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Factors That Female Higher Education Faculty in Select Science, Technology, Engineering, and Mathematics (STEM) Fields Perceive as Being Influential to Their Success and Persistence in Their Chosen Professions

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FACTORS THAT FEMALE HIGHER EDUCATION FACULTY IN SELECT SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) FIELDS PERCEIVE AS BEING INFLUENTIAL TO THEIR SUCCESS AND PERSISTENCE IN THEIR CHOSEN PROFESSIONS

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ABSTRACT

FACTORS THAT FEMALE HIGHER EDUCATION FACULTY IN SELECT SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) FIELDS PERCEIVE AS BEING INFLUENTIAL TO THEIR SUCCESS AND PERSISTENCE IN THEIR CHOSEN PROFESSIONS

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Old Dominion University, 2012
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The purpose of this study was to determine factors female higher education faculty in select science, technology, engineering, and mathematics (STEM) fields perceived as influential to their success and persistence in their chosen professions. Females are underrepresented in STEM professions including academia, despite the fact that female educational attainment in all fields have increased significantly.

Four research questions were used to guide this study and they are: 1) What personal factors affect females' ability to successfully persist in STEM faculty positions? 2) What social factors affect females' ability to successfully persist in STEM faculty positions? 3) What academic/institutional factors affect females' ability to successfully persist in STEM faculty positions? 4) What other notable factors affect females' ability to successfully persist in STEM faculty positions?

The study was conducted using a 3-round modified Delphi technique. The participants were selected from STEM departments at 26 public institutions labeled as DocSTEM by the Carnegie classification of institutions. An online search yielded Email addresses for 447 female faculty in the above category who were invited to participate in the study; 73 responded and who constituted the study population while 43 completed

Round 1 of the study, thus constituted the study sample. Meanwhile 38 of the 43 completed both Rounds 2 and 3.

In Round 1 participants provided a list of factors, which they refined in Round 2 and validated in Round 3. At the end of Round 3 participants came to a consensus that several personal, social, and academic/institutional factors were influential to their success and persistence. The personal factors provided by participants were positive mental attitude, self-efficacy in STEM, intrinsic motivation, positive personality traits, and positive self-esteem. Participants also cited such social factors as, affirmation and encouragement, mentors and mentoring relationship, and supportive/enabling environments, as being influential to their success and persistence. Finally, the academic/institutional factors cited by participants included supportive/enabling environments, affirmative/equity policies, financial aid and research opportunities, networking and collaboration, institutional expectation of excellence, service opportunities, and collegiality. The retained consensus factors had a mean of 3-4 and a coefficient of variation less than 0.5.

Dedication

This dissertation is dedicated to my mother –Madam Comfort Cecilia Forkuoh – who gave up all she had to make sure that I gained a quality education.

Phyllis Bernice Opare

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There is no way to accomplish any work of such enormity without the able guidance and assistance of a caring and dedicated committee. In the case of this study, my committee members have had to go beyond the norm and make numerous accommodations for my unique situation. There is no way this work will have been done without their help and encouragement.

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CHAPTER I

INTRODUCTION

Males continue to outnumber females in upper levels in many fields within the science, technology, engineering, and mathematics (STEM) sectors. This is in spite of the fact that female participation in education at all levels has increased significantly, and in most fields far exceeds the participation of their male counterparts (Hill, Corbett, & St. Rose, 2010). This low rate of participation of females in STEM majors and professions inhibits social and economic development in many nations (Ainley, 1990; Blickenstaff, 2005; Cronin & Roger, 1999). Female participation in STEM in the elementary, middle, and high school levels have increased to the point where there is no longer a significant difference between boys' and girls' preparedness to pursue STEM majors in college when they leave high school (Hill et al., 2010). This could be the result of several initiatives instituted by the United States Congress, the National Science Foundation (NSF), and other high-level organizations to address this problem.

However, graduate STEM education continues to be dominated by males in certain key sectors such as engineering, where at the master's level women comprise only 20% of the students. At the doctoral level of education, the two highest levels of female enrollment are found in medical programs and the humanities, and in both fields, female doctoral students make up just about 30% of the enrolled students. They account for about 13% of doctoral enrollments in all majors combined, even though they make up over 60% of the total number of students who graduate with a bachelor degree annually. This is because there is low persistence as well as high attrition among females in many

educational majors, particularly STEM majors as they progress up the educational pathway to higher degrees (Hill et al., 2010).

