entry of women into leadership positions within the workplace (Ibison & Baily, 2009; Jackson, Hillard, & Schneider, 2014). For the purposes of this study, leadership included the definition of women's upward career mobility where the participant continued to work in the STEM field and progressed in STEM disciplines at the same or higher levels of leadership as compared to men (Hewlett, 2007). Women in these positions will benefit from further research on the tools that equip them for career success that is specific to organizational climate and tangible examples such as female role models that are cited as one of the most important factors leading to a woman's retention in STEM (Sealy & Singh, 2010).

The results of Dugan and Komives' (2010b) research indicate that women's ability to predict their own leadership capacity and overcome the challenges of stereotype threat is a more critical concern within STEM disciplines. The research of Hill, Corbett, and Rose (2010) supports similar findings on academic efficacy and performance. The Hill et al. (2010) study shows that a woman's leader efficacy is strongly influenced by STEM organizational context and a woman's persistence and identity within a STEM community. Dugan et al. (2013) characterized the STEM climate as an area more accommodating for students to exercise critical skills training and research rather than developing leadership potential through membership and leadership development activities. Female STEM majors are more likely to succeed in their academic program, but struggle with activities that indicate leadership efficacy including peer engagement, participation in sociocultural conversations, group membership, and mentoring relationships (Dugan et al., 2013). The research conducted by Hill et al. (2010) shows that women's achievements and interest in math and science are positively influenced by collegial workplace environments.

Hill et al. (2010) draw on eight recent research findings that highlight the social and environmental factors that contribute to the underrepresentation of women in math, science and engineering. The study highlights factors including collegiality, a woman's sense of belonging within the department, and institutional policies regarding parental leave. Lester, Hannah, Harms, Vogelgesang, and Avolio (2011) conducted a series of interviews in a longitudinal field study over six months with women in leadership positions across higher education and the workplace to understand if leader efficacy impacted leader performance. The empirical study concluded that mentoring positively impacted a leader's development. Through a comparison intervention conducted in group settings, the study provided ways educational institutions and organizations can enhance women's levels of leader efficacy and make inclusion and diversity a performance accountability of leadership through effective mentorship models (Ibison & Baily, 2009; Sealy & Singh, 2010).

Gender equity in secondary and postsecondary STEM disciplines. Colwell (2002) suggests that women who are interested in STEM do not persist in critical transition points between secondary and post-secondary education. The representation of women in science and engineering drops substantially from high school on through full professorships. According to Colwell (2002), women have made up over 30% of the doctorates in social sciences and behavioral sciences and over 20% in the life sciences. At large research institutions, women make up only 15.4% of the full professors in the social and behavioral sciences and 14.8% in the life sciences (2002).

According to Etzkowitz, Kemelgor, and Uzzi (2000), institutions can take action by implementing active recruitment strategies and intentional outreach programs to target women as they transition from high school to college, to graduate school, and from doctorate programs to entering the workplace. Because there are proportionately fewer women than men in the applicant pool for tenure-track positions, there will be even less women who advance to administrative positions unless institutions address the leak in the pipeline (Fine & Sheridan, 2006).

Mirroring the Dugan et al. (2013) research results, Hill et al. (2010) emphasized that negative stereotypes impact a woman's aspirations for science and engineering, even if women are equally capable of achieving the same scores in math and science competencies as men in secondary education. The results support Gerstenberg, Imhoff, and Schmitt's (2012) research that concludes that women have a lower self-perception of their mathematical abilities than male counterparts with similar mathematical achievements. Although female performance in high school mathematics matches that of males, there is still a strong belief that women are not as good in mathematics as men (2012). Bridgeman and Wendler (1991) show that gender differences are predictors of college mathematics performance, but are not indicators of a women's ability to achieve high scores in mathematics test.

At the same time, women showed positive outcomes with increased performance in learning environments that offered positive messages from mentors who emphasize the potential women have for increased intelligence and higher scores in math (Hill et al., 2010). The results indicated that women had a more accurate self-awareness and were more likely to assess their skills and abilities in an environment that emphasizes gender equality in cognitive abilities in math and science (2010).

Scott and Mallinckrodt (2005) conducted a study focusing on women's perceptions of science self-efficacy of 41 high school women. The participants were involved in an enrichment program for high school girls with aspirations to work in a science-related field. Findings of this study indicated that women who scored higher in science self-efficacy were more likely to major in STEM fields.

Persistence and retention of women in STEM. Research on human motivation in the workplace has offered insight into worker persistence and retention in STEM professions (Cech et al., 2011; Deemer, Mahoney, & Ball, 2012; Steers, Mowday, & Shapiro, 2004). Studies related to the factors that influence employees' satisfaction and decision to leave a work environment indicate that science and engineering professions are more volatile due to the emerging technologies and in-demand industry workforce (Baumgartner & Schneider, 2010; Lambert & Hogan, 2009). STEM administrators and faculty in STEM professions must stay informed and knowledgeable of the industry changes within high-skilled workforce sectors to align STEM disciplines and curriculum with industry needs.

Extensive research has been conducted on why workers leave employers (Baumgartner & Schneider, 2010; Fouad, Fitzpatrick, & Liu, 2011; Lambert & Hogan, 2009). Several contemporary workplace motivation theories have potential to illuminate factors that influence a woman's persistence and retention in STEM careers. For example, Herzberg's two-factor theory of motivation separates extrinsic and intrinsic factors (Furnham, Eracleous, & Chamorro-Premuzic, 2009; Robbins & Judge, 2012), expectancy-value theory focuses on competency beliefs and values in motivation (Matusovich, Streveker, & Miller, 2010; Osborne & Jones, 2011), and equity theory considers evidence suggesting individuals are motivated to eliminate inequities compared to their peers (Robbins & Judge, 2012). Self-efficacy theory emphasizes that worker motivation occurs when self-efficacy is developed by positive feedback (Robbins & Judge).

Hill et al. (2010) highlight the change offered through institutional reform as faculty and administrators advocate that women can accomplish professional goals while taking time for family care. The authors conclude that early in their careers, women are less satisfied with their jobs compared to men due to expectations regarding scholarly productivity and quality of workplace relationships. More specifically, a significant source of stress for women is the additional time needed to conduct research that is necessary for career advancements (Rosser, 2012). Women who have family-related obligations early in their career are vulnerable to negative social and emotional effects of an academic work environment that is less flexible and less accommodating to work-life balance (Hill, Holmes, & McQuillian, 2014; Hill et al., 2010).

Goldin (2014) examines non-linear compensation when women leave full-time positions for flexible work conditions that perform similar work. According to her research, Goldin shows women are more likely to leave a work environment that does not accommodate the flexibility needed for a healthy work-life balance. As a result, Goldin shows that structural changes to an organization including technological advantages make it easier for companies to provide flexible-hours for employees without compromising the quality of work. However, the gender wage gap still exists when women leave positions with traditional hours for work accommodations that pay less but offer the opportunity to work from home or as needed.

Similarly, Gorman, Durmowicz, Roskes, and Slattery (2010) show that women are more likely to leave STEM fields due to subtle biases and discrimination that can accumulate over time when they experience lower pay for equal work and are not included in department communication. Gorman et al. (2010) highlights another major career disadvantage is the additional needs of women without spousal support who have household, family, and community obligations. In support of Hill et al. (2010), Gorman et al. (2010) show issues to balancing career and family

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Stereotype threat. Ceci and Williams (2007) conducted longitudinal studies which showed that gender related differences exist, but that cognitive ability within science disciplines is not gender specific. Men and women differ in degree attainment and motivation in pursuing and remaining in STEM fields. However, data indicated stereotype threat has a higher impact on the shortage of women in STEM compared to the difference of cognitive strength between genders (Bilen-Green et al., 2008; Ceci & Williams, 2007; Steele & Aronson, 1995). The research of Gerstenberg, Imhoff, and Schmitt (2012) found that individuals were most vulnerable to stereotype threat when they identified with the group that was believed to be underrepresented or considered less likely to perform compared to another group.

The study from Gersentberg et al. (2012) reaffirms Steele and Aronson's (1995) Stereotype Threat Model that examined racial identity in relation to undergraduate performance on standardized tests. Gersentberg et al. (2012) study examines vulnerabilities to a stereotype when individual performance is subject to an individual's understanding of the past performance of a group in which they identify. The researcher used stereotype manipulation to reinforce the findings that women were specifically vulnerable to conforming to the expectation pre-conditioned about the under-performance of women performing a similar task. The authors emphasized psychological barriers that contributed to suboptimal performance across groups including anxiety and degree of worry (2012).

The results of Morganson, Jones and Major's (2010) research offered further evidence supporting the claim that negative stereotypes for women in male-dominated STEM disciplines is identified as a pervasive phenomenon that results in low participation and retention of women in STEM. The findings found that women reported a stronger commitment to a STEM major when they had established social ties and a support network. The results suggest that women benefit more from social coping than men.

Societal gender bias. Cultural perceptions that men are better at math and science than women can lead to gender inequalities as fewer women are willing to enter a career that is riddled with gender bias (Britton, 2010). Researchers link issues of discrimination, motivation, and performance to the lack of gender diversity in STEM fields (Jackson, Hillard, & Schneider, 2014). The research of Xu (2008) supports women's ability to perform in education and engineering work environments. Joshi (2014) concludes that gender integration in science and engineering can shape role expectation. The results of this study indicate that increasing the number of women involved in team assignments will reduce gender bias and improve morale in technical engineering environments. In a comparison study between teams in which women were the majority and those that were gender balanced, the teams that were primarily made up of women showed increased productivity and performance compared to their peers.

Purcell, MacArthur, and Samblanet (2010) considered factors that contribute to gender bias in the workplace including lack of diversity, hiring practices, and limited perspectives within the work environment. The survey responses from their study of women in STEM workplace indicate that societal gender bias is still present in a workplace environment that lacks diversity. Furthermore, the study results highlight that professional expectations are different for women compared to their male counterparts in a climate that has limited perspectives (Purcell et al., 2010). For example, having math self-efficacy is important for women pursuing STEM careers (Cordero et al., 2010). This study concluded that women and men have equal testing abilities in mathematics, yet men have higher self-efficacy in math and science than women (2010).

Self-efficacy. Hoyt and Blascovich (2007) examined women leaders' self-efficacy and responses to stereotype activation. The study focused on women's ability to lead as indicated by their self-efficacy scores. Women with lower levels of leadership self-efficacy had lower perceptions of performance when presented with negative gender stereotypes (Hoyt & Blascovich, 2007). Women can successfully establish themselves as professionals in academic careers even if their experiences differ from men's as they move up in professional status and administrative positions in the academic workforce (Dezure, Shaw, & Rojewski, 2014). The transition from a position as a faculty member to an administration position as a departmental chair or dean is another challenge for women entering positions of academic leadership in the STEM fields (2014). The gravity of certain administrative decisions is potentially more devastating for women who already feel isolated from the community of STEM scholars due to disproportionate female representation in the field (Etzkowitz, Kemelogor, & Uzzi, 2000; Hill et al., 2010).

Additional separation from the academic community due to responsibilities in leadership can dissuade women from entering positions of leadership to protect relations with their peers that are needed to advance their research (Buch, Huet, Rorrer, & Roberson, 2011; Dezure et al., 2014). The strain an administrative position places on a faculty members' relationship with colleagues is a concern shared by both genders; however, there is a greater disparity in how women leaders are viewed in disciplines in which women are the minority (Hill, et al., 2010).

Psychology of women in STEM leadership. Over the past decade, women have been increasingly recognized for their scholarly efforts and leadership in STEM related fields

(Gorman, Durmowicz, Roskes, & Slattery, 2010). Unintentional biases and outmoded institutional structures can hinder the access and advancement of women (2010). Research suggests innate gender differences such as brain structure and function, hormonal modulation of performance, human cognitive development, and human evolution have not found any significant biological differences between men and women in performing science and mathematics (Xu, 2008). Penner's (2015) research shows that intrinsic drive and motivation of women scientists and engineers is demonstrated by persistence in academic careers despite barriers, and that gender has less impact on the underrepresentation of women in STEM compared to societal bias and individual preferences. The representation of women in leadership positions in our academic institutions, scientific and professional societies, and honorary organizations is low relative to the numbers of women qualified to hold these positions (2015).

The research of Risman and Adkins (2014) explore challenges women encounter in their rise to and retention in leadership positions within higher education. In male-dominated STEM-related careers, women must overcome gender-related obstacles to advance and maintain positions of leadership within higher education (Bilen-Green et al., 2008; Dugan et al., 2013; Kincaid, 2015). Academic research related to women in science and engineering from the fields of psychology and sociology address important issues on the potential threats to women in STEM careers.

Bilen-Green et al. (2008) address the stereotype threat and the notion that men are mathematically superior and innately better suited than women. Psychological studies addressing the shortage of female representation of STEM relative to cognitive gender differences have concluded with limited findings related to the superiority of innate ability of men as compared with women (Dugan et al., 2013).

Additional research focusing on barriers within the STEM workplace including bias and work-life balance offer deeper insight into the persistence and retention of women in STEM careers. A study performed by Hewlett et al. (2008) concludes with a series of midcareer challenges found by examining women in STEM professions within the private sector that resulted in women's abandonment of careers within the STEM workforce. The study gave insight into why women made decisions to leave the STEM profession, specifically engineering, through statements of 1,863 women in the field. The results show that well-qualified and highly productive women scientists face barriers when others question their abilities in science and mathematics and their commitment to career. Additionally, women's decisions to leave were related to inequitable compensation, poor working conditions, and an inflexible and demanding work environment that made work-family balance difficult. The qualitative study revealed that women left the field of engineering when they had lack of recognition at work and in adequate opportunities for advancement (2008).

In the academic community, women are hired in tenure track positions at lower rates than men and leave STEM fields at higher rates than men at every career level (Ceci & Williams, 2010; Pinker, 2009). The authors highlighted the following factors that influenced women's decisions to leave the STEM profession: feelings of isolation, an unsupportive work environment, extreme work schedules, and unclear rules about advancement and success (Ceci & Williams, 2010; Dovidio, 2013; Hewlett et al., 2008). Ceci & Williams (2010) findings show that sex differences in career preferences are less to do with discrimination and ability and more to do with lifestyle choices and fertility decisions. When reviewing the gender gap, women are expected to make the greatest career achievements at a comparable age when women are in child-rearing ages and have the greatest physical and emotional demands on their bodies.

Further research is needed to contribute to the research knowledge base on gender equity and the influence of gender bias in STEM academic leadership careers (Settles et al., 2006). Women who are hoping to have children must pursue child-bearing at a time in their career that is most crucial in establishing their career in STEM-research to advance into positions of leadership (Dugan et al., 2013). Across the nation, only 48% of women are in tenured-track academic positions compared to 82% for males. A study by Kittelstrom (2010) found that men who take on parental roles in their early careers are promoted more women who do likewise, and academic fathers advance at a greater rate than women.

Various theories have been used to explain why this gender gap in STEM persists. Male-dominated fields have the potential to create a “chilly” environment in which individuals are isolated or treated differently because of their race, gender, or ethnicity. According to some researchers, this prejudicial treatment can be traced to faculty attitudes on advancement and persistence within STEM disciplines (Riegle-Crumb, 2006; Vogt, Hocevar, & Hagedorn, 2007).

Women who are treated differently based on gender can either feel encouraged due to favorable treatment or powerless based on a hierarchy of power. Women who feel powerless and isolated are more likely to leave STEM disciplines compared to male counterparts. Turban, Dougherty, and Lee (2002) noted that women in STEM programs at the postsecondary level are more likely to leave school without completion at a greater rate as compared to their male counterparts when they experience feelings of isolation.

Cultural Change in Academia

Perceptions of female faculty in STEM. Female faculty members avoid activities and responsibilities in leadership outside of teaching and research due to the extensive time commitment that is required for research and publication in high-quality journals (DeZure et al., 2014; Laursen & Rocque, 2009). Beliefs that women are less capable of achieving recognition for scholarly contributions in STEM fields negatively affect the education, hiring, promotion, and retention of women in STEM (Goltz & Hietapelto, 2013; Jackson et al., 2014). In male-dominated STEM-related careers, women must overcome gender-related obstacles such as unmet achievement needs and lack of recognition of their abilities in math and science to achieve upward career mobility (Dugan et al., 2013; Kincaid, 2015). The research of Deemer et al. (2012) confirm that positive change occurs across gender and tenure status groups within STEM disciplines when women's accomplishments are recognized and accepted in male-dominated disciplines.

Equal rights legislation. Title IX of the Education Amendments of 1972 was intended to help women achieve equal access of education at all levels by prohibiting sex discrimination in education programs (Walters & McNeely, 2010). Title IX of the Education Amendments of 1972 prohibits sex discrimination in education as stated in the following passage:

> No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving Federal financial assistance (Education Amendments Act of 1972, 20 U.S.C. §1681 - 1688).

Many institutions that receive any form of federal funding are required to evaluate their current policy and practices based on Title IX regulations. Title IX can lead to positive improvements in campus environments where women and men of comparable achievements and experience have equal opportunity to advance in STEM (McNeely & Vlaicu, 2010). Over the last three decades, Title IX has been recognized primarily in gender equity in athletics (Hill et al., 2010). The 2004 report significantly changed the climate in higher education as it brought attention to the need for federal agencies to do more to ensure that colleges and universities comply with Title IX and help identify institutional policies and practices that negatively impact the representation of women in STEM (Munro, 2009).

Current research addresses Title IX topics related to recruitment and hiring, compensation, pregnancy and dependent care, work environment, and sexual harassment (McNeely & Vlaicu, 2010; West & Curtis, 2006). McNeely and Vlaicu (2010) reviewed the hiring practices of over a hundred public four-year institutions in the United States. The results indicated an institution's concerted efforts to identify and hire qualified female faculty decreases once institutions meet a specific quota or target to ensure gender equity within a department, as relative to comparable institutional types hiring status (2006). Walters & McNeely (2010) research shows how Title IX of the Education Amendments of 1972 can be used as a tool for combating gender inequities in the academic workforce. Public institutions have to provide services and establish programs that meet federal requirements and remove constraints that limit staff and faculty who have caretaking responsibilities. For example, institutions can require all departments to adhere to family policies that treat pregnancy the same as other temporary disabilities.

Viable advocates. Without viable advocates, STEM disciplines will remain a male-dominated environment that reinforces career stereotypes and lacks female representation (McCullough, 2011). Xu (2008) shows the potential for institutions to successfully recruit and retain women by creating positive messages advocating for women in STEM and aggressively challenging inequality in the workplace. Weber (2011) supports the research of Xu (2008) and emphasizes the impact professional networks and mentoring programs have on women's decisions to actively engage in the career planning needed to consider a future in a STEM field (Buch et al., 2011; Burrelli, 2008).

Women advance and are retained longer in positions of leadership when they participate in professional women's advocacy organizations that create mentoring relationships (Hill et al., 2014). Mid-level faculty of both genders share in the need for career development opportunities and support from professional networks for advancement (McCullough, 2011; Weber, 2011). Although both male and female genders can benefit from practices that support career mobility in STEM disciplines (Buch et al., 2011), outcomes of interdisciplinary research identify that interventions that promote a collaborative learning environment and professional network opportunities will address the challenges specific to women's promotion and attainment of academic leadership positions (Buch et al., 2011; Laursen & Rocque, 2009; McCullough, 2011).

Despite the evidence-based practices showing the positive outcomes of women's participation in professional networks, Polkowska (2013) highlights the difficulty women have engaging in informal networks within male-dominated STEM fields. Advocates, both male and female, offer women additional channels of communication and give women access to key resources. Informal networking in STEM departments with role models of both genders can be equally effective (Drury, Siy, & Cheryan, 2011; Sturm, 2006). Male and female advocates can support women faculty by offering a support structure with potential to deepen their understanding of organizational policies, the political climate, research and funding opportunities, and pathways for advancement (Polkowska, 2013).

The research of Drury et al. (2011) shows that men and women alike can have a positive effect on the recruitment and persistence of women through professional interactions and mentoring. Hill et al. (2010) highlight that female mentoring programs create positive reinforcement for the value of women in leadership and build a sense of belonging among women in STEM fields. Small changes in institutional environments can have a large impact on women's satisfaction and retention in STEM careers and positions of leadership (Buch et al., 2011). Creating mentoring programs, developing STEM pipelines, and encouraging participation in professional organizations that empower women in STEM are evidence-based best practices that institutions can implement to advance women in STEM careers (Gorman et al., 2010; Laursen & Rocque, 2009). Women in male-dominated STEM fields may feel that the pace of their professional career is non-traditional with time away from the workplace and less professional accolades than male counterparts. However, all advocates for the advancement of women can help build awareness for the value of family and work/life balance for all faculty, especially new mothers (Hill et al., 2010; Kittelstrom, 2010).

Participation in women's organizations such as the Women Chemists Committee of the American Chemical Society, American Association of University Women, and Society for Women Engineers, improve the condition of women in the STEM workforce and reinforce the importance of women in positions of leadership in STEM disciplines (Bordonaro, Borg, Campbell, Clewell, Duncan, Johnson,…Vela, et al., 2000; McCullough, 2011). To improve participation in STEM leadership, women must enlist other women to be involved in mentorship programs that will guide others down similar STEM pathways (DeZure et al., 2014). A woman who takes time off for raising her children may have a slower pace in accomplishing professional goals like tenure or academic leadership positions, but can still reach for and be retained in leadership positions.

The Role of the Institution

Faculty and administrative perceptions. As the culture of women in academia continues to promote equity within STEM disciplines, educational leaders must identify the institution's role in addressing significant barriers to women's attainment of positions of leadership (DeZure et al., 2014; Goltz & Hietaplto, 2013). Research trends focus on gender equity, retention, motivation, and success of women in STEM disciplines, primarily at four-year research institutions. A study conducted by Laursen, Austin, Soto, and Martinez (2011) reported strategies for addressing shortcomings and finding the means to support the success of women in STEM. The study used a mixed methods approach to draw upon conceptual frameworks addressing organizational change. The study guides institutions on identifying institutional change interventions and examples of strategies to support women through the structural, human resource, political, and symbolic perceptions of women in STEM disciplines (Laursen et al., 2011). To emphasize the research findings, the authors provide examples of cross-institutional projects that have been successful in creating cultural shifts in faculty and administrative perceptions toward women in STEM disciplines.

Both quantitative and qualitative data confirm that women are underrepresented compared to their male counterparts in academic STEM leadership positions (Su, Johnson, & Bozeman, 2014). However, some authors posit that colleges and institutions can implement evidenced-based strategies to increase the number of women in leadership positions (Hallar, Avallone, Thiry, & Edwards, 2015; Sturm, 2006; Su, Johnson, & Bozeman, 2014). In the mixed methods approach, Su et al. (2014) interviewed principal investigators in STEM from various institutions to explore strategies that have been effective in impacting organizational culture. Over 170 participants and leaders were interviewed to determine interventions that best fit a specific institutional context. The results showed that departmental comradery and leadership equity within hiring practices impacted women's perceptions of institutional culture.

Su et al. (2014) support the findings of Hallar et al. (2015) and Dovidio (2013) that highlight the challenges women in scientific disciplines face including work-life balance, family issues, feelings of isolation, lack of female mentors, and male-oriented culture in science. A similar study by Etzkowitz et al. (2000) provides quantitative evidence documenting women's experiences in five science and engineering disciplines at 11 universities exploring women's entry into positions of leadership within academia.

Policy review and reform. As institutional members build awareness for issues related to gender equality, policy review and reform will continue to develop across disciplines and expose the specific needs within STEM departments (Jackson et al., 2014). Rosser and Lane (2002) document the impact of additional funding for programs related to equity and institutional transformation has on the increased entry of women into science and retention of women in academic STEM disciplines. Research by Etzkowitz et al. (2010) defends the pervasive personal and career difficulties women discuss during interviews regarding their university experience.

Etzkowitz et al. (2010) argue the success of women scholars, particularly in the STEM fields, requires institutional environments that are conducive to women's specific needs. Institutions that focus on inequity in STEM positions of leadership have the potential to create systematic change across departments. DeZure et al. (2014) confirm that negative cultural perceptions and gender inequalities in higher education contributes to the shortage of female administrators and faculty in STEM related careers. Compounding this challenge, many women struggle to keep a healthy work-life balance, and mid-career faculty often view leadership roles as an extra burden of responsibilities and time commitments (2014). Leadership positions can also deter women from pursuing research or teaching in the STEM fields (Schuster, 2006; Sturm, 2006).

Through collaborative efforts in higher education, institutions make efforts to change hiring practices and assess faculty perceptions and attitudes toward women in the academic workplace (Goltz & Hietapelto, 2013; Su et al., 2014). Upward mobility in the academic workforce is especially difficult when women must address matters that pertain to the physical changes and conditions surrounding childbirth (Kittelstrom, 2010; Massachusetts Institute of Technology, 1999; Rosser, 2004). For example, women can face discrimination if they make sacrifices for family planning (Mason et al., 2013). If women experience discrimination due to issues related to family planning or childbearing, they need advocates in the academic community leaders who recognize that women can be successful as caregivers and as working professionals (Hill et al., 2014; Mason, 2013).

Women may experience unfair treatment and impediments to their professional mobility if critical institutional administrators or colleagues view childbearing or motherhood as a detriment to a woman's professional success (Hill et al., 2014). Depending on the institutional climate, some departments are more willing to adhere to policy than others (Olivas & Benjamin, 2011; Su et al., 2014). A strong support network provides opportunities for professional advancement and gender equality from individuals who advocate for needs that are unique to women (Goltz & Hietapelto, 2013; Kincaid, 2015; Weber, 2011). Even amidst these challenges, many women have been recognized for their scholarly efforts and leadership in STEM and have prepared pathways for the next generation.

To create gender equality within our academic workforce, human resources staff and institutional recruiters must reinforce policy that deters discrimination and change any negative perceptions of women in the workplace. A cultural shift will take place when institutional members build awareness for issues related to gender equality that are addressed in each department throughout disciplines (Jackson et al., 2014). As both men and women continue to compete for senior-ranked positions of leadership, advocates for gender equity is vital for transformation of institutions.

Institutional types. The research of Gerstenberg et al. (2012) and Riegle-Crumb (2006) show extensive research conducted at four-year research institutions and private colleges; however, there is a gap in the research needed to understand equity in STEM leadership positions at community colleges in relation to systemic approaches to increase the representation and advancement of women. Pascarella, Ethington, and Smart (1988) observed that women attending a public university are more likely to enter a scientific discipline than women who attend a private institution. Federal funding through initiatives including National Science Foundation, Improving Undergraduate STEM Education grant program, and the National Institution of Health, Bridges to Baccalaureate grant program emphasize the need for undergraduate research to occur within STEM disciplines at two-year colleges. However, data show a greater number of students at two-year colleges are underprepared for the rigor of upper division STEM disciplines after transfer (Gerstenberg, 2012; Riegle-Crumb, 2006).

Institutions can offer varying educational differences for undergraduate students that are also present among working STEM professionals (Burrelli, 2008; Cech et al., 2011; Laursen & Rocque, 2009). For example, two-year colleges that are non-residential commuter institutions may offer fewer opportunities for engagement and interaction among faculty and staff compared to a large research institution. STEM faculty at institutions with a high online participation may be less available on campus because their office hours and professional responsibilities are met in the online arena (2009).

Faculty interactions through on-campus initiatives can be dependent on the number of interactions that are available across a broad range of educational platforms and institutional types. As highlighted in the research of Scott and Mallinckrodt (1995), women who engage in research and participate in leadership activities are more likely to persist in the sciences. Further research is needed to understand the impact institutional type has on faculty engagement in leadership, specifically at two-year institutions that have limited scientific research being conducted by faculty (Riffle et al., 2013).

Over the last decades, institutions have made great strides in changing institutional outcomes and policies related to gender equity and creating accommodating conditions for women seeking to advance their careers (Risman & Adkins, 2014). However, despite the changes in academic climate, significant gaps still exist, specifically when women experience perceptions of low autonomy and institutional support. Although there is an understanding of what institutional factors influence a women's satisfaction and motivation in STEM disciplines, the role institutions play may differ across institutional type with varying campus climates present at two-year colleges, four-year research institutions, and small private colleges.

Workplace environments. Barriers such as negative stereotypes and gender bias may deter women from entering and staying in academic leadership positions (Britton, 2010); however, further research is needed to identify institutional factors that may be more conducive to women's advancement in leadership positions (Buch et al., 2011). Hill et al. (2014) reviews the barriers women faculty face early in their career when competing for full-time teaching positions within STEM due to lack of child-care on college campuses (Kittelstrom, 2010; Mason et al., 2013).

Negative social perceptions that institutions are not willing to allocate funding to assist with childcare can be especially detrimental to parents early in their career. For example, two-year colleges that have increased partnerships with childcare service providers can accommodate the large population of non-traditional working students who have childcare needs. Mid-career faculty have more access to the resources available to assist with childcare and fewer restrictions on time required on campus at a commuter non-residential campus (Kittelstrom, 2010).

According to Burrelli (2008), from 1973-2006, fewer career promotions with increased wages were given to married women and women with children. Depending on the competitive climate in the department, faculty may choose to abandon personal obligations to invest additional time and effort in advancing their careers (Risman & Adkins, 2014). Kittelstrom (2010) recognized that women who are committed to succeeding in a male-dominated STEM field may abstain from family planning or relationships that create added time commitments outside of professional efforts. Kittelstrom’s (2010) research shows that men and women struggle to establish themselves early in their profession and invest the most time into their academic disciplines in their 20s and 30s. Consequently, this is the same age groups are investing in family development and raising children that can create challenges with work life balance. The research of Bordonaro et al. (2000) explores the careers of men and women scientists and the conditions of academia on the relations among STEM faculty. The research reveals motives of scientists and faculty to pursue leadership positions per institutional types is still limited and specific to four-year institutions.

The National Science and Technology Council for the Advancement of Women and Minorities in Science, Engineering, and Technology recognize the need to diversify our STEM workforce and leaders to maximize the innovation, creativity, and development in both academia and industry (Bordonaro et al., 2000). The research of Buch et al., (2011) Gorman et al., (2010) and McCullough (2011) support the success of program initiatives that expose women to academic pathways that are grounded in peer network and mentoring.

Gorman et al., (2010) include strategies from a case study institution, Stevenson University, to demonstrate a model for effective practices. The findings where that women respond best in more collaborative learning environments with additional opportunities for group work and interaction with peers. For example, academic administrators showed positive outcomes including retention and professional improvement when they participated in one or more national meetings targeted to academic leadership.

As McCullough (2011) reports, women must continue to advance and remain in academic leadership positions in the STEM fields to provide effective networking and advocacy for other women to enter the field. The qualitative study concludes that women responded well when they engaged in a small group of colleagues that offer support, guidance, and mentoring in academic growth and professional development.

Summary

This chapter provided an analysis of existing literature related to factors that hinder the advancement of women within STEM disciplines and changes that have occurred over the last few decades within higher education to support the advancement of women in higher education and broaden participation in STEM. This study will contribute to the body of literature regarding equity in STEM specific to institutional support mechanisms and policy changes that offer additional support for women. Following this chapter is a description of the methods used by this study to answer the research questions posed in the introduction and further explore the findings cited in the literature review in this chapter.

CHAPTER 3

METHODOLOGY

This chapter will detail the methodology of the study. The chapter will examine scholarly literature that follows a similar framework to the study proposed in this document and highlight the research design, sampling frame, data collection procedures, data analytics, and justification.

Research Questions

This research was guided by two specific questions that were addressed through data collection and analysis:

1) What factors have the most impact on women's professional advancement and success in leadership positions within STEM and workforce education-related disciplines at two-year institutions?
2) What factors inhibited women's professional advancement and success in leadership positions within STEM and workforce education-related disciplines at two-year institutions?

Research Design

The Delphi technique offers a system for collecting data using a panel of experts within STEM and workforce education programs related to STEM to generate consensus on the most important factors related to the research questions (Hsu & Sanford, 2007; Rowe, Wright, & Bolger, 1991). The approach will increase the confidence of the results by obtaining consensus from experts through a group communication process while providing anonymity to the respondents (Dalkey, 1972; Okoli & Pawlowski, 2004).

Schmidt (1997) provides a framework for the study through a controlled interaction with multiple rounds that allows for independent thought and assists experts through a problem-solving process until a unified opinion emerges and is decided upon by group consensus. Participants have the opportunity to explore the topics related to the research question over multiple rounds without pressure to conform to the group response that may be present in an in-person focus group setting and they can continue to improve the accuracy of results between rounds (Ludwig, 1997).

The study includes four rounds built on the framework of Schmidt (1997) that provides the guidelines for conducting a Delphi study to explore the research questions. The Delphi technique was the most appropriate approach because it draws a conclusion based on group consensus after soliciting qualified experts to explore an emerging phenomenon in STEM education. The study addresses the need to examine factors related to institution type through a controlled process that assists experts in the “gradual formation of a considered opinion” (Stitt-Gohdes & Crews, 2004, p. 62). The four rounds of the study includes the perspectives of a purposive sampling of former or current administrators who have overseen STEM or workforce programs at institutions that offer two-year degrees in workforce education related STEM disciplines.

The Delphi technique offers a mechanism for group decision to explore the issues related to their advancement or obstacles that hinder their advancement based. Participating experts will be selected based on their experiences and knowledge of higher education culture, departmental climate, stereotype threat within STEM fields and administrative experiences within STEM, and membership within a women’s advocacy organization or program focused on broadening participation in STEM. The Delphi procedure offers the group controlled feedback and anonymity to the process to reduce the effects of group persuasion, social pressure, or individual dominance of the group opinion that is important due to the sensitive nature of the topic being explored (Dalkey, 1972; Dalkey and Helmer, 1963; Hill & Fowles, 1975).

A Delphi study relies on the judgement of the experts to forecast information related to the research question that is then collated by the researcher to create a comprehensive list and is submitted to the panel for consensus (Powell, 2003). This approach is a pragmatic research method for building practice theory, for informing direct practices and for decision-making (Ried, 1988). The Delphi process is suited to inform administrators and researchers in higher education on the key factors concerning organizational climate, institutional policies, and departmental conditions that impact women's advancement or hinder their advancement in STEM fields.

Although data are available for the factors that lead to women's persistence and retention in STEM disciplines, further research is needed that is specific to the institutional type and cultural climate at two-year degree offering institutions concerning women in STEM and workforce education (Cech et al., 2011). The Delphi methodology will generate consensus amongst expert panelists utilizing multiple iterations through intentional consideration and deduction to fulfill an emerging phenomenon related to gender issues and diversity within STEM at two-year institutions (Dalkey, 1972). As a result, the method will employ a problem-solving oriented approach to research and minimize the effects of noise within traditional qualitative studies (Hsu & Sanford, 2007).

The Delphi approach is limited to the experts' interests in the findings and willingness to make meaningful contributions; however, a consensus can be reached through informed judgement based on re-submission of the results after the data in the previous round have been analyzed (Okoli & Pawlowski, 2004: Wilhelm, 2001). The study relies on guidelines within literature on the Delphi process for choosing the most appropriate experts to increase the quality of the responses (Schmidt, 1997; Williams & Webb, 1994).