In the report, *Proposing a National Action Plan for Addressing the Critical Needs of the United States Science, Technology, Engineering, and Mathematics (STEM) Education System,* the National Science Foundation (NSF) (2007) made some critical observations. The study showed that despite the fact that the U.S.A. possesses the most innovative, technologically capable economy in the world, its STEM education system is failing to ensure that all students receive the skills and knowledge required for success in the 21st century workforce. Skilled workers in STEM fields are needed to ensure the continued prosperity and security of the nation in the current technological and knowledge based global society (NSF, 2007).

The trend of underrepresentation of females in STEM majors, institutions, and particularly academia has been described as both progressive and persistent. Females represent less than 15% of all full-time tenured faculty in the top research and teaching universities and colleges in the U.S.A. (Nelson, 2007). Fewer females than males elect to study STEM courses, and among those who choose STEM majors, more females than males switch to other majors as they progress through the educational and professional careers (Cronin & Roger, 1999; NRC, 1991; Seymour, 1995). The phenomenon has sometimes been compared to a leaky pipeline, or a funnel effect, and it has persisted despite various interventions (Blickenstaff, 2005; Cronin & Roger, 1999; Seymour, 1995).

Data indicate that the disparity in male and female STEM attainment is reducing, at least at the secondary and undergraduate levels; however, there are still major

disparities in progression in several key STEM areas. According to the National Center for Educational Statistics (NCES) 2000 report, females represented 18% of bachelor degree graduates in engineering, 37% in the physical sciences, 34% in mathematical/computer science, and 26% in chemistry graduates. By 2005, the numbers had increased significantly in some fields; 45% of graduates in mathematics and 52% of chemistry graduates were females. However, as the data indicate, female progression rates decreases as one goes up in the higher education continuum. By 2007, females had only obtained 22.4% of master's degrees in mathematics and 20.8% of doctoral degrees in chemistry (Hill et al., 2010; NCES, 2007). Hill et al.'s (2010) report for the American Association of University Women (AAUW), *Why so Few? Women in Science, Technology, Engineering, and Mathematics,* also indicated that in 1960 females constituted 27% of biologists. Forty years later, in 2000, they consisted of approximately 44% of the workers in the field. Similarly, females made up only 1% of engineers in 1960 and barely 11% by 2000. Within this same period, females employed as chemists increased from 8.2% to 32.3%, physics and astronomers moved from 3.4% to 13.9%, while female mathematical and computer scientists increased from 26.9% to 30%. Thus while there are gains among female participation in certain STEM fields, these gains are not evenly distributed, and they tapper off as careers advance.

Because of women's underrepresentation within the high paying STEM majors, women are more likely to take jobs that are considered traditionally "feminine" and have low status and low pay. For instance, at the turn of the 21st century, women held only 9% of engineering positions, 22% of physical science positions, and 20% of all science, mathematics, and engineering positions in the U.S.A. (NCES, 2000). Frome, Alfeld,

Eccles, and Barber (2006) conducted a longitudinal study of a cohort of young women who aspired to hold male-dominated jobs when they graduated high school. After seven years, the majority of them had changed their career aspirations to those of female-dominated occupations (occupations with more than 70% personnel being women) or neutral jobs (occupations with 31%-69% women populations). Since few women persist in STEM fields, fewer still emerge as leaders and decision makers in those fields.

Background of the Study

The fact that females are underrepresented in several key STEM careers, particularly in academia, is undeniable. However, the causes of this trend are varied and complex. In the report, *Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering* (NAP, 2006), researchers noted that women are seriously underrepresented in academic science and engineering faculties because of a mix of 'unintentional' biases and outdated institutional policies and structures.

The trend of female underrepresentation in STEM professions, including higher education faculties, persists despite the fact that they are not underperforming in any of these areas of study. In fact, the 2005 Nation's Report Card published by the National Center for Educational Statistics (NCES) indicated that females have greater success than males in attaining postsecondary education, and yet they are underrepresented in science, engineering, computer science, and physical science majors and careers (NCES, 2007).

Furthermore, females are reportedly less likely than males to pursue careers in STEM areas, as shown by the percentage of males and females who graduated with bachelor degrees in various fields. The total number of females graduating with a bachelor's degree increased from 43% in the 1969 – 1970 academic year to 57% in the

2000 – 2001 academic year. At the same time, the percentage of females who graduated with engineering degrees increased from 0% to 28%; those in mathematics increased from 37% to 48% (NCES, 2007). Compared to the total number of females graduating with a college degree, those graduating with a STEM degree are significantly lower. Even fewer persist in pursuing a graduate degree in STEM. Since the path to academia involves the pursuit of higher degrees, and fewer females than males pursue graduate degrees in STEM fields, there is a lesser number of female faculty within the STEM fields (NAP, 2007).