By employing a four-round sequence to determine the factors that are most relevant to the research questions, the panelists will first identify the factors and then in subsequent rounds, further clarify and rate the factors. The Delphi technique will obtain opinions from a group of experts from a variety of STEM disciplines with characteristics designed to offset shortcomings of conventional means of pooling opinions from a group interaction (Dalkey, 1972; Stitt-Ghodes & Crews, 2004). The strategy is particularly important to the research questions, so the responses of the experts are not limited to individual experiences, but the agreement of the group as a whole to establish optimal assessment of the factors (Dalkey, 1972; Taylor & Judd, 1994).

The Delphi method has the flexibility to allow a consensus to emerge in a space that is not inhibited by individual persuasion of the most dominant group members (Dalkey, 1972; Schmidt, 1997). The process allows for an honest opinion with the potential to educate the group through interrelated aspects of the topic that includes a wide-range of opinions from experts that represent the diversity within STEM (Settles et al., 2006; Williams & Webb, 1994; Young & Jamieson, 2001).

Research Setting

Size and Composition of the Panel. The Delphi method focuses on selecting experts on criteria identified by the researcher and consistent with the literature on the knowledge and background necessary for the panelists to be qualified to offer an informed opinion on the research topic (Hsu & Sanford, 2007; Jacobs, 1997). The panel size was determined based on the anticipated response rate needed from a minimum of 10 participants (Delbeq et al., 1975; Okoli & Pawlowski, 2004; Williams & Webb 1994). Because the Delphi method is dependent on a relatively limited number of experts with the knowledge about the research question, the researcher will solicit a panel size up to 20 to ensure there will be a minimum number of 10 after attrition. Although the sample size can range from 10 to 1685 participants, the size is subject to the researcher's needs in fulfilling the standards of the research questions being explored (Murphy et al., 1998; Reid & Nygren, 1988).

The target panel size is consistent with Dalkey's (1967) group estimation process in achieving experimental results with small discussion groups. The size relates to the quality of the results generated because the purposive sample requires specific criteria from the panelists regarding their current or former role within administration at an institution that offers two-year degrees. The range of the panel size is arbitrary because it varies according to the needs of the study for achieving the appropriate response rate from a panel composed of members who have been singled out based on their expertise, experience, knowledge, and skill in offering sound judgement and information processing capability on the factors being explored (Delbecq et al, 1975).

The study is set at a minimum of 10 participants to constitute a minimally sufficient pool of experts that represent the diversity within STEM fields and workforce education disciplines specific to STEM (Delbecq et al, 1975). An initial purposive sample of 10 former and current administrators identified by the researcher will be invited to participate in the study based on their qualifications. A snowball sampling technique will be used to recruit at least an additional 10 eligible panelists from among their peers based on their understanding of the research questions. A minimum of 20 panelists will be selected to participate in the first round to adjust for attrition in the second, third, and fourth rounds to ensure a minimum of 10 respondents within the last round. Attrition rates vary according to sample population and Delphi techniques that employ more than four rounds. White's (1991) study had low attrition rates (4%) compared to Farrell & Scherer (1983) study that had an attrition rate of 8% from the panel.

The design of this study is consistent with the preponderance of advice in the literature for the selection of panelists because the identified members must be based on more than just knowledge on the target issues (Oh, 1974). Schmidt (1997) creates standards in choosing the panelists based on additional characteristics including backgrounds and experiences. The researcher will establish the first level of criteria for determining potential panelists' eligibility under the following guidelines. The panelists must self-identify as female and they must have experience as a former and/or current administrator overseeing STEM and workforce education programs at two-year degree offering institutions.

To be eligible to participant, the panelists were required to be female and must have held a Ph.D. or terminal degree in their field. Panelists will be asked to self-disclose information regarding their current and previous roles in administration within STEM and additional qualifications such as experiences and research background in STEM-disciplines. They also must be an active member in national and regional chapters of organizations that promote broadening participation of women in higher education and STEM such as the Society for Women Engineers, American Association for Women in Community Colleges, Society for Women Chemists, and selected federally-funded programs through the National Science Foundation that focus on the inclusion of women in STEM. In addition to active membership, the researcher will choose the most qualified panelists to participate in the study to ensure a variety of STEM disciplines are represented and the panelists have adequate academic backgrounds and research experiences in STEM and workforce education-related fields of study.

The researcher will send out an introductory email to the most appropriate individuals to serve on the panel based on the established criteria including their expertise and career longevity within STEM and understanding of issues related to leadership and gender equity within STEM fields, and their previous or current role at their respective institutions. After an initial 10 eligible panelists are identified, the researcher will ask the panelists to confirm their willingness to participate in the study and to provide nominations of respected individuals that also meet the criteria within the target group (Jones & Twiss, 1978). The researcher will invite experts who self-identify as female to participate and meet the established criteria in the study and will stop when the maximum number is reached with a pool limited to the individuals who sufficiently met the study's criteria (Schmidt, 1997). Prospective panelists will be emailed a letter of introduction to the study requesting their commitment to participate.

To ensure that multiple STEM disciplines and workforce education programs within the STEM fields are represented, the research will send a letter of introduction to a minimum of 20 eligible panelists that represent a variety of STEM and STEM-related workforce education disciplines to ensure that diversity of STEM fields are obtained. The panelists only interact with the researcher and will not provide the names or location of the other panelists to minimize pressure to conform to other panelists based on personal ties or biases (Dalkey, 1972).

The researcher will ask panelists to provide opinions based on their experiences with the aim of eliciting a broad range of responses (Hasson, Keeny & McKenna, 2000). However, there is potential for a narrow range of opinions because the panelists will be enlisted by specific set of criteria related to their role as administrators within STEM and knowledge of issues pertinent to women's advancement in higher education (Rescher & Helmer, 1959; Judd, 1972).

Data Collection and Analysis

The study will consist of four rounds. Each round will include a questionnaire that the researcher will e-mail to the panelists. This will expedite the time between rounds as compared to a design that uses hard copies that rely on the postal system. The researcher will ask all respondents to return the survey directly through email. One week after the initial email is sent for each round, the researcher will ask panelists that have not responded to indicate if they intend to respond and why they did not respond. Individuals will be asked to include their name, institution, and role as a former or current administer in STEM or a workforce education related field. The questionnaires will be guided by the survey design and follow Schmidt's (1997) framework for rating factors in the panelists' responses. The rounds include 1) identifying factors related to both research questions; 2) aggregating the list of factors identified by the group-at-large and identifying missing factors; 3) rating each item based on panelists' perceptions of each item; and 4) obtaining group consensus on the final factors that were previously identified and rated.

Round 1. Delbecq et al. (1975) estimates that a Delphi study can take up to five months to complete. To accelerate the turnaround time and thus response rate, the researcher will ask the panelists to choose a maximum of three factors for each research question in the first round. The researcher will also ask panelists to add a two or three sentence description for each factor (Okoli & Pawlowski, 2004). The description will serve the purpose of providing a qualitative element to use when interpreting the panelists' intent. It will also assist in the categorization of factors when the data are consolidated and coded for the next round because panelists may identify similar issues using different terms (Hsu & Sanford, 2007; Schmidt, 1997).

The first round is specific for collecting information about the content area that requires the panelists to be more creative in their responses compared to the subsequent rounds that requires judgement opinions and decision-making to rate the factors (Custer, Scarcella, & Steward, 1999). A review committee made up of educational researchers who are not panelists in the study will interpret the descriptions, code the data, and aggregate the list of factors based on emerging themes. The review committee will have experience with qualitative research, gender studies, research within higher education administration, and understanding of organizational climate and structure at two-year degree institutions. The committee will aggregate the list of factors based off emerging themes, categorize similar responses and provide common descriptions for each one.

The data collected will be sent out in Round 2 to validate the consolidated lists of factors based on common themes and descriptions for each factor that addresses both research questions. Because the initial phase is brainstorming, the review committee will review the descriptions the panelists provide for each factor and eliminate identical responses to consolidate the list to make each factor more distinguishable as related to the literature in preparation for the next round (Okoli & Pawlowski, 2004).

Round 2. The second round utilizes a modified questionnaire with the consolidated list of factors from the review committee based on the analysis of the data obtained in the first questionnaire. Panelists will be asked to review the findings that the researcher, in collaboration with the review committee, summarized from the first round. The researcher will ask panelists if there are additional factors or modifications that need to be considered in their responses that require further clarification for the categorizations that were created. The panelists will identify additional factors that are relevant to each research question that may be missing or need additional clarification from the last round. This round provides a basis for achieving agreement on the researcher's interpretation of each category and to ensure a valid, consolidated list was produced by the review committee (Schmidt, 1975). The randomly ordered list from the first round will allow the panelists to agree on an established list of factors that are relevant to the research questions.

The panelists will be asked to refine the categories, if necessary, and provide a brief description of why they included any additional factors, if any (Jacobs, 1997). The second round builds an understanding of the groups' responses and creates the categories that emerged from Round 1. In this round, the panelists will provide judgements on the importance of each item and insight on why they included any additional items that were outside the original lists of factors identified (Dalkey, 1972).

Round 3. In the third round, the researcher will ask panelists to review the list of factors for each research question and rate each factor identified in Round 2. The researcher will ask panelists to rate the factors by relevance to the research questions (Schmidt, 1975). The rating scale consists of a five-point Likert-type scale with a numeric value (5 point = Most Relevant Factor, 4 point = Significant Relevant Factor, 3 point = Moderate Relevant Factor, 2 point = Limited Relevant Factor, and 1 point = Not Relevant Factor). The factors will be randomly arranged to eliminate bias to ensure the panelists are not influenced by the groups' responses in the previous round. The purpose of Round 3 is to validate relevance of the factors in relation to the research questions and reach a consensus in the ratings within the categories identified in Round 2. The researcher will establish a factor as relevant based on a mean score of 3.50 or higher on the 5.00 scale based on Delphi studies that used a similar cut off score as appropriate (Kosloski & Ritz, 2016; Martin & Ritz, 2012; Pate, Warnick, & Myers, 2012).

Because the panelists were intentionally selected based on their homogeneity in experiences, background, and knowledge as subject matter experts, there should be less difficulty identifying relevant factors and reaching a consensus compared to studies that include a large diverse sample population (Delbecq, 1975). The researcher will establish that the panelists reached consensus for any factors that have an interquartile range (*IQR*) 2.00 or below (Childress & Rhodes, 2006; Kosloski & Ritz, 2016). Factors with an interquartile range *(IQR)* over 2.00 indicates that consensus has not yet been gained due to the high dispersion of the ratings for each factor.

Round 4. In Round 4, the panelists will be sent their individual ratings from Round 3 along with the group mean (*M*), median (*Mdn*), interquartile range (*IQR*), and standard deviation (*SD*) for each factor. Panelists will have the opportunity to change their ratings in Round 4 after considering their individual ratings in Round 3 compared to the group response. Round 4 offers further identification of relevant factors based on anything with a mean of 3.50 or higher and an *IQR* of 2.00 or lower that indicates that the factor was relevant and consensus was reached. Four rounds should be sufficient based on the degree of consensus necessary to identify the most relevant factors based on the minimum mean score threshold of 3.50 (Delbecq et al., 1975: Kosloski & Ritz, 2016). Panelists will only submit the new ratings to factors that differ from their original rating in Round 3. I will use the ratings to determine the factors that have met the relevance threshold ($M \geq 3.50$) and eliminate factors that do not reach the cut off score.

Quantitative Procedures

I will establish guidelines for quantitative analysis to determine the panelists' rate of agreement based on an *IQR* of 2.00 or below and on the highest rated factors identified by a mean score of 3.50 or above (Kosloski & Ritz, 2016). By using measures of central tendency and level of dispersion to show collective judgement of the panelists, I will determine relevance of the factors based off the group mean for each factor once the expert panelist send their final ratings in Round 4 (Hasson, Keeny, & McKenna, 2000).   I will use the mean score to report the data based on relevance, a criteria which Jacobs (1997) recommends to describe the convergence of group opinion to related items. I will use the scores to find the factors that show both relevance and consensus to arrive at a final list of factors determined by the panelists.

Summary

The sampling frame, data collection, and data analyses have been described in this chapter. Chapter 4 outlines the results of data analysis. Chapter 5 will explore implications of these findings and identify areas for future research.

CHAPTER 4

FINDINGS

This chapter will present the findings for the study. The four rounds of the Delphi were presented to the panelists from February 2019 to May 2019. This chapter will summarize the findings from each Delphi round and the responses collected from the panelists.

Round 1

The criteria for the panelists included gender affiliation as female, role as a former or current administrator in STEM or related workforce education programs, a membership in national or regional chapters of the Society for Women Engineers, American Association for Women in Community Colleges, Society for Women Chemists, and selected federally-funded programs focused on broadening participation in STEM. In addition to active membership, the researcher chose panelists that represent a variety of STEM disciplines and were the most qualified, based on their expertise and career longevity within STEM, to possess an understanding of issues related to leadership and gender equity within STEM fields.

On February 24, 2019, the researcher sent an introductory email to 10 panelists who met the criteria set by the researcher (Appendix A). On February 25, 2019, an additional 12 emails were sent based on nominations from the previous 10 panelists. This process yielded 15 eligible female administrators willing to serve on the panel from varying STEM disciplines. To increase the pool of potential panelists, the researcher compiled a list of an additional 10 administrators that were nominated by panelists, until 20 eligible panelists who met the eligibility criteria agreed to participate. Individuals who were nominated that served in administrative roles in STEM and workforce education were not considered if their academic background or faculty experiences were not relatable to the STEM and related workforce education division within their administrative oversight. For example, if a panelist's previous faculty appointment and research were in an area outside of STEM (e.g. Public Administration or Communications), they were not selected even if their Dean's appointment included STEM areas of oversight.

Each panelist's membership and active participation in a professional organizations or federally-funded grant program that promotes broadening participation of women in STEM fields was verified by the researcher through verbal and membership confirmation. After invitations were sent out to 28 potential panelists, a total of 20 panelists agreed to participate by responding yes to the invitation through email. On March, 1, 2019, the 20 panelists who agreed to participate in the study were sent the Round 1 introduction letter (Appendix B) and survey (Appendix C). Panelists were asked to complete the Round 1 survey within a two-week period. This round consisted of two sections.

Round 1 Section 1. The first section asked the panelists for specific demographic information confirming name, affiliated institution that offered two-year degree programs, and former or current administrative role in STEM or a workforce education-related field. In the second section of the survey, panelists were asked to provide two to three factors that had the most impact on their advancement and success in leadership positions within STEM disciplines and the factors that inhibited their advancement and success in leadership positions within STEM disciplines.

In Round 1, 17 out of 20 (85%) panelists responded to the surveys and sent their responses back through email by March 19, 2019. One panelist representing Allied Health, one panelist representing Mathematics, and one panelist representing STEM-related Fields within Workforce Education failed to respond after follow-up. These three panelists were withdrawn from the study.

The first section of the Round 1 survey revealed that the panelists were responsible for STEM and related workforce education programs. The most common STEM cluster was Mathematics (6), followed by Workforce and STEM Education (4), then Health (3), and last, Engineering (2).

Table 1

Panelists' Area of Responsibility by STEM and Workforce Education Program Affiliation

STEM and Workforce Education Program	# of Panelists
Mathematics and Related Fields	6
Workforce and STEM Education	4
Health	3
Engineering	2
Aeronautics	1
Environmental Sciences	1
Total	17

Eight of the panelists served as deans within a STEM academic discipline, six of the panelists were in administrative roles and oversaw federally-funded STEM and STEM-related workforce education programs as a director or principal investigator, and three of the panelists served as Assistant Vice Presidents responsible for STEM and workforce education-related programs. All panelists had a minimum of three-years of experience within an administrative role as a program chair, dean, principal investigator, or assistant vice president and all panelists had extensive research and academic experience within their related STEM discipline. All panelists held a doctorate or a terminal degree within their field and are active members in an organization that promotes the advancement of women in leadership and STEM fields.

Table 2

Panelists Current or Former Administrative Roles

Administrative Roles	# of Panelists
Dean	8
Principal Investigator or Director of a Federally-Funded STEM and Workforce Related STEM Program	6
Assistant Vice President	3
Total	17

Round 1 Section 2. In the second section of the Round 1 survey, panelists were instructed to provide two to three factors and a few sentences describing each factor or related experience for context. Table 3 lists a few of the exemplary responses from the panelists that relate to the categorized themes that emerged.

Table 3

Round 1 Examples of Responses on Factors related to Each Research Question

Examples of Panelists' Responses on Factors that Lead to Advancement
Background in industry related to STEM and CNC programming.
Mentoring. Mentoring is a key component as I was able to learn the culture of my organization, placed on strategic initiatives, and grew as a leader.
A network of individuals who can assist me with specific concerns that arise.
Access to quality professional development throughout my career in higher education.
I mastered the classroom and wanted a challenge to take my career to the next level.
An empowering undergraduate experience at a historically, black college or university HBCU and majored in a STEM field with a number of strong women mentors.
Interpersonal and leadership skills that enhanced collaboration and respect of others.

Table 3, *Continued*.

Examples of Panelists' Responses on Factors that Lead to Advancement
Supportive supervisors who gave me space to introduce my direct reports to new instructional Strategies.
Participation in leadership programs and corporate training for administrators and the institutions leadership academy.
Being in a high-profile profession that has been a focus of the college's marketing plan and is recognized nationally for excellence.
Varied background experiences in STEM.
Support and mentorship of a female who helped me develop my leadership skills and encouraged me to pursue a job opportunity that I otherwise would not have considered.
Community colleges tend to have a higher percentage of female in their STEM faculty ranks, so there was not a problem within the academic division.
I received support guidance, networking, a strong community from women who shared a similar identify and background.
Willingness to participate in a lot of STEM activities and initiatives early in my career combined with the opportunity provided for me by my institution to have access to these activities.
Adapting to change – In my environment (which serves the business world) our response have to be fast and nimble.
Panelists' Responses on Factors that Inhibited Advancement
Connections to STEM through vocational trade education that others do not always value or understand the linkages to STEM topics.
Oversight of vocational programs is often delegated to a director, where in other STEM areas oversight is delegated to a dean. As a result, leadership opportunities and effectiveness are impacted.
Parental responsibilities forced me to make choices while my children were young that changed my trajectory and delayed me taking the initiative to apply for a leadership position.
Lack of support from the current administration inhibits the implementation of positive changes.

Table 3, *Continued.*

Panelists' Responses on Factors that Inhibited Advancement
My graduate advisor was male and did not appear to respect the capabilities and contributions of women.
I was treated as an outsider as the only female at the table while working with industry partners.
Invisible walls for women due to the majority of male leaders in STEM fields.
I definitely think my gender plays a role in people forming first opinions of me.
Individuals countering my decisions and not being considered a valued member at the table.
Lack of experience in the field and limited confidence.
Limited exposure to other college employees and college activities due to working remotely or on a smaller branch campus.
The absence of a supportive, affirming culture in many places I sojourned for a time.
A negative experience in a graduate program with minimal faculty support and little recognition as a woman of color.
Unwieldy policies and procedures make it difficult to accomplish simple tasks.
I have balanced parenting, and more recently caregiving for my parents with my career. I have at times stepped away from work for extended periods of time to address family needs. This balancing process is often not required of my male counterparts.
I was treated more like a servant rather than a leader by colleagues that was a stark contrast to how male deans were treated in a similar role.
In advocating in STEM vocational programs, I am cognizant of the "hysterical female" or "emotional female" and other stereotypes, which may at times impact the success of my argument in ways a male would not be impacted.

Following the completion of the Round 1 survey, a review committee of educational researchers assisted the researcher in categorizing the responses. The review committee had experience with qualitative research within higher education administration, and an understanding of organizational climate and structure at two-year degree institutions.

The committee reviewed the responses from the panelists and categorized the factors by similarities. This reduced the number of related factors and descriptions to 10 factors that support advancement and 12 factors that inhibit advancement for a total of 22 factors with associated descriptions and examples of personal experiences for context. The common descriptions were taken from the panelists' input and based on the similarity of themes such as mentoring, support systems, industry experience, parental and caregiver responsibilities, and desire to advance. Table 4 shows the compiled list that was returned by the panelists in preparation for Round 2.

Table 4

Categorized List of Factors by Review Committee

Factors Supporting Advancement	Descriptions and Examples from Participants
Support Systems	Support such as the presence of a mentor, membership in professional organizations, a supportive organizational climate, and the support of family members and female and male advocates.
Willingness to Advance	Desire and willingness to advance. This includes ambition and curiosity for new experiences.
Desire to See Women in Leadership	Desire to see women represented in leadership positions that contribute to strong messages and advocacy for other women to advance.
Industry Experience	Related-industry experiences in STEM that gave participants additional qualifications to advance in leadership positions within higher education settings.

Table 4. *Continued.*

Factors Supporting Advancement	Descriptions and Examples from Participants
Awareness of the Institutional Environment	Awareness of environmental, organizational and job factors within STEM departments and higher education institutions that lead to advancement opportunities. This includes team work, collegiality, sense of community, and other institutional factors that support women in STEM leadership roles
Knowledge of Institutional Assessment	Ability to analyze institutional data and offer an assessment of programs for leaders to make data-driven decisions.
Experiences in Undergraduate and Graduate Programs	Positive experiences in undergraduate and graduate programs that gave participants the foundational knowledge and support for future advancement in STEM leadership positions.
Personal Attributes	Personal attributes, such as faith, passion, vision, and ability to adapt to change.
Role Models	The presence of respected role models in STEM leadership positions.

Factors Inhibiting Advancement	Description and Examples from Participants
Feelings of Isolation	Feelings of being alone associated with limited interaction with other women, no connection to the institutional community, limited faculty support, and being separated from the main campus.
Stereotype Threat	Struggling against perceptions that women do not belong in STEM fields, particularly in leadership roles.
Discrimination	The presence of negative attitudes from factors such as physical attributes, race/ethnicity, age, gender, and behaviors.

Table 4, *Continued.*

Factors Inhibiting Advancement	Description and Examples from Participants
Lack of Support	Experiencing lack of support from limited respect for women in leadership positions, challenges or reversals to decisions, being treated as servants not leaders, and limited support from supervisors.
Limited Experience or Degree	Lack of opportunity for experiences and STEM degree-attainment required to advance in leadership.
Lack of Compensation	Taking on more work without a corresponding change in title, recognition, or increased pay.
Personal Concerns	Issues related to health, family, and emotional issues impacting participants' ability to advance.
Limited Skills Training and Ability	Limited access to the leadership training and experiences that prepare participants for STEM leadership positions.
Lack of Desire	Being unmotivated to advance when opportunities arise.
English as a Second Language	Language barriers causing a problem with communication.

Round 2

In Round 2, each panelist was sent an introductory email (Appendix D) to explain the purpose of Round 2 and directions (Appendix E). The panelists' responses in Round 2 formed the basis for additional insights to gain consensus on factors identified in Round 1. I asked the panelists to review the categorized list of factors with descriptions from the review committee and either confirm their approval of the list or add additional factors with a description they felt may have been missed or eliminated from the list during the review process. On April 5, 2019, an e-mail was sent to the 17 panelists along with directions. All 17 panelists responded to this round (100%). There were 12 panelists who validated the categorized list as it was presented to them. Five panelists provided additional modifications to the factors and descriptions. Table 5 is a summary of the panelists' comments regarding additional factors and description.

Table 5

Round 2 Examples of Responses on Categorized List of Factors

Examples of Panelists' Responses on Categorized List of Factors
• Add coach and advocate to the support systems. You speak to advocacy further down, but female leaders are less likely to have coaches and advocates than men.
• Add caregivers to aging parents under conflicting family obligations and change parental duties to familial duties.
• Add access to and funding for professional development
• Add faith in oneself and emotional stability under personal attributes as a different category from faith through a religious affiliation
• Add opportunities to motivate and prepare women for leadership roles and professional development that can be achieved within a current position such as a fellowship for a residency at the National Science Foundation, chairing national committees, serving as PI on complex grants, involvement in industry partnerships, a sabbatical opportunity, faculty senate officer positions, internships in the Dean's/Provost's office, and leadership workshops/retreats.
• Under leadership skills add fiscal management abilities
• Modify description under willingness to advance since curiosity for new experiences may not be the reason one chooses not to advance. Advancement into an administration role may limit time for research that is a greater priority for some women.
• Under stereotype threat add in the description that this includes the perception that women leaders are thought of as aggressive and dominant.
• Modify the word unmotivated to include lack of interest in an administrative role.
• Modify the lack of opportunity to include failing to perceive room or opportunity for advancement.

The revised list based on panelists' feedback increased the number of related factors and description from 10 to 13 factors that support advancement and 12 factors that inhibit advancement for a total of 25 factors with associated descriptions and examples of personal experience for context. The researcher edited the factors and descriptions using the same method used earlier by the review committee and made additions to the descriptions to add further clarification on the panelists' responses. Table 6 shows the updated list of factors and descriptions.

Table 6

Categorized List of Factors by Review Committee

Factors Supporting Advancement	Descriptions and Examples from Participants
Support Systems	Support such as the presence of a mentor, membership in professional organizations, a supportive organizational climate, access to and funding for professional development, and the support of family members. Examples can extend to a significant other or family member as well as a coach and advocate who offers tangible and emotional support.
Willingness to Advance	Desire and willingness to advance include the ability to take on new experiences and additional roles and responsibilities that come with a change in position. Example include the willingness to accept an administrative role although it may mean less time for other scholarship activities (e.g. teaching or research).
Curiosity about New Experiences	This includes ambition and desire to seek out new positions within leadership and explore new opportunities and education to move beyond one's current role and responsibilities.
Leadership Skills	Skills that made participants qualified for positions, such as soft skills, communication skills, interpersonal skills, leadership training, understanding of data analysis and interpretation, and fiscal management abilities.

Table 6, *Continued.*

Factors Supporting Advancement	Descriptions and Examples from Participants
Desire to See Women in Leadership	Desire to see women represented in leadership positions that contribute to strong messages and advocacy for other women to advance.
Industry Experience	Related-industry experiences in STEM that gave participants additional qualifications to advance in leadership positions within higher education settings. Further descriptions include one's ability to advance in positions of leadership within private industry that has a lack of women in leadership positions led to the ability to advance in higher education as well.
Awareness of the Institutional Environment	Awareness of positive departmental climate, organizational culture and job factors within STEM departments and higher education institutions that lead to advancement opportunities. This includes teamwork, collegiality, sense of community, and institutional factors that support women in STEM leadership roles.
Knowledge of Institutional Assessment	Ability to analyze institutional data and offer an assessment of programs for leaders to make data-driven decisions.
Experiences in Undergraduate and Graduate Programs	Positive experiences in undergraduate and graduate programs that gave participants the foundational knowledge and support for future advancement in STEM leadership positions.
Faith	Religious faith and a strong belief in God or in the doctrines of a religion, based on spiritual apprehension rather than proof that offers inner strength and ability to advance.
Personal Attributes	Personal attributes, such as confidence in oneself, passion, vision, emotional stability and ability to adapt to change.

Table 6, *Continued.*

Factors Supporting Advancement	Descriptions and Examples from Participants
Role Models	The presence of respected role models in STEM leadership positions who were willing to share/mentor.
Opportunities for Leadership Roles and Professional Development	Additional leadership opportunities and professional development experiences that motivate and prepare a person for academic leadership roles that can be achieved within a current position. These leadership opportunities may not require a job title change, but maybe accomplished through a temporary leave of absence from the institution such as a fellowship for a residency at the National Science Foundation, chairing national committees, serving as PI on complex grants, involvement in industry partnerships. Additional examples include sabbatical opportunities, Faculty Senate officer positions, internships in the Dean's/Provost's office, and leadership workshops/retreats.

Factors Inhibiting Advancement	Description and Examples from Participants
Feelings of Isolation	Feelings of being alone associated with limited interaction, no connection to the institutional community, limited faculty support, and being separated from the main campus. Examples may include working remotely without a support system or sense of community.
Stereotype Threat	Struggling against perceptions that women do not belong in STEM fields, particularly in leadership roles or that others are more competent than oneself. Also, the perception that women leaders are thought of as aggressive and dominant.
Discrimination	The presence of negative attitudes from factors such as physical attributes, race/ethnicity, age, gender, and behaviors.

Table 6, *Continued.*

Factors Inhibiting Advancement	Description and Examples from Participants
Failing to Perceive Room or Opportunity for Advancement	Positions are not available for women due to factors such as unwieldy policies and procedures and perceived invisible walls for women.
Lack of Support	Perceiving a lack of support and respect for women in leadership positions, challenges or reversals to decisions. Additional examples include being treated as servants, not being acknowledged as leaders, and limited support from supervisors.
Limited Experience or Degree	Lack of opportunity for experiences and STEM degree-attainment required to advance in leadership.
Lack of Compensation	Taking on more work without a corresponding change in title, recognition, or increased pay.
Personal Concerns	Factors related to health, family, and emotional issues impacting participants' ability to advance.
Limited Skills Training and Ability	Limited access to the leadership training and experiences that prepare participants for STEM leadership positions.
Lack of Desire	Being unmotivated to advance when opportunities arise. Examples may include having little interest in leadership the roles because the additional responsibilities are administrative or not relative to one's career interests.
English as a Second Language	Language barriers causing a problem with communication.

Round 3

The purpose of Round 3 was to seek panelists' opinions for rating the importance and relevance of each factor identified and/or modified in Rounds 1 and 2 of the study. The researcher emailed the panelists on April 21, 2019, with an introduction to the purpose of Round 3 (Appendix F) and directions for rating each factor (Appendix G). With the panelists' input from Round 2, I informed the panelists that several factors were added along with description sentences for further clarification and contexts.

The panelists were sent a survey which included the revised list of factors (Appendix G) along with a rating scale for each factor. They were asked to rate their level of agreement on the relevance of each factor to the research questions. The rating scale used a five-point Likert-type scale with a numeric value (i.e. 5 point = Most Relevant Factor, 4 point = Significant Relevant Factor, 3 point = Moderate Relevant Factor, 2 point = Limited Relevant Factor, and 1 point = Not Relevant Factor). By May 3, 2019, 17 out of the 17 (100%) of the panelists completed the survey and responded with ratings on each factor.

Descriptive statistics were used to determine the level of agreement amongst the panelists regarding each factor. The interquartile range for each factor represented the level of agreement by the panelists and the mean indicated the level of relevance based on the research question. The median described the central numeric value of the responses. The standard deviation represented the dispersion of the responses. A lower standard deviation would indicate a greater consensus amongst the panelists. The *IQR* was used to determine the strength of the consensus amongst the panelists and an IQR over 2.00 indicated that consensus was not gained due to the high dispersion of the panelists' ratings (Childress & Rohodes, 2006; Kosloski & Ritz, 2016).

All factors with a 3.50 or higher mean score on the 5.0 scale indicated that the factor was considered relevant (Kosloski & Ritz, 2016). Table 7 shows the results of the Round 3 surveys. In Round 3, eight out of 13 factors supporting advancement and one out of the 12 factors inhibiting advancement met the minimum threshold of 3.50 for a total of nine out of the 25 factors. The group responses in Round 3 deemed nine factors as relevant, and out of those deemed relevant, all nine reached the IQR threshold.

Table 7

Round 3 Results from Group Responses on the relevance of each factor to the research question

Factors Supporting Advancement	*M*	*Mdn*	*SD*	*IQR*
Support Systems*	4.31	4.00	0.60	1.00
Willingness to Advance*	4.06	4.00	1.06	1.00
Leadership Skills*	4.00	4.00	0.63	0.00
Personal Attributes*	3.88	4.00	0.81	1.25
Opportunities for Leadership Roles and Professional Development*	3.88	4.00	0.81	0.50
Curiosity for New Experiences*	3.81	4.00	0.75	1.00
Role Models*	3.63	4.00	0.81	1.00
Experiences in Undergraduate and Graduate Programs*	3.50	4.00	0.73	1.00
Awareness of the Institutional Environment	3.44	3.00	1.15	1.25
Knowledge of Institutional Assessment	3.00	3.00	0.97	0.75
Industry Experience	2.88	3.00	1.02	2.00
Desire to See Women in Leadership	2.50	2.00	1.03	1.00
Faith	2.38	2.00	1.45	2.25

Factors Inhibiting Advancement	*M*	*Mdn*	*SD*	*IQR*
Conflicting Family Obligations*	3.75	4.00	1.34	2.00
Lack of Support	3.44	4.00	1.26	1.75
Personal Concerns	3.44	4.00	1.03	1.00
Feeling of Isolation	3.31	3.00	0.79	1.00
Lack of Compensation	3.31	3.00	1.14	1.00
Discrimination	3.25	3.00	1.13	1.50
Stereotype Threat	3.13	3.00	1.26	2.00
Limited Skills Training and Ability	3.06	3.00	1.06	2.00
Failing to Perceive Room or Opportunity for Advancement	3.06	3.00	1.29	2.00
Limited Experience or Degree	2.63	3.00	1.15	1.00
Lack of Desire	2.88	3.00	1.54	2.75
English as a Second Language	1.94	2.00	1.06	1.25

* Factors that were both relevant and reached consensus.

The researcher compiled a list of group responses and compared the group responses to each panelist's own individual responses for the next round.

Round 4

On May 5, 2019, the researcher sent an email explaining the purpose of Round 4 (Appendix H). A survey was sent with each factor and the group responses provided in Table 8 along with each panelist's individual responses from Round 3. Panelists were informed that Round 4 was the final round for reaching consensus and was intended for the panelists to confirm their original rating of the importance and/or relevance of each factor to the research questions after reviewing the responses of other panel members per factor from Round 3. The Round 4 survey included *M*, *Mdn*, *IQR*, and *SD* for each factor based on the group ratings.

Panelists were asked to review the factors and change their ratings, if desired, after reviewing the group response. Factors without changes remained the same from the panelists' responses in Round 3. The panelists were given the descriptive statistics from Round 3 and their own individual responses from Round 3 for comparison. Table 8 is an example of the descriptive analysis results that were provided to the panelists along with their individual rating for the factor and overall rating for factor supporting advancement.

The 17 panelists who contributed to the Round 3 survey were invited to participate in Round 4. They were asked to consider their original rating and the group ratings. Out of the 17 panelists who participated in Round 3, 15 responded in Round 4. As Round 4 was designed to confirm consensus amongst the panelists, the panelists were asked to consider their original rating compared with the group responses. The panelists had the opportunity to change their ratings based on the group mean. The researcher informed the panelists that an *IQR* over 2.00 indicated that consensus has not yet been gained based on the threshold established for the study. All factors were included in the Round 4 survey. Eight panelists responded with the same ratings from Round 3 and seven responded with changes to their previous ratings based on the group responses.

Table 8

Descriptive Analysis Results from Group Responses on Round Three

Example of Factor and Results from Group Responses
1. Factor: Support Systems
Group results from the Round 3 Survey for this factor:
Mean: 4.31 Median: 4.00 St. Dev.: 0.60 IQR: 1.00
Do you wish to change your original rating for this factor in Round 4? If yes, please mark the degree of relevance below:
_____ 5 - Most Relevant Factor _____ 4 - Significant Relevant Factor _____ 3 - Moderate Relevant Factor _____ 2 - Limited Relevant Factor _____ 1 - Not Relevant Factor
Panelist 1 Rating for Support Systems = 4.
Average Panelists 1 Rating for Factors Supporting Advancement = 2.92

Following the same protocol as Round 3, the mean score was used as the primary indicator for a factor's relevance to the research questions and was the most appropriate based on the small population size and the five-point Likert-type scale used in the survey instrument (Kosloski & Ritz, 2016). Table 9 shows the results of Round 4 and the factors that have a mean of 3.50 or higher and an *IQR* less than or equal to 2.00.