Again, the National Academies Press (NAP) (2007) report indicated that although females leave science at nearly every stage of the pipeline:

> Females are underrepresented on faculties even in fields in which they have reached relative parity. They made up only 15.4% of full professors in the social and behavioral sciences and 14.8% in the life sciences, despite having earned more than 30% and 20% of the doctorates in those fields respectively over a period of more than 30 years (p. 2).

It would be logical to conclude that if the obstacles or factors that promote low female participation in STEM courses were reversed, more females would participate in STEM majors and careers. Nonetheless, it appears that in spite of these prevailing factors, some females have been able to overcome and persist in their STEM aspirations to high levels. What separates these women from those who leave? If they survive the same conditions that cause other females to leave, then perhaps they possess certain additional personality attributes, or were exposed to some other external enabling factors that have helped them to persist. Sadly, Cronin and Roger (1999) and Zubrisky (2000) noted that

despite the fact that this problem concerns women, very few women in STEM fields have been the subject of objective, valid, and reliable evaluations. Hence, even when studying the underrepresentation of females in STEM not many women who have managed to persist and progress in STEM have been studied to find out how they have managed to succeed. The goal of this study is to provide female faculty in STEM departments in select post-secondary institutions in the United States of America an opportunity to share with others how they have succeeded in spite of their challenges. The resulting understanding of the phenomenon of low female participation in STEM fields, and how some females have been able to overcome their challenges, would be beneficial in finding solutions that can be used to encourage and increase the number of females in these fields.

Reasons for the Underrepresentation of Females in STEM Fields

Various reasons have been assigned in literature to explain why so many females choose not to study STEM majors or switch once they begin with STEM majors. These reasons may be classified as personal, social, and academic/institutional. They are so complex and intricately interrelated that it is sometimes difficult to isolate which ones apply in a particular case. Personal factors are those that are believed to emanate from the individual's perception of self and personal abilities. Social factors include what an individual observes in the larger society, as well as the limitations placed on persons because of expected social norms and cultural practices. Academic/institutional factors are those that occur in institutions by staff and students to mold individuals into preconceived roles and statuses. The occurrence of some of these factors may be overt, or

sometimes subtle, so people are not conscious of their influence on themselves and others (Bandura, 1977; Guidmond, 2004).

Among the personal factors cited in research as being important in the low participation of females in STEM fields is the concept held by some, that physiological differences exists between the genders, particularly between the brain sizes, which limits the female's ability to comprehend and succeed in STEM subjects. The proponents of this view believed that female brains are smaller than males and as a result are inferior. However, this has been found not to be the case by the Committee on Prospering in the Global Economy of the 21st Century (CPGE, 2005). Conclusions drawn from some of the studies in Hill et al. (2010) indicated that although female and male brains were found to be physically distinct, how these differences translate into specific cognitive strengths and weaknesses remains unclear. The misconception about different brain sizes among the genders gives rise to cultural pressures and predetermined social roles that tend to discourage females from studying certain subjects, including those in the STEM fields. In extreme cases, some people have taken this even further to justify and advance social structures that oppress the weak and vulnerable and to promote racial elitism (Bandura, 1977; Guidmond, 2004).

The interrelated concepts of self, self-perception of intellectual ability, educational self-efficacy, and self-esteem are among the factors that research has shown can affect a person's confidence in succeeding in a chosen field of study or profession. What a person believes they are capable of, often translates into successful performance of tasks. The successful performance of a given task engenders confidence, which in turn

leads to future success (Bandura, 1977, 1997; Blickenstaff, 2005; Boulter, 2002; Campbell, 1992; Guidmond, 2004; Lent, Brown, & Larkin, 1986, 1989).

Furthermore, evidence indicates that social norms, expectations, and cultural congruity can also affect individuals' selection and persistence in a course of study or career (Gloria & Kurpius, 1996). Certain cultures have set expectations of their members, so when members find themselves in the midst of a new culture that has different expectations, they become uncomfortable and experience feelings which are incongruent with what they are familiar (Gloria & Kurpius, 1996). Several cultural and social expectations make many females concerned about combining a STEM career with having a family (Bloch, 1987; Campbell, 1992; Cronin & Roger, 1999).

Again, there are several factors within schools and institutions that tend to inhibit female participation in STEM or perpetuate the trends of low female participation in STEM. These factors include:

1. Girls lack of positive experiences with STEM in childhood due in part to attitudes of parents, male peers, teachers, and other school staff,
2. Narrow course content and didactic teaching approaches,
3. Lack of opportunities for cooperative or interactive learning,
4. Emphasis on individual competition,
5. Inadequate counseling and advising,
6. Lack of instructional support,
7. Girls' lack of adequate academic preparation in STEM areas, due in part to poor advising or peer pressure to study subjects other than those in STEM, and

8. Many girls also view science curricula as irrelevant and not practical in real life (Blickenstaff, 2005; Hill et al., 2010; Murphy, 2007).