Table 9

Round 4 Results from Group Responses on the Relevance of Each Factor

Factors Supporting Advancement	*M*	*Mdn*	*SD*	*IQR*
Support Systems*	4.40	4.00	0.51	1.00
Personal Attributes*	4.13	4.00	0.74	1.00
Willingness to Advance*	4.07	4.00	1.10	1.00
Leadership Skills*	4.00	4.00	0.53	0.00
Curiosity for New Experiences*	3.73	4.00	0.70	1.00
Role Models*	3.73	4.00	0.70	0.75
Opportunities for Leadership Roles and Professional Development*	3.73	4.00	0.80	0.75
Experiences in Undergraduate and Graduate Programs*	3.67	4.00	0.62	0.75
Awareness of the Institutional Environment*	3.60	3.50	1.12	1.50
Knowledge of Institutional Assessment	3.20	3.00	0.86	1.00
Industry Experience	2.93	3.00	0.88	1.25
Desire to See Women in Leadership	2.60	2.00	0.91	1.00
Faith	2.40	2.00	1.59	2.50
Factors Inhibiting Advancement	*M*	*Mdn*	*SD*	*IQR*
Conflicting Family Obligations*	4.00	4.50	1.20	2.00
Lack of Compensation*	3.67	4.00	0.98	1.00
Personal Concerns*	3.53	4.00	0.92	1.00
Lack of Support	3.47	4.00	1.25	1.75
Feeling of Isolation	3.40	3.00	0.91	1.00
Failing to Perceive Room or Opportunity for Advancement	3.33	3.50	1.23	1.75
Discrimination	3.20	3.50	1.08	1.75
Limited Skills Training and Ability	3.20	3.00	1.01	1.00
Lack of Desire	2.93	3.00	1.33	1.50
Stereotype Threat	2.87	3.00	1.19	2.00
Limited Experience or Degree	2.60	3.00	1.06	1.00
English as a Second Language	1.93	2.00	1.07	1.00

* Factors that were both relevant and reached consensus.

Twelve of the 25 factors (48%) were deemed relevant as indicated by the *M* score of 3.50 or above. Of those 12, consensus was reached on 12. The *IQR* for the factors deemed relevant were less than or equal to 2.00. One factor, Awareness of the Institutional Environment, moved up to “relevancy” in the support category. Two factors, Lack of Compensation and Personal Concerns moved up to “relevancy” in inhibitors category.

Nine of the 13 factors were identified as relevant to Research Question 1) What factors have the most impact on women's professional advancement and success in leadership positions within STEM and workforce education-related disciplines at two-year degree offering institutions? Three of the 12 factors were identified as relevant to research Question 2) What factors inhibited women's professional advancement and success in leadership positions within STEM and workforce education-related disciplines at two-year degree offering institutions?

Table 10

Round 4 Summary of Most Relevant Factors According to Group Mean of 3.50

Factors Supporting Advancement	*M*	*IQR*
Support Systems	4.40	1.00
Personal Attributes	4.13	1.00
Willingness to Advance	4.07	1.00
Leadership Skills	4.00	0.00
Curiosity about New Experiences	3.73	1.00
Opportunities for Leadership Roles	3.73	0.75
Role Models	3.73	0.75
Experiences in Undergraduate and Graduate Schools	3.67	0.75
Awareness of Institutional Environments	3.60	1.50
Factors Inhibiting Advancement	*M*	*IQR*
Conflicting Family Obligations	4.00	2.00
Lack of Compensation	3.67	1.00
Personal Concerns	3.53	1.00

Summary

The purpose of this Delphi study was to identify factors that could be used to inform administrators, faculty and staff in higher education, policy makers, and industry and business leaders on factors that support the advancement of women and factors that inhibit the advancement of women who serve in administrative roles in STEM and workforce-related STEM disciplines at two-year degree offer institutions. Through the four rounds of the Delphi technique, the panelists identified the factors and came to a consensus of agreement regarding the factors that were most relevant to each research question.

In Round 1 of the study, the panelists developed a list of factors and descriptions. Factors along with descriptions and examples of personal experiences for context were provided by 17 panelists. A review committee categorized the factors, condensed the factors by similar themes and responses, and provided a description for each. The review committee reduced the list to 22 factors (10 factors that led to the advancement and 12 factors that inhibited the advancement of women in leadership positions in STEM).

In Round 2, panelists reviewed the categorized list and provided additional factors they determined were needed to be added to the list. Through their input, 13 factors for factors that led to the advancement and 12 factors for factors that inhibited advancement were identified. The list of 25 factors with descriptions was used for Round 3 and 4. In Round 3, the panelists built consensus by rating the factors according to relevance to each research question. Round 4 was used to further develop consensus among the panelists regarding the ratings and group responses from Round 3. Descriptive statistics were used to determine the strength of the consensus and relevance of each factor.

The panelists were given the descriptive statistics from the third round along with their responses and asked to re-rate any factors if necessary after considering the group responses. For factors that supported advancement, nine of the 24 factors of which consensus was reached had mean scores of 3.50 or higher (e.g. Support Systems, Personal Attributes, Willingness to Advance, Leadership Skills, Curiosity about New Experiences, Role Models, Opportunities for Leadership Roles, Experiences in Undergraduate and Graduate, Awareness for Institutional Environment), indicating that the factors were relevant to Research Question 1. For factors that inhibited advancement, three of the factors reached a mean scores of 3.50 or higher (e.g. Conflicting Family Obligations; Lack of Compensation and Personal Concerns), indicating that the factors were relevant to the Research Question 2.

Chapter V will discuss the summary and conclusions of this study. Based on the findings of this study, the researcher will provide recommendations for the use of the factors to inform higher education professionals, policy makers and industry leaders and implications for further research.

CHAPTER 5

CONCLUSIONS AND DISUSSION

Summary of the Study

Chapter 5 will summarize the study by addressing the research questions offering a detailed discussion of the results that align with the scholarly literature presented in Chapter 2. Last, the chapter will examine implications for further research and practical applications to stakeholders in the research. The full study will be summarized with a final conclusion. The problem of the study is to address the conceptual framework for establishing institutional conditions and a work environment across higher education institutions that support women's advancement and retention in administrative positions of leadership related to STEM disciplines and workplace education.

Research questions. This research was guided by two specific research questions:

1) What factors have the most impact on women's professional advancement and success in leadership positions within STEM and workforce education-related disciplines at two-year degree offering institutions?

2) What factors inhibited women's professional advancement and success in leadership positions within STEM and workforce education-related disciplines at two-year degree offering institutions?

Overview of methods. Through the four rounds of the Delphi technique, the panelists came to a consensus regarding the factors that were most relevant to each research question. This provided a method of data collection using a panel of experts who were current or former postsecondary administrators and who identified nine relevant factors that support advancement and three factors that inhibit women's advancement in leadership within STEM and workforce-related fields at two-year degree offering institutions.

Round 1 of the study was conducted using an email survey that consisted of two sections. The first section asked the panelists to identify their institutional affiliation and the STEM programs which they were responsible. The information in the first section of Round 1 was used to validate the panelists' qualifications. The second section of the Round 1 asked the panelists to provide two to three factors and descriptions for each research question. Of the 20 panelists invited to participate, 17 panelists (85%) provided a list of factors and descriptions. Three panelists who failed to complete the survey were withdrawn from the study.

Once data were collected from Round 1, a review committee consisting of higher educational researchers were invited by the researcher to review and categorize the list of factors and descriptive responses by themes. The review committee members were familiar with STEM programs at two-year degree offering institutions and had a strong knowledge and understanding of relevant literature on women and gender studies and broadening participation of STEM, but were not associated with the study. The review committee members condensed the similar factors based on themes and provided common descriptions for each one. The review committee members reduced the number of factors and related descriptions to 22 factors with common characteristics.

In Round 2, the 17 panelists who responded to Round 1 were e-mailed the consolidated list and asked if there were additional factors that needed to be added to the list. 100% of the panelists responded. There were 12 panelists who validated the list of factors and five panelists who provided additional modifications to the factors and descriptions. These additional changes and additions to the factors and descriptions were added to the original list by the researcher using the same method used by the review committee members. The final list consisted of 13 factors supporting advancement and 12 factors inhibiting advancement for a total of 25 factors.

The purpose of Round 3 was to further build consensus among the panelists regarding the relevancy of each factor to the research questions. The panelists were e-mailed an explanation letter with a survey and asked to rate each factor's level of relevance in addressing the research questions using a five-point Likert-type scale. All 17 panelists responded to the survey (100%). The data were collected and used to determine group opinion by mean, median, standard deviation, and interquartile range.

Round 4 was sent out to 17 panelists who participated in Round 3 to further the process of building consensus among the panelists regarding the factors and descriptions. In this round, each panelist was e-mailed a survey that included the descriptive statistics (*M*, *Mdn*, *SD*, *IQR*) for each factor compiled in Round 3, along with the panelist's Round 3 individual responses. The panelists were then asked to re-rate any factors if they desired to change their response rating from Round 3 after reviewing the group responses. There were 15 panelists who responded to the survey (88%). The two that did not respond were removed from the study. Round 4 results included nine factors supporting advancement and three factors inhibiting advancement for a total of 12 factors that were considered both relevant based on the mean score of 3.50, and where consensus was reached, based on an IQR of 2.00.

Discussion of the findings. The factors supporting advancement (i.e. Curiosity about New Experiences, Role Models, and Opportunities for Leadership Roles and Professional Development) all had a mean score of 3.73; however, Opportunities for Leadership Roles and Professional Development had higher standard deviation (*SD* = 0.80) compared to the other two factors in which the standard deviation is 0.70, indicating there was less dispersion and stronger agreement for Curiosity about New Experiences and Role Models even though the mean score was lower. The mean scores are higher with less dispersion of ratings for factors supporting advancement (*M* = 3.55; *SD* = .85) over factors hindering advancement (*M* = 3.18; *SD* = 1.10). This indicates a stronger sentiment and agreement of support factors as compared to factors that hindered advancement among panelists. The findings are supported by Dugan et al. (2013) and Hoyt (2005) who argue that high levels of leadership efficacy can offset barriers that inhibit advancement, and women who have made it into positions of leadership may possess characteristics (e.g. personal attributes such as confidence in oneself) that made barriers to advancement less relevant.

The average mean score increased from Round 3 to Round 4 for factors supporting advancement, as the average mean score in Round 3 (*M* = 3.48) increased in Round 4 (*M* = 3.55). For the factors inhibiting advancement, the average mean score in Round 3 (*M* = 3.09 increased in Round 4 (*M* = 3.18). However, the relevancy of the factors are fairly consistent across panelists and data sets between Round 3 and Round 4, with only one additional factor added as relevant in Round 4 (Awareness of Institutional Assessment) which moved from Round 3 (*M* = 3.44) to (*M* = 3.60) in Round 4. The increase in average mean score from Round 3 to Round 4 may be attributed to the elimination of two panelists in Round 3 who had lower ratings for the factors and did not participate in Round 4. Round 3 also had factors with slightly lower average interquartile range (*IQR* = 1.2) compared to Round 3 (*IQR* = 1.3), indicating level of consensus was increased.

An increased level of consensus in Round 4 further validates the results of the study and adds to the study’s trustworthiness, showing there was less dispersion around the relevant factors. For example, in Round 3 Support Systems had scores of *M* = 4.31, *IQR* = 1.00, and *SD*

= 0.60, compared to Round 4 of *M* = 4.40, *IQR* = 1.00 and *SD* = 0.51. This change between rounds indicates a stronger group consensus based on interquartile range and a greater indication that the group rated this factor with stronger relevance as a factor supporting advancement based on the higher mean score.

Although the interquartile range was used to determine the cut off score for group consensus, the standard deviation also revealed how much dispersion exists around each response and validated the levels of consensus that were determined by the interquartile range. For example, the mean of Support Systems is 4.40, the highest rating for factors supporting advancement in which consensus was reached. The interquartile range is 1.00 indicating a strong consensus around the highest rated item that was deemed relevant that is further validated by standard deviation (0.51).

Comparably, panelists consistently agreed that Personal Attributes was a factor of high relevance (*M* = 4.13). The interquartile range is 1.00 and the standard deviation is 0.74, and that indicates there was also a strong agreement among the panelists, but less agreement compared to Support Systems. Willingness to Advance earned a mean score of 4.07, indicating this is a significantly relevant factor; however, the factor had a standard deviation of 1.10, indicating there was less agreement compared to Personal Attributes and Support Systems even though consensus was reached as indicated by the interquartile range of 1.00. This suggests that some panelists felt it was a factor of high relevance and consensus was reached according to the interquartile cut off score of 2.00, but agreement around that factor is weaker compared to the other two factors.

Leadership Skills has a mean score of 4.00 and an interquartile range of 0.00, indicating the factor was both relevant and consensus was reached. The standard deviation is 0.53, also shows stronger agreement around Leadership Skills as a relevant factor supporting advancement even though the mean is lower than the factor Willingness to Advance. The mean scores are generally higher around factors supporting advancement than factors hindering advancement. Similarly, the standard deviation is generally smaller for factors supporting advancement (*SD* = 0.85) compared to factors hindering advancement (*SD* = 1.11), and that shows greater agreement on the relevant factors in which consensus was reached.

Each of the themes that emerged in Round 1 and Round 2 responses were analyzed through the lens of existing literature on gender and equity within higher education settings. Conflicting Family Obligations was considered the most relevant factor that inhibited advancement according to the analysis of the mean score (4.00). This finding was supported by the literature that parental responsibilities, work life balance, and childbirth can create challenges for women's advancement (Hill et al., 2010; Goldin, 2014; Su et al., 2014).

The panelists had high mean score ratings for Support Systems and Personal Attributes which may have created countermeasures to factors such as Stereotype Threat and Discrimination that were not considered relevant in this study. Although the literature found these as relevant factors that impact women early in their academic experiences (Ceci & Williams; 2007; Gersentberg et al., 2012), these factors may not be relevant to the panelists who had a greater understanding of the experiences of women in administrative positions and already entered careers in STEM. The panelists were chosen based on their knowledge of organizational climate at two-year institutions that may have had strong systems of support intact that offset issues related to discrimination and stereotype threats, which may differ in other types of institutions.

The panelists described conditions such as collegiality, a sense of community, positive departmental climate, and female role models as part of their reasons for success within their responses, which highlights the positive conditions that impacted their desire and motivation to advance. The identified factors for support will continue to inform educators and policy makers in the design of high-quality programs and organizational support for women aspiring to be in leadership roles in STEM and workforce education-related programs.

The results show that the panelists agreed that women in leadership positions in STEM who advanced were more inclined to focus on the factors that lead to their advancement. Because the panelists were selected as experts based on their understanding on the conditions that led to women's advancement in STEM and workforce education, their knowledge of the positive institutional conditions available to women at two-year institutions and behaviors of women who entered into leadership in STEM may have further minimized the barriers to advancement such as stereotype threat and feelings of isolation.

Conceptual Framework

The results of this study offer a conceptual framework that supports women's advancement across institutional types, but specifically in two-year degree offering institutions. The identified factors can be used to establish institutional conditions and a work environment within higher education that support women's advancement and retention in administrative positions of leadership related to STEM disciplines and workforce education.

The study identified 12 factors that can be used to define and assess work conditions and a high quality postsecondary institutional culture where women can be supported within their career trajectory if they aspire to reach an administrative position in STEM. The findings support the continued perception of nine relevant factors supporting advancement: Support

Systems, Personal Attributes, Willingness to Advance, Leadership Skills, Curiosity for New Experiences, Role Models, Opportunities for Leadership Roles and Professional Development, Experiences in Undergraduates and Graduate Programs and Awareness of Institutional Environments. Three factors were also identified as inhibitors to women's advancement: Conflicting Family Obligations, Lack of Compensation, and Personal Concerns. Each factor contributes to the conceptual framework that informs future practitioners on the conditions needed to broaden participation and the representation of women in STEM leadership positions.

Factors Supporting Advancement

Support systems. McCullough (2011) reports that women must continue to advance and remain in academic leadership positions in the STEM fields to provide effective networking and advocacy for other women to enter the field. Brewster and Rindfuss (2000) emphasized that structural factors in place at institutions, such as family benefits, can offer women additional systems of support that are especially important when women are presented with challenges. The study of Weber (2011) is consistent with two of this study's relevant factors, Support System and Role Models, showing that a strong group identity and social environments have a considerable impact on advancement. Weber confirms that in-group behaviors can create a desired culture change and support, and that having more women in formal leadership positions actually models opportunities for valuable networking for both women and men to advocate for women's advancement in STEM leadership.

The research of Hoyt (2005) reaffirms that women benefit from advocates who recognize the opportunity to diversify a professional field by broadening participation within STEM support systems. Hoyt's findings indicate that women's identification with leadership and connections with other women in leadership can deter the impact of negative stereotypes.

Personal attributes. Su, Johnson, and Bozeman (2014) found that women leaders who had a strong vision and ability to combat significant barriers to their advancement were more likely to persist in STEM. When it comes to the topic of personal characteristics such as vision and confidence, the women panelists in the current study described the factor Personal Attributes as confidence in oneself, passion, vision, emotional stability, and ability to adapt to change. According to both Bordonaro et al. (2000) and McCullough (2011), participation in women's advocacy organizations can strengthen women's confidence and commitment to STEM, and help them develop a stronger affinity toward their career goals. This reinforces the factor Personal Attributes, as women in many networks learn to believe in themselves even if their career trajectory may be slower than male counterparts who work without the same personal and family obligations.