Other factors within the secondary and tertiary institutional realm include the stress of being a minority, coping with multiple demands on their time, inhospitable university environment, and inadequate academic ability. The academic climates within many STEM departments have been described as 'chilling' toward females (Bennett & Okinaka, 1990; Boulter, 2002; Campbell, 1992; Cronin & Roger, 1999; Gloria, Kurpius, Hamilton, & Willson, 1999; Johnson, 1994; Pancer, Hunsberger, Pratt, & Alisat, 2000).

In addition, there is evidence to show that a major contributory factor of the underrepresentation of females in post-secondary STEM faculties is discrimination. Such discrimination may sometimes be deliberate or conducted indirectly through traditional institutional biases. This makes some institutions less likely to hire females, or when they do, provide unequal access to resources, progress, promotion, and tenure. In many institutions, females receive less remuneration than their male counterparts with similar qualifications (Hill et al., 2010; NAP, 2007; MIT, 2011). Since discrimination is usually not something a person does overtly, hearing from women who may have gone through it and survived, may lead to the generation of behavior modification recommendations that can assist in curtailing or minimizing it.

The factors that inhibit the participation of females in STEM fields are varied and multi-faceted, and it seems that not one, but, a combination of personal, social, and academic/institutional factors work together to limit females' access or persistence in STEM courses and careers. While these factors appear throughout the literature as an extensive and entrenched behavior, many people are not conscious of their contribution

in perpetuating them, and this lack of awareness is itself a major aspect of the problem. It is anticipated that discovering what helped some females in STEM to persist and succeed may be used to better equip educators, policy makers, parents, and female students to provide enabling environments to foster these factors among young female STEM scholars, so that their persistence and success rates may be increased.

Statement of the Problem

The purpose of this study was to determine factors that female higher education faculty in select science, technology, engineering, and mathematics (STEM) fields perceive as being influential to their success and persistence in their chosen professions.

Research Questions

The following questions were used to guide this research to discover factors that helped females persist and succeed in faculty positions in STEM fields:

RQ_1: What personal factors affect females' ability to successfully persist in STEM faculty positions?

RQ_2: What social factors affect females' ability to successfully persist in STEM faculty positions?

RQ_3: What academic/institutional factors affect females' ability to successfully persist in STEM faculty positions?

RQ_4: What other notable factors affect females' ability to successfully persist in STEM faculty positions?

Significance of the Study

Knowledge and skills required in the workplace have changed drastically over the last few years. The U.S.A. Department of Labor projections indicate that the majority of

the fastest growing occupations, by the year 2014, will require significant science or mathematics training to successfully complete required tasks. Furthermore, information technology (IT) jobs will increase by at least 24% between 2006 and 2016. In spite of the projected growth in occupations requiring skills in science and mathematics, fewer students are choosing to major in these areas (Peter & Horn, 2005).

If this trend continues in the U.S.A. there could be serious shortfalls in the workforce needed to effectively maintain the developmental agenda and compete in the global economy (Peter & Horn, 2005). It is projected that the U.S.A. will need 400,000 new graduates in STEM fields every year by 2015; however, the number of new graduates appeared to have reached a plateau of 225,000 a year in 2005. Meanwhile, an initiative that was launched in 2005, proposing that the annual STEM graduation rates should double by the year 2015, is reported to have fallen behind in its projection. Thus, making it almost a certainty, the U.S.A. will have a significant STEM workforce deficit by the year 2015 (Pope, 2008). If this workforce gap is to be addressed, then women and other underrepresented minorities need to be encouraged to enter STEM fields in greater numbers. Otherwise, as Colwell (2002) aptly puts it, "as our national workforce becomes increasingly diverse, a scientific enterprise with mainly white males faces the risk of sending the signal that others are not welcome" (p. 2).

In spite of the discussions and the number of initiatives put in place to address the underrepresentation of females in key STEM fields, the problem persists on several levels, and it is a cause for concern (Ainley, 1990; Blickenstaff, 2005; Campbell, 1997; Cronin & Roger, 1999; NAP, 2006; Seymour, 2002). In as much as females represent 50.9% of the U.S.A. population (USCB, 2008), their underrepresentation in STEM fields

continues to deprive society of talent and productive individuals in these areas. STEM areas would benefit greatly from the diversity of skills and approaches that equitable gender participation would bring. Such equity and diversity would make scientific knowledge more robust and diverse (Blickenstaff, 2005; Colwell, 2002; Cronin & Roger, 1999; NAP, 2006; Seymour, 2002). Hill et al. (2010) cites the example of automobile airbags; since the first batch of airbags were engineered, produced, and tested by a predominantly male group of engineers, the female and child bodies were not considered. As a result, many women and children died avoidable deaths. Thus, the underrepresentation of females in STEM fields and careers do not only contribute to STEM workforce shortages, but it also deprives those fields of the diversity and variety that a fair gender representation would bring.