Laursen and Rocque (2009) further support the need for professional organizations that empower women to find passion for STEM, build confidence in their identification as STEM professionals, and find a unified vision for their goals and abilities in STEM. Leadership, including self-leadership, is crucial to a women's development. This includes the personal attributes necessary to "change their current condition" (Mosedale, 2005, p. 248). Mosedale proposed that identifying constraints to action and working toward desired change requires positive feelings about oneself. The study confirms that women who find the "power within" (p. 254) can analyze their situations and believe their actions have an effect. Although Mosedale does not say it directly, the author implies that personal attributes, such as confidence in oneself, empowers women to advance in their educational and career trajectory and take on new positions of leadership.

Leadership skills. As institutions of higher education attempt to offer purposeful leadership development opportunities, women within STEM fields are able to take advantage of them to build their leadership efficacy. Dugan et al. (2013) argues that leader efficacy and capacity are influenced by a variety of learning experiences including formal leadership training. The factor Leadership Skills, along with Systems of Support, align with the findings of Dugan et al. who seek to disaggregate the findings of leadership development specifically within individual STEM academic units. Dugan et al.'s findings show that women in STEM majors reported the same levels of leadership capacity as their non-STEM peers, yet lower levels of leadership efficacy. The findings support the factor found relevant in the current study which shows that leadership skills are necessary to help women "successfully navigate the institutional and psychological barriers that characterize the STEM climate" (p. 14).

According to Dugan et al. (2013), women in STEM fields are more likely to succeed in their academic program, but struggle to engage in activities that build leadership efficacy and confidence among their peers. This demonstrates that the women who advance in STEM may have developed stronger leadership skills early in their academic career compared to other women. The findings of Dugan et al. confirm that professional development opportunities along a woman's academic and career journey are critical for skills development compared to others who did not advance into administration positions even if they were academically talented (2013).

The findings from the current study align with the research of Hoyt (2005) and defends that women's identification with leadership and involvement in academic programs that build their confidence as leaders will allow them to successfully navigate stereotype threat and advance in their careers. This relates to the panelists' description that leadership skills helps women in STEM fields overcome barriers within their careers and prepares them to enter positions of more responsibilities and staff oversight.

Willingness to advance. Literature on self-efficacy reveals the powerful role of organizational culture and support systems that offer motivation and influence women's activity choices, the level of goals set, persistence in one's career, and ability to cope with adversity (Dugan & Komives, 2010b; Hoyt, 2005). Although many women confront stressors in their leadership roles that may come from stereotypical expectations and biases, the panelists may not have rated factors such as Discrimination as relevant because they believed organizational climate was different for women at two-year degree offering colleges and women were more inclined to advance based on the conditions. This may be due to their own ambition and curiosity for new experiences that were available due to the strength of the networks at two-year institutions that support women (Rosser, 2004; and Hoyt, 2005).

Dugan et al. (2013) further defend this position and emphasize that the effects of stereotype threat and discrimination can be offset by a women's development of leadership efficacy and willingness to advance within the STEM context when supported by relationships and institutional systems that offer positive influences within their development.

Furthering the discussion, Bilen-Green et al. (2008) confirm that women in leadership tend to have a strong understanding of their personal experiences with pragmatic work policy obstacles and barriers faced by other women. It may be that the panelists in the current Delphi study who understand conditions at two-year degree offering institutions, acknowledged that women in leadership can be instrumental to the improvement of recruitment, retention, and promotion of females and create an organizational cultures where more women are willing to advance.

Role models. Hill et al. (2010) emphasized that positive role models influence a woman's aspirations for science and engineering. Furthermore, women show an increased performance in learning environments that offer positive messages from other women. The qualitative study by McCullough (2011) emphasized that women responded well when they engaged in a small group of colleagues that offer support, guidance, and mentoring in academic growth and professional development. Growe and Montgomery (1999) confirm the need for role models in the development of female leaders, and stress that mentoring can have a significant impact on incoming women. The study confirms that mentoring and the presence of role models can assist in attracting and retaining women professionals in the academic work environment.

Growe and Montgomery (1999) defend the position that mentors and role models are necessary to help prepare future leaders and guide others in navigating institutions' structure and culture. Their findings reveal that role models may help women further develop communication behaviors and gain leadership skills in STEM departments where women may feel isolated or marginalized in new positions of leadership.

Role Models is a relevant factor supporting advancement and can be used to inform leaders within higher education and encourage them to institute practices and support programs that successfully prepare women for leadership positions within institutions through the availability of role models and a mentoring program. Furthering the discussion, Dugan and Komives (2010b) insist that faculty and administration within STEM need to receive training on how to facilitate sociocultural conversations with peers and women in academic settings to help women develop their positive interactions with administrative peers and with faculty.

Role models are crucial in leadership development as women continue to advocate for additional opportunities for women. The lack of role models and mentors is identified within the literature as a large disadvantage to women's advancement in leadership when institutions do not have the programs in place for women to identify mentors and be empowered by others (Cejda, 2008; Gibson-Benninger, Ratliff, & Rhoads, 1996).

Opportunities for leadership roles and professional development. The research of Buch et al. (2011) and Gorman et al. (2010) demonstrates the success of program initiatives that expose women to academic pathways that are grounded in peer network and mentoring. Buch et al. (2011) specifically shows that institutional factors, such as professional development opportunities and women's advocacy networks, are necessary for persistence and advancement in STEM pathways.

Bilen-Green et al. (2008) agree that women's positions in leadership can lead to the advancement of other women who start to facilitate change in the institution for the professional development and advancement of other women. Bilen-Green et al. further defend the need for leadership opportunities for women by stating that women in leadership often see the need for specific programming that offers women access support systems and leadership skills development through mentors and networks. The panelists' understanding of institutional environments and the support structures at two-year degree offering institutions are highlighted in the descriptions of each factor with further explanations regarding the professional development opportunities, leadership training and support structures that can potentially impact women's advancement.

According to the findings of this study, the more women advance to leadership positions at two-year degree offering institutions, the greater the opportunity for positive changes in an organization's process. Additional opportunities for advancement of women in STEM can be facilitated by administrators who build awareness for new opportunities and create environments in which women are more willing to advance.

Experiences in undergraduates and graduate programs. Hill et al. (2010) emphasize that women have a more accurate self-awareness and are more likely to assess their skills and abilities in an environment that promotes gender equality in cognitive abilities in math and science (2010). Their findings support the study by Scott and Mallinckrodt (2005) whose research focused on women's perceptions of science self-efficacy. The participants were involved in enrichment programs with aspirations to work in a science-related field and had positive experiences at early stages in their academic careers that formed their commitment to STEM pathways in their future careers.

The panelists in the current study identified a factor which describe positive experiences in their postsecondary and graduate education programs which, in turn, influenced their decision to advance later in their careers. They provided additional descriptions that included the positive experiences they had in their educational pathway that gave them knowledge and foundational support for future advancement in STEM. This suggests the idea for educators to embed meaningful STEM programs and connections to other women early in students' academic pathways to prepare them for their future careers as leaders in STEM.

Awareness of institutional environments. McGrath and Tobia (2008) findings support this factor and conclude that women leaders perceive their institutions' culture to have the greatest impact on their advancement in leadership. Barber (1995) emphasized that there is less attrition and greater productivity when women are in collegial STEM workplace environments where there is open communication regarding opportunities and programs focused on inclusion and equity. Based on the panelists' findings, the existence of a positive organizational culture at two-year colleges can offer capacity for women to advance as leaders when women are aware of the strong positive messaging regarding institutional supports available at their institution. Barber further supports the panelists' views and identifies institutional conditions such as departmental policies and diversity programming that can support women in their advancement.

The research of Mason et al. (2013) and Kittelstrom (2010) describe the additional support an institution can provide when they offer services and resources to assist with childcare and flexible work hours to accommodate the needs of women in academic careers. Risman and Adkins (2014) confirm these findings and highlight that women have more opportunities when institutions have strong messaging regarding gender equity and create accommodating conditions for women to seek career advancement.

Factors Inhibiting Advancement

Conflicting family obligations. Conflicting Family Obligations was identified as a relevant factor in the findings of this study. Hill et al. (2010) argue that family obligations, including parenting obligations, can create additional time restrictions for women and result in lower job satisfaction early in women's careers. The panelists' in the current study support the findings of Hill et al. (2010) and describe Conflicting Family Obligations as an issue when there are additional time constraints required to balance work and parental duties. The panelists describe barriers such as limited flexibility in work schedules needed to address family obligations as a challenge to advancement.

Hill, Holmes and McQuillian (2014) suggest that many women are vulnerable to negative social and emotional effects of less accommodating and flexible work environments that impact their abilities to take care of their families and uphold parental responsibilities. The findings of this study support the factor in their discussion of the need for additional institutional conditions to support family care.

Goldin's (2010) research supports the findings of this study and highlights that women are more likely to leave a work environment that does not accommodate the flexibility needed for a healthy work-life balance. As a result, Goldin recommends that structural changes to an organization that can result in organizational improvements resulting from technological advances, making it easier for companies to provide flexible-hours for employees without compromising the quality of work. The findings are consistent with the research by Fox (2010) that indicated women who perceive less support from their supervisors due to personal and household responsibilities have more interference with achieving tenure and balancing work and family obligations.

Lack of compensation. Panelists acknowledged that women often voluntarily take on more work without corresponding change in title, recognition, or increased pay. Although Settles et al. (2006) and Riffle et al. (2013) argue that gender differences are barriers to women's persistence in STEM, this current study does not deny that gender differences may contribute to the Lack of Compensation. In spite of the fact that gender differences did not result in a significant factor, it still may be considered an inhibitor based on the additional work women may assume that is not always recognized with the same compensation as seen in their male counterparts.

The findings support the research of Goldin (2014) who argues that non-linear compensation takes place when women leave full-time positions for flexible work conditions while devoting the same effort and performing similar work. Similarly, Fouad, Fitzpatrick, and Liu (2011) highlight that STEM workplace environments can often have limited upward career mobility for women, specifically within engineering pathways. The panelists describe similar STEM workplace conditions as barriers to advancement when they take on more responsibility and work overtime at non-traditional hours due to family obligations without an increased pay compared to male counterparts.

The findings are confirmed by the *Chronicle of Higher Education* Almanac (2017) that shows women represented slightly more than half of all employees in three of six selected positions at colleges, but they still earned only 85% to 87% of what their male counterparts did. Further discussions by Burrelli (2008) highlight that from 1973-2006, fewer career promotions with increased wages were given to married women and women with children. The research of Bichsel and McChesney (2017) support Burrelli (2008) and highlights that women with advanced degrees are earning less than men and there is a pay gap between men and women in administrative positions within higher education over the past 15 years.

Personal concerns. Personal Concerns had a mean score of 3.67. Personal concerns that are not addressed by organizational support systems and departmental cultures can continue to create barriers to women's advancement at two-year colleges and can be a cause for the current underrepresentation of women leaders in senior level administrative positions in STEM. Cech et al. (2011) believe that persistence and retention in STEM professions are directly related to human motivation. In STEM professions in high-demand industries, there is less room for work life balance and emotional concerns related to inequities in the workplace (Robbins & Judge, 2012). This can impact worker motivation and create further anxiety and when personal concerns arise.

In discussions presented by Gorman et al. (2010), one controversial issue that has arisen is that women are at a major career disadvantage when they have to balance household, family, and community obligations compared to colleagues without these same responsibilities. On the other hand, Joshi (2014) argues that gender integration in science and engineering can shape role expectations and create improvement in workplace morale in technical engineering environments when there is additional team support.

Purcell, MacArthur, and Samblanet (2010) contend that limited perspectives within the workplace environment can create additional personal concerns and less support when personal factors related to health, family, and emotional issues impact a women's ability to advance. This can be associated with societal gender bias (Purcell et al., 2010). However, Personal Concerns is a factor that inhibits advancement in STEM fields that can be a shared concern by both men and women. Yearout, Williams, and Brenner (2017) supported the factor Personal Concerns as a barrier to advancement and insisted that women in STEM fields with conflicting personal obligations and time constraints are more likely to face challenges to advance in their careers.

Implications of the Contextual Framework

The factors identified in this study can be used by educational leaders for establishing institutional conditions conducive to women's advancement and retention in STEM and workforce education in higher education. Leaders within STEM fields should anticipate perceived gender and salary gaps while incorporating institutional policies and practices that will create organizational support for rising female professionals. The identified factors can be used to establish an equitable educational setting based on the panelists' responses. For example, Lack of Compensation for the work required was a barrier to advancement, specifically when they were given more work without a change in title or recognition for the work being accomplished. Institutions can continue to make strides to reduce the pay gap in certain STEM disciplines to make salaries more equitable between men and women with the same experience and education.

Additionally, there is a need to establish practices for professional development and career progression, mentoring programs, and role model reinforcement (Amey & VanDerLinden, 2002). There was a stronger agreement by panelists and higher mean scores for factors supporting advancement compared to factors hindering advancement. This could possibly mean that the panelists found the factors that supported advancement more relevant within women's career trajectories compared to the barriers that they overcame to achieve administrative leadership positions. Although there was strong agreement across all relevant factors with a mean score of 3.5 or higher, the factors supporting advancement had a lower average *IQR* (1.04) than factors hindering advancement (1.40) indicating that there was less agreement in this study among the factors hindering advancement.

The findings show that the panelists' had strong beliefs that institutional support during a women's career may have led to advancement in STEM as indicated by the high mean score for the factor Opportunities for Leadership Roles and Professional Development (M = 3.73). These findings reveal that organizational structure at two-year colleges can create common patterns of perception, thought, and feelings toward room for advancement. Structural and cultural inclusiveness and strategic goals set by leadership can promote and grow leaders within STEM, who will be competitive and prepared to meet the skills gap for community college leaders within STEM.

To create opportunities and support for women's advancement within the academic workforce, human resources staff and institutional recruiters must reinforce policy that supports women through increased networks and support to change any negative perceptions of women in the workplace. A cultural shift will take place when institutional members build awareness for issues related to gender equality that are addressed in each department throughout STEM disciplines (Jackson et al., 2014).

<table>
<tr><th>Recent Graduates</th><th>Early and Mid-Career Transitions</th><th colspan="2">Context of Support</th></tr>
<tr><td>Math and science self-efficacy builds</td><td>Intent and willingness to advance in STEM fields</td><td>Entrance into an overall STEM Community and Network of Support</td><td>Entrance into discipline specific STEM and workforce education positions of leadership</td></tr>
<tr><td>Exposure to career mentors and role models</td><td>Self-confidence and self-efficacy builds</td><td>STEM identity development through a support network and connection to STEM role models</td><td>Identity development and engagement in a community of STEM leaders</td></tr>
<tr><td>Early achievements and skills development in STEM leadership positions</td><td>Connection to STEM Community</td><td>Understanding of personal attributes that influence career trajectory</td><td>Development of leadership competencies and awareness of institutional environments</td></tr>
<tr><td>Support community of peers in graduate programs</td><td>Work-life integration</td><td>Exposure to career opportunities</td><td>Engagement in institutional systems of support</td></tr>
<tr><td colspan="4">Context of Barriers
Life/Career Stages: Prolonged time to advancement and limited recognition for work achieved along the STEM pathway.
Social and Cognitive Development Needs: Conflicting family obligations and detachment from a STEM community; Limited support and lack of compensation from institutions; Personal concerns and lack of connection to peers and faculty.</td></tr>
</table>

Figure 1. Conceptual framework supporting women’s advancement and retention in STEM and workforce education.

Recommendations for Further Research and Practice

This study can be especially important to key stakeholders: family members, educators, employers, and policy makers. Research has shown that family members, as well as educators, have an impact on women from a young age with regard to STEM education (Scott & Mallinckrodt, 2005). During the four Delphi rounds, the researcher saw a correlation between the findings in the literature and the results of the Delphi study that related to institutional climates with Support Systems, Role Models, and Opportunities for Leadership Roles and Professional Development that supported women's advancement in STEM disciplines. Just as family support can build confidence in women's ability and willingness to lead, the results showed that caregiving and parental obligations can also inhibit one's advancement into leadership positions as identified by the factors Conflicting Family Obligations and Personal Concerns.

Further research is needed to examine women in comparable roles of leadership in industry and at different institution types because the findings from this study may or may not be generalizable to the greater population of women in STEM. To develop a deeper understanding of women in STEM, comparing traditional environments with non-traditional environments and the effect it has on women in leadership is a topic to be considered. Fathers and husbands most often were noted as being influential for motivation and self-efficacy (Deemer et al., 2012). While it was not a topic for this research, role reversal was mentioned by one of the panelists and further research can enlist the opinions of men and women who have a strong understanding and knowledge of the supporting and inhibiting factors of a women's advancement in STEM.

The study only investigated factors related to women in postsecondary STEM and workforce education-related programs who served at two-year degree offering institutions, and does not account for secondary education, other types of postsecondary education institutions, or organizations outside of an academic settings. Further research is needed to examine similar institutional environments that exist at different institution types that include a majority of women whose initial career experiences are in industry prior to moving into leadership positions within academia.

The panelists' responses offered insight into the organizational climate and culture of two-year degree offering institution and its influence on the aspirations of women in the STEM and workforce-related STEM programs. Another possibility for future research is the investigation of the factors specific to institutional type and asking panelists specific research questions that require their responses to include experiences at their respective type of institution.

The impact of home environments and living situations could add depth and breadth to this topic related to the type of opportunities women experience at rural institutions in small towns compared to institutions in metropolitan areas. This was of particular interest in two of the panelists' responses who shared challenges with validating their position as women in STEM because their leadership and oversight were limited to vocational STEM programs that did not offer additional opportunities for professional development in new areas of leadership.