Furthermore, the knowledge of what has helped some females to persist in their chosen STEM fields can assist educators and other stakeholders to devise appropriate intervention strategies that would help get more females into STEM fields and help those who are already in, to stay. The decline in the number of graduates entering STEM careers transcends gender borders; there is a general decline in the number of graduates from STEM majors among both males and females (Peter & Horn, 2005). It is possible that the factors female STEM faculty members identify as contributing to their success and persistence could be of equal benefit to young students of both genders, and other individuals underrepresented in STEM fields.

Also, in view of the problems arising from rapid globalization, rapid technological advancement, and the fact that economies are becoming more knowledge-based, there is a greater need to have citizens who have developed better capabilities in

STEM areas than what has been acceptable in the past (Friedman, 2005; NSF, 2007). This will ensure that citizens possess the needed scientific and technological literacy to boost and sustain greater innovations.

> The United States can no longer afford the underperformance of academic institutions in attracting the best and brightest minds to the science and engineering enterprise, nor can it afford to devalue the contributions of some members of that workforce through gender inequalities and discrimination... Because the danger exists that Americans may not know enough about science, technology, or mathematics to contribute significantly to, or fully benefit from, the knowledge-based economy that is already taking shape around us. (CPGE, 2005, pp. 4, 94)

In order to ensure that the American populace attains the desired technological and scientific literacy levels, there is a need to increase the number of females in academia. This is because female faculty members are influential as role models and mentors in encouraging other females as well as other individuals of minority descent to pursue and persist in careers within the STEM fields (Ainley, 1990; Guidmond, 2004).

As a result, it is imperative that successful female faculty members be studied to learn the strategies and factors – within and without – that contributed to their success and to replicate those conditions for other females. This study was designed to seek consensus among female faculty in STEM departments, in institutions that offer doctoral level degrees in those fields, about the factors they consider influential to their persistent success.

Limitations

This study was limited to:

1. Female faculty in STEM departments at institutions labeled as DocSTEM in the Carnegie classification of institutions
2. Female faculty in STEM departments within DocSTEM institutions that published their faculty Emails addresses
3. Female faculty in STEM departments who had obtained all their higher education degrees within the United States of America
4. Female faculty in STEM who had attained associate professor rank or higher
5. STEM departments for the study included: physics, chemistry, biology, mathematics, diverse engineering departments, information technology, computer science, environmental science, and geology.
6. The study did not include some of the life and behavioral sciences, such as nursing, psychology, and medical sciences, because these have already attained gender equity.

Delimitation

In order to offset some of the above limitations, the following steps were taken: First, the experts were female faculty in academia and hence had opinions that come from their own personal experiences, as well as from the experiences of their colleagues and students. Secondly, the kind of institution selected for the study were in the same categorization according to the Carnegie classification, ensuring that current experiences of participants will be fairly similar. Finally, all the participants had attained at least

associate professor status, ensuring that they can be classified as having successfully persisted within their chosen STEM field.

Assumptions

The following assumptions were made in this study:

1. The female faculty listed in STEM departments in DocSTEM institutions are cognizant of factors that have helped them to persist and succeed in their chosen STEM professions
2. The female faculty in STEM will be able to articulate the factors they perceive as being influential to their persistence and success in STEM professions
3. The female STEM faculty from different fields will agree on factors of successful persistence
4. The number of female faculty in STEM departments need to increase significantly to escalate female enrollment in STEM majors, STEM faculty and other STEM professions

Procedures

After developing workable research questions, a review of different research methods was conducted to discover what would be the best method to help answer the research questions. The Delphi technique was selected because of its flexibility and the fact that it gives participants freedom to express their opinions and subjective judgments without undue influence from the monitor or researcher and other participants.

In this study, participants outlined factors they perceived as being instrumental in their abilities to persist and succeed in their chosen STEM field. The issues raised in the study were subjective, thus the selection of the Delphi technique.

A convenient sample of female STEM faculty members was selected from public four-year institutions labeled as DocSTEM in the Carnegie classification. These educational institutions offer doctoral degrees with a dominant STEM focus. Graduation data from these institutions indicate that they award doctoral degrees in a range of fields, many in the STEM fields. The majority of them also offer professional education at the doctoral level or in fields such as law or medicine (Carnegie, 2010). Within this list, only those labeled as public, and had faculty Emails posted on their institutional websites, were included in this study.