Educators are other stakeholders who can be positively impacted by the results of the study. The participants were motivated to advance and work hard at institutions that offered opportunities for professional development for women to learn additional leadership skills. Common themes emerged as the panelists described their journeys from faculty to administration that were fueled by organizational climates that supported skills development and strong systems of communication regarding opportunities for advancement among men and women. The researcher suggests that educators' training include components designed to increase awareness of the impact of communication for equal opportunities for advancement and the repercussions that limited institutional support has on women in STEM fields.

Employers and policy makers can be influential in hiring and supporting women for STEM-related leadership positions and initiatives that offer opportunities for professional development and support networks. It was especially noted in this study that women valued and appreciated institutional leaders and institutions that focused on diversity and inclusion. A common theme was experiences women had in their undergraduate and graduate programs and the mentors that supported their efforts and encouraged leadership within their STEM programs. Also noted was that women's perceptions of the organizational environment impacted their decision to move forward into leadership positions and administrative roles.

During the course of this study, the panelists explored factors related to lack of compensation and gender inequities that affected them in their willingness and ability to advance into leadership roles. Higher education institutions that are consciously progressive can motivate women to achieve and empower them to succeed. Supervisors have a large role in exploring options on how to retain talented women in the STEM workforce and academia. Further qualitative research focused on the STEM workplace environment and the impact of Lack of Compensation on job performance and advancement opportunities can also be further explored as a result of the findings.

Previous studies of STEM workplaces, specifically engineering, emphasize why and how women consider leaving a job and exiting a STEM career altogether. The literature identifies "chilly" work environments with descriptors such as hostile cultures with ambiguous pathways to career advancement as reasons for limited upward career mobility (Fouad, et al., 2011). This Delphi study identified Personal Concerns and Conflicting Family Obligations as factors inhibiting advancement, but further research is needed to explore the correlation between these two factors and the availability of institutional support to offset these factors. For example, did negative working conditions within the STEM departments create additional obstacles when personal concerns and conflicting family obligations became a challenge for women?

Glass and Minnotte (2010) highlighted that women may advance into leadership positions within industry and academics, yet they have less perceived recognition and significance in their influence as a leader. The panelists identified the factors Opportunity for Leadership Roles and Willingness to Advance as relevant for advancement. Women who perceive limited opportunities to move up due to an invisible glass ceiling will be less likely to advance (Glass & Minnotte, 2010), compared to women in leadership who experiences opportunities for leadership roles and do not perceive such obstacles. Higher education administration can make changes to current organizational conditions to help women feel valued and recognized. As a result of this study, higher education administration can continue to make efforts to minimize the salary gap between men and women within STEM departments and advance programming efforts to recognize women for their contributions to the organization and STEM community.

Conclusions

The focus of this study was to identify factors that can be used to inform educators and policy makers in the design of high-quality programs and organizational support for women aspiring to be in leadership roles in STEM and workforce education-related programs. To address this need, two research objectives were developed. Through the four rounds of the Delphi study, 12 of the 24 factors were considered relevant based on the 3.50 mean cut off score, and reached group consensus based on the interquartile range of 2.00 or below. Table 10 lists all 24 factors deemed relevant, including those that reached consensus. As the panelists represented diversity within STEM and workforce-related areas, the findings of this study demonstrate that the factors may be applied to a wide range of institutions both private and public across the nation that offer two-year degrees.

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APPENDIX A

Delphi Introductory Letter

Date: Sun, Feb 24, 2019 at 9:20 PM

Good afternoon, Xxxx,

I am at the final stages of my doctoral journey and hope you are willing to participate in my study.

My dissertation study is examining factors leading to women's advancement in leadership positions within STEM disciplines. By sharing your thoughts and experiences concerning your own advancement in STEM leadership, you will help inform future educators and administrators on ways to support women in advancing in STEM leadership roles.

If you are willing, I am asking for your participation in a four round Delphi study. Your participation will require a total of approximately one hour and will involve a series of surveys distributed through email.

The first round will take about 10 minutes, asking for your experiences and factors that promoted or inhibited your advancement as a STEM leader. I will compile responses from other participants, leading to the second round asking for any additional factors not already described. The second round should take you about 10 minutes, as well. In the third round, I will ask you to rate order factors identified; this should take about 10 minutes. The final round, also about 10 minutes, asks for your comments on factors identified and rated by all participants.

Your participation is voluntary and your responses will be kept anonymous. Any publication resulting from this study will be reported in the aggregate and your identity will never be revealed. At the conclusion of this study, data and responses connected to individual participants will be destroyed.

May I count on your participation in this study? Please respond to this email with a "yes". With your "yes" response, you are providing informed consent and you will receive the two questions associated with round one in a week or two. Thank you for your willingness to support this important study. If you have any questions, please feel free to contact my dissertation chair, Dr. Kosloski, or me using the information provided below. Also, please let me know if you have additional recommendations for panelists who are female and previously or currently serve as an administrator in STEM. Thank you for your help!

Sincerely,

Kimberly Taylor
Ph.D. Candidate
Community College Leadership

Dr. Michael Kosloski
Assoc. Professor
STEM Education & Professional Studies

Department of Educational Foundations & Leadership
Old Dominion University
352-443-9011
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Old Dominion University
757-683-3314
mkoslosk@odu.edu

APPENDIX B

Round 1 Cover Letter

Date: Fri, Mar 1, 2019 at 8:58 AM

Good afternoon, Xxxx,

Thank you for your support and willingness to participate. Please feel free to send your responses back to me in the attached word document or in the email body below.

ROUND ONE:

Thank you for your participation in this study that seeks to gain consensus on factors that contribute to women's advancement in leadership positions within STEM disciplines. The factors may be used to inform educators and administrators on practices that promote women in STEM leadership positions. Your responses in Round 1 will form the basis for additional insights and ratings from participants.

Name:

Institution:

Former or Current Administration Role in STEM or a Workforce Education STEM related field:

Research Questions:

1) Please describe two or three factors that had the most impact on your advancement and success in a leadership position within STEM disciplines. Feel free to provide examples and context, if possible.

2) Please describe two or three factors that inhibited your advancement and success in a leadership position within STEM disciplines. Feel free to provide examples and context, if possible.

Thank you for your responses. You will be hearing from me soon for Round 2 as I compile responses from all participants. In Round 2, I will ask for any other factors not already noted by participants.

Kindest Regards,

Kimberly Taylor

APPENDIX C

Round 1 Instructions and Survey

ROUND ONE:

Thank you for your participation in this study that seeks to gain consensus on factors that contribute to women's advancement in leadership positions within STEM disciplines. The factors may be used to inform educators and administrators on practices that promote women in STEM leadership positions. Your responses in Round 1 will form the basis for additional insights and ratings from participants.

Name:

Institution:

Former or Current Administration Role in STEM or a Workforce Education STEM related field:

Research Questions:

1) Please describe two or three factors that had the most impact on your advancement and success in a leadership position within STEM disciplines. Feel free to provide examples and context, if possible.

2) Please describe two or three factors that inhibited your advancement and success in a leadership position within STEM disciplines. Feel free to provide examples and context, if possible.

Thank you for your responses. You will be hearing from me soon for Round 2 as I compile responses from all participants. In Round 2, I will ask for any other factors not already noted by participants.

APPENDIX D

Round 2 Cover Letter

Date: Fri, Apr 5, 2019

Good afternoon, Xxxx,

Thank you for your support and responses in Round 1. The purpose of Round 2 of this Delphi study on factors that contribute to women's advancement in leadership positions within STEM disciplines is to seek your feedback on the list of factors generated from the 18 panelists responses in Round 1.

Directions: Please review all the factors in the attached document. Through track changes, please leave a factor as is (in cases where you have no experience with or nothing to add to the factor), or offer minor modifications or additions to the factors in a way that makes it applicable to you. With your input, the original factors identified and/or modified through Rounds 1 and 2 of this study will be presented in Round 3 for rating of importance.

Please send responses in the attached word document by April 12th. If the list of factors are sufficient, please respond, that you have no suggested changes.

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APPENDIX E

Round 2 Instructions and Survey

ROUND TWO:

Thank you for your participation in this study that seeks to gain consensus on factors identified in Round 1. The factors may be used to inform educators and administrators on practices that promote women in STEM leadership positions. Your responses in Round 2 will form the basis for additional insights and ratings from participants. Below is the categorized list of factors with descriptions from examples provided by participants. Please review and confirm your approval or add an additional factor with a description that is missing from the list.

	Factors Supporting Advancement	**Description and Examples from Participants**
1	Support Systems	Support such as the presence of a mentor, membership in professional organizations, a supportive organizational climate, and the support of family members and female and male advocates.
2	Willingness to Advance	Desire and willingness to advance. This includes ambition and curiosity for new experiences.
3	Leadership Skills	Skills that made participants qualified for positions, such as soft skills, communication skills, interpersonal skills, leadership training, and understanding of data analysis and interpretation.
4	Desire to See Women in Leadership	Desire to see women represented in leadership positions that contribute to strong messages and advocacy for other women to advance.
5	Industry Experience	Related-industry experiences in STEM that gave participants additional qualifications to advance in leadership positions within higher education settings.
6	Awareness of the Institutional Environment	Awareness of environmental, organizational and job factors within STEM departments and higher education institutions that lead to advancement opportunities. This includes team work, collegiality, sense of community, and other institutional factors that support women in STEM leadership roles
7	Knowledge of Institutional Assessment	Ability to analyze institutional data and offer assessment of programs for leaders to make data-driven decisions.

8	Experiences in Undergraduate and Graduate Programs	Positive experiences in undergraduate and graduate programs that gave participants the foundational knowledge and support for future advancement in STEM leadership positions.
9	Personal Attributes	Personal attributes, such as faith, passion, vision, and ability to adapt to change.
10	Role Models	The presence of respected role models in STEM leadership positions.
	Factors that Inhibiting Advancement	**Description and Examples from Participants**
1	Feelings of Isolation	Feelings of being alone associated with limited interaction with other women, no connection to institutional community, limited faculty support, and being separated from the main campus.
2	Stereotype Threat	Struggling against perceptions that women do not belong in STEM fields, particularly in leadership roles.
3	Discrimination	The presence of negative attitudes from factors such as physical attributes, race/ethnicity, age, gender, and behaviors.
4	Conflicting Family Obligations	The time restraints required to balance work and parental duties including limited flexibility in work schedule.
5	Lack of Opportunity	Positions are not available for women due to factors such as unwieldy policies and procedures and perceived invisible walls for women.
6	Lack of Support	Experiencing lack of support from limited respect for women in leadership positions, challenges or reversals to decisions, being treated as servants not leaders, and limited support from supervisors.
7	Limited Experience or Degree	Lack of opportunity for experiences and STEM degree-attainment required to advance in leadership.
8	Lack of Compensation	Taking on more work without a corresponding change in title, recognition, or increased pay.
9	Personal Concerns	Issues related to health, family, and emotional issues impacting participants' ability to advance.
10	Limited Skills Training and Ability	Limited access to the leadership training and experiences that prepare participants for STEM leadership positions
11	Lack of Desire	Being unmotivated to advance when opportunities arise.
12	English as a Second Language	Language barriers causing a problem with communication.

APPENDIX F

Round 3 Cover Letter

Date: Sun, Apr 21, 2019

Good afternoon, Xxx,

Thank you for your support and responses in Round 2. The purpose of Round 3 of this Delphi study on factors that contribute to women's advancement in leadership positions within STEM disciplines is to seek your opinions for rating the importance and/or relevance of each factor identified and/or modified in Rounds 1 and 2 of this study. With your input from Round 2, we added several items to the descriptions and list of factors. Please see the directions for rating the factors in the attached document.

Thank you for your support.

Kimberly

Kimberly A. Taylor

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APPENDIX G

Round 3 Instructions and Survey

Round 3

The purpose of **Round 3** is to seek your opinions for **rating** the importance and/or relevance of each factor identified and/or modified in Rounds 1 and 2 of this study. With your input from Round 2, we added several items to the descriptions and list of factors.

Directions: Please review the following list of factors and rate each using the scale provided. Our scale includes responses of **5 - Most Relevant Factor, 4 - Significant Relevant Factor, 3 - Moderate Relevant Factor, 2 - Limited Relevant Factor, and 1 - Not Relevant Factor.**

Factors Supporting Advancement	Description and Examples from Participants
1. Support Systems	Support such as the presence of a mentor, membership in professional organizations, a supportive organizational climate, access to and funding for professional development, and the support of family members. Examples can extend to a significant other or family member as well as a coach and advocate who offers tangible and emotional support.
_____ 5 - Most Relevant Factor _____ 4 - Significant Relevant Factor _____ 3 - Moderate Relevant Factor _____ 2 - Limited Relevant Factor _____ 1 - Not Relevant Factor	
2. Willingness to Advance	Desire and willingness to advance includes ability to take on new experiences and additional roles and responsibilities that come with a change in position. Example include the willingness to accept an administrative role although it may mean less time for other scholarship activities (e.g. teaching or research).
_____ 5 - Most Relevant Factor _____ 4 - Significant Relevant Factor _____ 3 - Moderate Relevant Factor _____ 2 - Limited Relevant Factor _____ 1 - Not Relevant Factor	
3. Curiosity about New Experiences	This includes ambition and desire to seek out new positions within leadership and explore new

<table>
<tr><td></td><td>opportunities and education to move beyond one’s current role and responsibilities.</td></tr>
<tr><td colspan="2">______ 5 - Most Relevant Factor
______ 4 - Significant Relevant Factor
______ 3 - Moderate Relevant Factor
______ 2 - Limited Relevant Factor
______ 1 - Not Relevant Factor</td></tr>
<tr><td>4. Leadership Skills</td><td>Skills that made participants qualified for positions, such as soft skills, communication skills, interpersonal skills, leadership training, understanding of data analysis and interpretation, and fiscal management abilities.</td></tr>
<tr><td colspan="2">______ 5 - Most Relevant Factor
______ 4 - Significant Relevant Factor
______ 3 - Moderate Relevant Factor
______ 2 - Limited Relevant Factor
______ 1 - Not Relevant Factor</td></tr>
<tr><td>5. Desire to See Women in Leadership</td><td>Desire to see women represented in leadership positions that contribute to strong messages and advocacy for other women to advance.</td></tr>
<tr><td colspan="2">______ 5 - Most Relevant Factor
______ 4 - Significant Relevant Factor
______ 3 - Moderate Relevant Factor
______ 2 - Limited Relevant Factor
______ 1 - Not Relevant Factor</td></tr>
<tr><td>6. Industry Experience</td><td>Related-industry experiences in STEM that gave participants additional qualifications to advance in leadership positions within higher education settings. Further descriptions include one’s ability to advance in positions of leadership within private industry that has a lack of women in leadership positions led to ability to advance in higher education as well.</td></tr>
<tr><td colspan="2">______ 5 - Most Relevant Factor
______ 4 - Significant Relevant Factor
______ 3 - Moderate Relevant Factor
______ 2 - Limited Relevant Factor
______ 1 - Not Relevant Factor</td></tr>
</table>

7. Awareness of the Institutional Environment	Awareness of positive departmental climate, organizational culture and job factors within STEM departments and higher education institutions that lead to advancement opportunities. This includes teamwork, collegiality, sense of community, and institutional factors that support women in STEM leadership roles.
_____ 5 - Most Relevant Factor _____ 4 - Significant Relevant Factor _____ 3 - Moderate Relevant Factor _____ 2 - Limited Relevant Factor _____ 1 - Not Relevant Factor	
8. Knowledge of Institutional Assessment	Ability to analyze institutional data and offer assessment of programs for leaders to make data-driven decisions.
_____ 5 - Most Relevant Factor _____ 4 - Significant Relevant Factor _____ 3 - Moderate Relevant Factor _____ 2 - Limited Relevant Factor _____ 1 - Not Relevant Factor	
9. Experiences in Undergraduate and Graduate Programs	Positive experiences in undergraduate and graduate programs that gave participants the foundational knowledge and support for future advancement in STEM leadership positions.
_____ 5 - Most Relevant Factor _____ 4 - Significant Relevant Factor _____ 3 - Moderate Relevant Factor _____ 2 - Limited Relevant Factor _____ 1 - Not Relevant Factor	
10. Faith	Religious faith and strong belief in God or in the doctrines of a religion, based on spiritual apprehension rather than proof that offers inner strength and ability to advance.
_____ 5 - Most Relevant Factor _____ 4 - Significant Relevant Factor _____ 3 - Moderate Relevant Factor _____ 2 - Limited Relevant Factor ______1 - Not Relevant Factor	

<table>
<tr><td>11. Personal Attributes</td><td>Personal attributes, such as confidence in oneself, passion, vision, emotional stability and ability to adapt to change.</td></tr>
<tr><td colspan="2">_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor</td></tr>
<tr><td>12. Role Models</td><td>The presence of respected role models in STEM leadership positions who were willing to share/mentor.</td></tr>
<tr><td colspan="2">_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor</td></tr>
<tr><td>13. Opportunities for Leadership Roles and Professional Development</td><td>Additional leadership opportunities and professional development experiences that motivate and prepare a person for academic leadership roles that can be achieved within a current position. These leadership opportunities may not require a job title change, but maybe accomplished through a temporary leave of absence from the institution such as a fellowship for a residency at the National Science Foundation, chairing national committees, serving as PI on complex grants, involvement in industry partnerships. Additional examples include sabbatical opportunities, Faculty Senate officer positions, internships in the Dean’s/Provost’s office, and leadership workshops/retreats.</td></tr>
<tr><td colspan="2">_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor</td></tr>
<tr><th>Factors that Inhibiting Advancement</th><th>Description and Examples from Participants</th></tr>
<tr><td>1. Feelings of Isolation</td><td>Feelings of being alone associated with limited interaction, no connection to institutional community, limited faculty support, and being separated from the main campus. Examples may</td></tr>
</table>

	include working remotely without a support system or sense of community.
_____ 5 - Most Relevant Factor _____ 4 - Significant Relevant Factor _____ 3 - Moderate Relevant Factor _____ 2 - Limited Relevant Factor _____ 1 - Not Relevant Factor	
2. Stereotype Threat	Struggling against perceptions that women do not belong in STEM fields, particularly in leadership roles or that others are more competent than oneself. Also, the perception that women leaders are thought of as aggressive and dominant.
_____ 5 - Most Relevant Factor _____ 4 - Significant Relevant Factor _____ 3 - Moderate Relevant Factor _____ 2 - Limited Relevant Factor _____ 1 - Not Relevant Factor	
3. Discrimination	The presence of negative attitudes from factors such as physical attributes, race/ethnicity, age, gender, and behaviors.
_____ 5 - Most Relevant Factor _____ 4 - Significant Relevant Factor _____ 3 - Moderate Relevant Factor _____ 2 - Limited Relevant Factor _____ 1 - Not Relevant Factor	
4. Conflicting Family Obligations	The time restraints required to balance work and parental duties including limited flexibility in work schedule. Examples may include caring for aging parents, a significant other or family member, as well as dependents.
_____ 5 - Most Relevant Factor _____ 4 - Significant Relevant Factor _____ 3 - Moderate Relevant Factor _____ 2 - Limited Relevant Factor _____ 1 - Not Relevant Factor	
5. Failing to Perceive Room or Opportunity for Advancement	Positions are not available for women due to factors such as unwieldy policies and procedures and perceived invisible walls for women.