The initial Delphi outputs from an open-ended questionnaire were to identify answers to the research questions. These outcomes will be sent back to participants in the form of a Likert scale survey, so they could indicate their levels of agreement to the importance of the factors identified by the panel as influential to their success and persistence. The survey results were then analyzed using quantitative statistical analysis to determine which of the factors given by the selected female faculty were most influential in helping them to persist and succeed in their chosen STEM careers. The survey round was repeated once more among participants to build consensus about the factors emerging that participants considered most influential to their persistence and success in their STEM professions.

Definition of Key Terms

The following terms are defined to ensure the reader does not misinterpret their meanings as intended for this study:

Delphi: A method of consensus building that utilizes several rounds of questionnaire and controlled feedback, using people who are considered experts in the topic under discussion (Brill, Bishop, & Walker, 2006).

DocSTEM: Carnegie Classification for educational institutions that offer doctoral degrees with dominant STEM focuses and awards doctoral degrees in a range of fields, many in the STEM fields (Carnegie, 2010).

Expert: This is a person who possesses special knowledge, skill, and experience in a given area of study or a profession.

Faculty: For the purposes of this study, the term denotes full-time members within a higher education institution who are responsible for planning and developing instructional strategies, teaching, and conducting research.

Female faculty: Women who are employed with a full-time position in an institution classified as DocSTEM by the Carnegie classification.

Persistence: In this study, this refers to the tendency of an individual to select and remain within specific fields of study within the STEM fields.

Success: In relation to this study refers to a person's ability to grasp the concepts of scientific and technological literacy and being able to demonstrate this ability through various assessments, and thus being able to proceed to graduate and post-graduate levels of STEM studies. In reference to this study a successful participant is defined as a female faculty member in STEM who has attained a minimum rank of Associate Professor.

Self-Efficacy: Peoples' determination about their personal ability to complete a task or action (Bandura, 1986).

STEM: An acronym that stands for science, technology, engineering, and mathematics. In this study the definitions of STEM include "mathematics, natural sciences (including physical sciences, and biological/agricultural sciences); engineering/engineering technologies; and computer/information sciences" (Cheng, 2009, p. 2).

STEM-Majors: Refers to those courses of study that have a predominantly large number of classes in science, technology, engineering, and/or mathematics.

STEM-Switchers: This term for the purpose of this study refers to those students who changed their predominantly STEM related course of study to ones with less STEM emphasis.

Overview of Chapters

As students progress through higher education and careers, the number of females in STEM fields decreases. As a result, the number of females with a master's or doctoral degree in these areas is very low. This study sought to document the factors given by successful females at the collegiate faculty level as being instrumental in their ability to persist and succeed in their profession. Chapter I introduced the subject, providing a background and rationale for the study, while setting out the limitations as well as the assumptions for the study. In this chapter a brief review of the trend of female participation in STEM fields, the factors that contribute to this trend, the significance, and some personal, social, and national impacts of this situation were also discussed.

Chapter II focused on the review of literature that documents trends of female enrollments and participation in STEM majors and careers. Expert discussions on the personal, social, and academic/institutional factors that influence female participation in STEM majors and careers were explored. In addition, the effects of the

underrepresentation of females in STEM fields on individuals and society were noted. The search of literature revealed that few females choose electives in STEM, and females were more likely than males to drop out of these classes and careers. It was also revealed in recent studies that even though the numbers of females graduating with STEM degrees are increasing, even at the doctoral level, there is not a corresponding increase in the number of female faculty in STEM. In view of this, certain initiatives have been instituted to reverse the trend of female attrition at all levels in the STEM pipeline. Initiatives reviewed were aimed at increasing access, improving persistence, and encouraging more females to specialize and take up leadership positions in STEM.

In Chapter III, the Delphi technique was discussed in depth and reviewed to determine its advantages and disadvantages as well as its appropriateness for this study. The population for the study was comprised of females who taught classes and/or conducted research in STEM departments in selected colleges and universities labeled as DocSTEM in the Carnegie classification of universities and colleges. The sample institutions and the mode of selection of those institutions as well as the statistical procedures that were employed to analyze the data obtained were also discussed.

Chapter IV contains an in-depth explanation of the statistical analysis and treatment of the data obtained, as well as the corresponding findings of the study. Tables and figures indicate which factors female STEM faculty attributed to their persistence and success in their careers. In Chapter V conclusions were drawn and recommendations made for further study.

CHAPTER II

REVIEW OF LITERATURE

This study was designed to gain consensus among higher education female faculty in science, technology, engineering, and mathematics (STEM) fields about factors they perceive as having contributed to their success and persistence in these male-dominated fields. In order to understand the participation of females as STEM faculty, literature outlining the enrollment trends and persistence of women in STEM was reviewed. An examination of personal, social, and academic factors that are determined by researchers to be influential in their persistence in STEM majors and careers were also studied. Furthermore, some of the constraints faced by females in STEM majors, as well as notable effects of the underrepresentation of females in STEM on individuals, departments, and the nation were noted. Finally, a review of some initiatives instituted or recommended to remedy the underrepresentation of females in select STEM fields was also conducted.

School Success and Persistence Trends

Since the start of formal education, there have been divisions between the genders about what subjects were deemed appropriate for one gender and not for another. This goes back in history, where in various cultures social roles were pre-determined based on gender. Historically, subjects in mathematics, science, and activities that use tools have been considered male domain and few females have ventured into these studies. These gender roles were learned from the home and reinforced in school and the larger society. Society has realized that such trends have been detrimental to the development and

advancement in scientific knowledge and socio-economic development in many nations (Bloch, 1978; Witt, 1997).

In 1996, the National Education Goals Panel was established to set goals toward building a nation of learners. It had among its objectives the need to significantly increase the number of women studying STEM subjects in order to increase the overall number of students who enter these fields. The committee recognized that closing the general academic achievement gap was not enough, but there should also be a significant increase in the number of females within STEM fields (NCES, 1997). The attainment of this objective has been a slow and laborious process. According to Cheng (2009), only about 14%-15% of undergraduates enrolled in postsecondary institutions in the United States in 2003-2004 were enrolled in a STEM field. Looking even closer, only 5% of postsecondary students in 2003-2004 were in computer/information sciences, 4% in engineering/engineering technologies, 3% in biological/agricultural sciences, and less than 1% each was enrolled in physical sciences and mathematics.

Again, in spite of the fact that females have closed the gap and have in fact overtaken males in college enrollment and graduation rates, they are still behind in several STEM majors (Cheng, 2009; Hill et al., 2009; Peter & Horn, 2005). While 34% of all the males entering college enrolled in a STEM field, only 14% of females did so (Cheng, 2009). Cheng (2009) discussed the result of a longitudinal study of 9,000 students beginning in 1996, with follow-ups in 1998 and 2001, which examined students' entrance into and persistence toward degree completions in STEM fields. It was designed to answer three questions: "(1) Who enters STEM fields? (2) What are their educational outcomes (i.e., persistence and degree completion) several years after beginning

postsecondary education? (3) Who persisted in and completed a STEM degree after entrance into a STEM field of study?" (pp. 1-2)

With regard to student persistence, Cheng (2009) discovered that students who enrolled in STEM fields were more likely to graduate than those who enrolled in non-STEM majors. After six years, 35% of students who had enrolled in STEM majors had either completed a bachelor degree or were in the process of doing so, compared to 27%-29% of non-STEM majors. Similarly, while only 27% of STEM majors had left college without earning a degree after six years, 33%-36% of non-STEM majors had left without a degree. This could be because most STEM majors are linked to specific careers. Studies indicate that one of the strongest predictors of students' college persistence is a personal commitment to an academic or occupational goal (Tinto, 1993). An additional reason why many students leave college before graduation, which is becoming increasingly common, is the fact that they enter college only to get a certain number of credit hours or to gain specific job related skills and not necessarily to obtain a diploma (Tinto, 1993). The nature of STEM majors are such that very few short-term skill acquisitions are required or desired.

However, not all those enrolled in STEM majors exited with a degree in those fields. In fact, the study revealed that at the end of six years, 27% of students who entered college with a declared STEM major had switched to non-STEM fields. Yet only 7% of students who enrolled with a non-STEM major had switched to a STEM major, and 16% of those who had initially not declared a major selected a STEM major (Cheng, 2009).

Even though the Cheng (2009) study showed no significant differences in the percentage of STEM switchers or leavers between genders, because the number of female

entrants into STEM fields is so much less than their male counterparts, it makes the gap created by those who leave even more significant. This indicates a trend in which women are gradually filtered out of STEM fields through low participation in secondary and postsecondary STEM, as well as low progression in STEM beyond the undergraduate level (Cronin & Roger, 1999; Nelson, 2007). Using a funnel analogy and a science, engineering, and technology parity index, Cronin and Roger (1999) were able to establish that indeed the issue of low representation of females in these areas is both persistent and progressive.