______ 5 - Most Relevant Factor ______ 4 - Significant Relevant Factor ______ 3 - Moderate Relevant Factor ______ 2 - Limited Relevant Factor ______ 1 - Not Relevant Factor	
6. Lack of Support	Perceiving a lack of support and respect for women in leadership positions, challenges or reversals to decisions. Additional examples include being treated as servants, not being acknowledged as leaders, and limited support from supervisors.
______ 5 - Most Relevant Factor ______ 4 - Significant Relevant Factor ______ 3 - Moderate Relevant Factor ______ 2 - Limited Relevant Factor ______ 1 - Not Relevant Factor	
7. Limited Experience or Degree	Lack of opportunity for experiences and STEM degree-attainment required to advance in leadership.
______ 5 - Most Relevant Factor ______ 4 - Significant Relevant Factor ______ 3 - Moderate Relevant Factor ______ 2 - Limited Relevant Factor ______ 1 - Not Relevant Factor	
8. Lack of Compensation	Taking on more work without a corresponding change in title, recognition, or increased pay.
______ 5 - Most Relevant Factor ______ 4 - Significant Relevant Factor ______ 3 - Moderate Relevant Factor ______ 2 - Limited Relevant Factor ______ 1 - Not Relevant Factor	
9. Personal Concerns	Factors related to health, family, and emotional issues impacting participants' ability to advance.
______ 5 - Most Relevant Factor ______ 4 - Significant Relevant Factor ______ 3 - Moderate Relevant Factor ______ 2 - Limited Relevant Factor ______ 1 - Not Relevant Factor	

10. Limited Skills Training and Ability	Limited access to the leadership training and experiences that prepare participants for STEM leadership positions
_____ 5 - Most Relevant Factor _____ 4 - Significant Relevant Factor _____ 3 - Moderate Relevant Factor _____ 2 - Limited Relevant Factor _____ 1 - Not Relevant Factor	
11. Lack of Desire	Being unmotivated to advance when opportunities arise. Examples may include having little interest in leadership the roles because the additional responsibilities are administrative or not relative to one's career interests.
_____ 5 - Most Relevant Factor _____ 4 - Significant Relevant Factor _____ 3 - Moderate Relevant Factor _____ 2 - Limited Relevant Factor _____ 1 - Not Relevant Factor	
12. English as a Second Language	Language barriers causing a problem with communication.
_____ 5 - Most Relevant Factor _____ 4 - Significant Relevant Factor _____ 3 - Moderate Relevant Factor _____ 2 - Limited Relevant Factor _____ 1 - Not Relevant Factor	

APPENDIX H

Round 4 Cover Letter

Date: Sun, May 5, 2019

Good afternoon, Xxxx,

Thank you for your support and responses in Round 3. Round 4 will be the final round for reaching consensus for this Delphi study on factors that contribute to women's advancement in leadership positions within STEM disciplines. The purpose of Round 4 is to confirm your original rating of the importance or relevance of each factor after seeing the responses of other panel members per factor from Round 3.

I attached the survey with your original ratings in Round 3 and the Round 4 survey that includes the Mean, Median, Standard Deviation, and Interquartile Range for each factor based on the group ratings.

Please see the directions for rating the factors in the attached document. Only mark a new rating if you choose to change your previous rating after seeing the group responses. Answers without new ratings will remain the same as your response in Round 3. Please complete and return by May 10, 2019.

Thank you for your support.

Kimberly
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APPENDIX I

Round 4 Cover Letter Round 4 Instructions and Survey

Round 4

Purpose: Round 4 of this Delphi study seeks to confirm your original rating of the importance or relevance of each factor after seeing the responses of other panel members per factor from Round 3. An IQR over 2.00 indicates that consensus has not yet been gained. This will be the final round for reaching consensus for this study.

Directions: Please review the following list of factors and rate each using the scale provided. Our scale includes responses of 5 - Most Relevant Factor, 4 - Significant Relevant Factor, 3 - Moderate Relevant Factor, 2 - Limited Relevant Factor, and 1 - Not Relevant Factor.

The panelists have rated each factor and we show the ratings of the overall panel and your particular response to each factor from Round 3.

Please review each factor and its description and only mark a new rating if you choose to **<u>CHANGE</u>** to your previous rating after seeing the responses of the other panelists.

Factors Supporting Advancement

1. **<u>Factor</u>: Support Systems**
   <u>Description</u>: Support such as the presence of a mentor, membership in professional organizations, a supportive organizational climate, access to and funding for professional development, and the support of family members. Examples can extend to a significant other or family member as well as a coach and advocate who offers tangible and emotional support.

   Group results from the Round 3 Survey for this factor:

   Mean: 4.31 Median: 4.00 St. Dev.: 0.60 IQR: 1.00

   Do you wish to change your original rating for this factor in Round 4? If yes, please mark the degree of relevance below:

   _____ 5 - Most Relevant Factor
   _____ 4 - Significant Relevant Factor
   _____ 3 - Moderate Relevant Factor
   _____ 2 - Limited Relevant Factor
   _____ 1 - Not Relevant Factor

2. **<u>Factor</u>: Willingness to advance**
   <u>Description:</u> Desire and willingness to advance includes ability to take on new experiences and additional roles and responsibilities that come with a change in position. Example

include the willingness to accept an administrative role although it may mean less time for other scholarship activities (e.g. teaching or research).

Group results from the Round 3 Survey for this factor:

Mean: 4.06 Median: 4.00 St. Dev.: 1.06 IQR: 1.0

Do you wish to change your original rating for this factor in Round 4? If yes, please mark the degree of relevance below:

_____ 5 - Most Relevant Issue
_____ 4 - Significant Relevant Issue
_____ 3 - Moderate Relevant Issue
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor

3. <u>Factor</u>: Curiosity about new experiences
<u>Description</u>: This includes ambition and desire to seek out new positions within leadership and explore new opportunities and education to move beyond one's current role and responsibilities.

Group results from the Round 3 Survey for this factor:

Mean: 3.81 Median: 4.00 St. Dev.: 0.75 IQR: 1.00

Do you wish to change your original rating for this factor in Round 4? If yes, please mark the degree of relevance below:

_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor

4. <u>Factor</u>: Leadership Skills
<u>Description</u>: Skills that made participants qualified for positions, such as soft skills, communication skills, interpersonal skills, leadership training, understanding of data analysis and interpretation, and fiscal management abilities.

Group results from the Round 3 Survey for this factor:

Mean: 4.00 Median: 4.00 St. Dev.: 0.63 IQR: 0.00

Do you wish to change your rating for this factor in Round 4? If yes, please mark the degree of relevance below:

_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor

5. **Factor: Desire to see women in leadership**
Description: Desire to see women represented in leadership positions that contribute to strong messages and advocacy for other women to advance.

Group results from the Round 3 Survey for this factor:

Mean: 2.50 Median: 2.00 St. Dev.: 1.03 IQR: 1.00

Do you wish to change your original rating for this factor in Round 4? If yes, please mark the degree of relevance below:

_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor

6. **Factor: Industry experience**
Description: Related-industry experiences in STEM that gave participants additional qualifications to advance in leadership positions within higher education settings. Further descriptions include one's ability to advance in positions of leadership within private industry that has a lack of women in leadership positions led to ability to advance in higher education as well.

Group results from the Round 3 Survey for this factor:

Mean: 2.88 Median: 3.00 St. Dev.: 1.02 IQR: 2.00

Do you wish to change your original rating for this factor in Round 4? If yes, please mark the degree of relevance below:

_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor

7. **Factor: Awareness of the institutional environment**
Description: Awareness of positive departmental climate, organizational culture and job

factors within STEM departments and higher education institutions that lead to advancement opportunities. This includes teamwork, collegiality, sense of community, and institutional factors that support women in STEM leadership roles.

Group results from the Round 3 Survey for this factor:

Mean: 3.44 Median: 3.00 St. Dev.: 1.15 IQR: 1.25

Do you wish to change your original rating for this factor in Round 4? If yes, please mark the degree of relevance below:

_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor

8. <u>Factor</u>: Knowledge of institutional assessment
<u>Description</u>: Ability to analyze institutional data and offer assessment of programs for leaders to make data-driven decisions.

Group results from the Round 3 Survey for this factor:

Mean: 3.00 Median: 3.00 St. Dev.: 0.97 IQR: 0.75

Do you wish to change your original rating for this factor in Round 4? If yes, please mark the degree of relevance below:

_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor

9. <u>Factor</u>: Experiences in undergraduate and graduate programs
<u>Description</u>: Positive experiences in undergraduate and graduate programs that gave participants the foundational knowledge and support for future advancement in STEM leadership positions.

Group results from the Round 3 Survey for this factor:

Mean 3.50 Median: 4.00 St. Dev.: 0.73 IQR: 1.00

Do you wish to change your original rating for this factor in Round 4? If yes, please mark the degree of relevance below:

_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor

10. <u>Factor</u>: Faith
<u>**Description**</u>: Religious faith and strong belief in God or in the doctrines of a religion based on spiritual apprehension rather than proof that offers inner strength and ability to advance.

Group results from the Round 3 Survey for this factor:

Mean: 2.38 Median: 2.00 St. Dev.: 1.45 IQR: 2.25

Do you wish to change your original rating for this factor in Round 4? If yes, please mark the degree of relevance below:

_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor

11. <u>Factor</u>: Personal Attributes.
<u>**Description**</u>**:** Personal attributes, such as confidence in oneself, passion, vision, emotional stability and ability to adapt to change.

Group results from the Round 3 Survey for this factor:

Mean: 3.88 Median: 4.00 St. Dev.: 0.81 IQR: 1.25

Do you wish to change your original rating for this factor in Round 4? If yes, please mark the degree of relevance below:

_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor

12. <u>Factor</u>: Role Models
<u>**Description**</u>: The presence of respected role models in STEM leadership positions who were willing to share/mentor.

Group results from the Round 3 Survey for this factor:

Mean: 3.63 Median: 4.00 St. Dev.: 0.81 IQR: 1.00

Do you wish to change your original rating for this factor in Round 4? If yes, please mark the degree of relevance below:

_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor

13. <u>Factor</u>: Opportunities for leadership roles and professional development
<u>Description</u>: Additional leadership opportunities and professional development experiences that motivate and prepare a person for academic leadership roles that can be achieved within a current position. These leadership opportunities may not require a job title change, but maybe accomplished through a temporary leave of absence from the institution such as a fellowship for a residency at the National Science Foundation, chairing national committees, serving as PI on complex grants, involvement in industry partnerships. Additional examples include sabbatical opportunities, Faculty Senate officer positions, internships in the Dean's/Provost's office, and leadership workshops/retreats.

Group results from the Round 3 Survey for this factor:

Mean: 3.88 Median: 4.00 St. Dev.: 0.81 IQR: 0.50

Do you wish to change your original rating for this factor in Round 4? If yes, please mark the degree of relevance below:

_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor

Factors that Inhibit Advancement

14. <u>Factor</u>: Feelings of isolation
<u>Description</u>: Feelings of being alone associated with limited interaction, no connection to institutional community, limited faculty support, and being separated from the main campus.

Examples may include working remotely without a support system or sense of community.

Group results from the Round 3 Survey for this factor:

Mean: 3.31 Median: 3.00 St. Dev.: 0.79 IQR: 1.00

Do you wish to change your original rating for this factor in Round 4? If yes, please mark the degree of relevance below:

_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor

15. <u>Factor</u>: Stereotype Threat

<u>Description</u>: Struggling against perceptions that women do not belong in STEM fields, particularly in leadership roles or that others are more competent than oneself. Also, the perception that women leaders are thought of as aggressive and dominant.

Group results from the Round 3 Survey for this factor:

Mean: 3.13 Median: 3.00 St. Dev.: 1.26 IQR: 2.00

Do you wish to change your original rating for this factor in Round 4? If yes, please mark the degree of relevance below:

_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor

16. <u>Factor</u>: Discrimination

<u>Description</u>: The presence of negative attitudes from factors such as physical attributes race/ethnicity, age, gender, and behaviors.

Group results from the Round 3 Survey for this factor:

Mean: 3.25 Median: 3.00 St. Dev.: 1.13 IQR: 1.50

Do you wish to change your original rating for this factor in Round 4? If yes, please mark the degree of relevance below:

_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor

17. <u>Factor</u>: Conflicting family obligations
<u>Description</u>: The time restraints required to balance work and parental duties including limited flexibility in work schedule. Examples may include caring for aging parents, a significant other or family member, as well as dependents.

Group results from the Round 3 Survey for this factor:

Mean: 3.75 Median: 4.00 St. Dev.: 1.34 IQR: 2.00

Do you wish to change your original rating for this factor in Round 4? If yes, please mark the degree of relevance below:

_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor

18. <u>Factor</u>: Failing to perceive room or opportunity for advancement
<u>Description</u>: Positions are not available for women due to factors such as unwieldy policies and procedures and perceived invisible walls for women.

Group results from the Round 3 Survey for this factor:

Mean: 3.06 Median: 3.00 St. Dev.: 1.29 IQR: 2.00

Do you wish to change your original rating for this factor in Round 4? If yes, please mark the degree of relevance below:

_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor

19. <u>Factor</u>: Lack of support
<u>Description</u>: Perceiving a lack of support and respect for women in leadership positions, challenges or reversals to decisions. Additional examples include being treated as servants, not being acknowledged as leaders, and limited support from supervisors.

Group results from the Round 3 Survey for this factor:

Mean: 3.44 Median: 4.00 St. Dev.: 1.26 IQR: 1.75

Do you wish to change your original rating for this factor in Round 4? If yes, please mark the degree of relevance below:

_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor

20. Factor: Limited experience or degree
Description: Lack of opportunity for experiences and STEM degree-attainment required to advance in leadership.

Group results from the Round 3 Survey for this factor:

Mean: 2.63 Median: 3.00 St. Dev.: 1.15 IQR: 1.00

Do you wish to change your original rating for this factor in Round 4? If yes, please mark the degree of relevance below:

_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor

21. Factor: Lack of compensation
Description: Taking on more work without a corresponding change in title, recognition, or increased pay.

Group results from the Round 3 Survey for this factor:

Mean: 3.31 Median: 3.00 St. Dev.: 1.14 IQR: 1.00

Do you wish to change your original rating for this factor in Round 4? If yes, please mark the degree of relevance below:

_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor

_____ 1 - Not Relevant Factor

22. <u>Factor</u>: Personal concerns
<u>Description</u>: Factors related to health, family, and emotional issues impacting participants' ability to advance.

Group results from the Round 3 Survey for this factor:

Mean: 3.44 Median: 4.00 St. Dev.: 1.03 IQR: 1.00

Do you wish to change your original rating for this factor in Round 4? If yes, please mark the degree of relevance below:

_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor

23. <u>Factor</u>: Limited skills training and ability
<u>Description</u>: Limited access to the leadership training and experiences that prepare participants for STEM leadership positions

Group results from the Round 3 Survey for this factor:

Mean: 3.06 Median: 3.00 St. Dev.: 1.06 IQR: 2.00

Do you wish to change your original rating for this factor in Round 4? If yes, please mark the degree of relevance below:

_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor

24. <u>Factor</u>: Lack of Desire
<u>Description</u>: Being unmotivated to advance when opportunities arise. Examples may include having little interest in leadership the roles because the additional responsibilities are administrative or not relative to one's career interests.

Group results from the Round 3 Survey for this factor:

Mean: 2.88 Median: 3.00 St. Dev.: 1.54 IQR: 2.75

Do you wish to change your original rating for this factor in Round 4? If yes, please mark the degree of relevance below:

_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor

25. <u>Factor</u>: English as a second language
<u>Description</u>: Language barriers causing a problem with communication.

Group results from the Round 3 Survey for this factor:

Mean: 1.94 Median: 2.00 St. Dev.: 1.06 IQR: 1.25

Do you wish to change your original rating for this factor in Round 4? If yes, please mark the degree of relevance below:

_____ 5 - Most Relevant Factor
_____ 4 - Significant Relevant Factor
_____ 3 - Moderate Relevant Factor
_____ 2 - Limited Relevant Factor
_____ 1 - Not Relevant Factor