Data also indicate that although females represented 52.0% of the adult population in the United States, they accounted for only 29.5% of earned doctorates in the country. Gains made by women in attaining a doctorate degree has been quite impressive, given the fact that at the turn of the last century, almost 30 years after the first Ph.D. was awarded in the U.S.A., women represented only 6.0% of degrees awarded in 1900. By the year 2000, they represented 44.1% of all doctorate degrees awarded (Nettles & Millet, 2006). However, these gains are not evenly distributed among key sectors, such as STEM. Considering further that there are so few students generally electing to study STEM and more females currently pursing higher education, it makes logical sense to encourage even more women to consider all STEM majors of study.

Trends of STEM Gender Inequities in Education, Academia, and Industry

According to 2003 National Science Foundation data, women held about 28% of all full-time science and engineering faculty positions with 18% as full professors, 31% as associate professors, and 40% as assistant professors. Despite the significant growth of the number of women in the STEM Ph.D. pool, female faculty appointments, particularly

at the senior levels, are still lagging. While females constituted more than 50% of Ph.D. students in the life sciences, and up to 42% of the entire pool of life science Ph.D. recipients from 1997 to 2003, they represented just 34% of assistant professor appointments in those areas (Redden, 2007). Female faculty representation also varied among the STEM fields. According to the Hill et al. (2010), they made up less than one-quarter, or 22% of the faculty in computer and information sciences, 19% of mathematics faculty, 18% of the physical sciences faculty, and 12% of engineering faculty. Furthermore,

> In the life sciences, an area in which many people assume that women have achieved parity, women made up only one-third (34%) of the faculty. In all cases women were better represented in lower faculty ranks than in higher ranks among STEM faculty in four-year colleges and universities. (Hill et al., 2010, p. 15)

This trend has not increased much over the years since Trower and Chait (2002) had reported on the entire faculty in American universities and colleges. They reported:

1. 94% of full professors in science and engineering were white; 90% were male,
2. 91% of the full professors at research universities were white; 75% were male,
3. 87% of the full-time faculty members in the United States were white; 64% were male,
4. Only 5% of the full professors in the U.S.A. were black, Hispanic, or Native American, and

5. The gap between the percentage of tenured men and the percentage of tenured women had not changed in 30 years. (p. 34)

Furthermore, fewer women were found in the faculties of the top rated research institutions in the U.S.A., particularly minority women. Nelson (2007) indicated that the top 50 institutions in this category had virtually no African American, Native American, or Hispanic tenured or tenure track female faculty. The percentage of female full professors in these institutions ranged from 3% to 15%, well below the national averages. A prominent female professor is noted as saying, "It was discouraging to know that when I went to the University of Texas in 1976, I was the second woman in a faculty of about 50, and when I left in 1998, they were again hiring a second woman" (Nelson, 2007, p. 2).

In view of the current gains made by females in undergraduate STEM attainment, Trower and Chait (2002) maintain that the issues of access are no longer the major factor in the equitable distribution of females in STEM professions. Because, even with more women entering the STEM pipeline, a fundamental challenge remains, female graduates enter a climate that is too often uninviting, unaccommodating, and so unappealing that many chose to switch from STEM or even when they obtain their degrees they elect to work in professions other than STEM.

Similarly, the United States Government Accountability Office (USGAO) in a 2005 study established that the total number of students and employees in the STEM fields increased significantly from the 1995-1996 academic year to the 2003-2004 academic year. However, the percentage of women did not change, but those of minorities and international students varied. During the study period, the total number of

students in the STEM fields increased by 21%, and the number of students enrolled in STEM fields as a percentage of all student enrollments increased from 21% to 23%. In this same period, the total number of graduates in STEM fields increased by 8% compared to a 30% increase in graduates in non-STEM fields. Furthermore, the percentage of graduates with STEM degrees decreased from 32% to 28% of total graduates, particularly at the doctorate levels (USGOA, 2005).

Meanwhile, employment in the STEM fields increased by 23% in this period compared with 17% increases in the non-STEM fields. While there was no statistically significant change in the percentage of female employees, African American employees continued to be less than 10% of all STEM employees. This is significant in relation to females in STEM, since African American females make up more than 60% of graduate students among students of that race. This problem is made even worse by the fact that the international workforce pool seems to be drying up for the U.S.A. The number of applicants for H1-B visas in certain critical STEM areas such as systems analysis and programming positions declined by 106,671 from 2006 to 2007. This was due to stricter homeland security measures resulting from the September 11, 2001, attacks, as well as strong competition for international students by Europe, Australia, and some Asian countries (Siaya & Hayward, 2003; Stohl, 2007; USGAO, 2005).

If current trends continue, by the year 2020, 60% of all jobs will require skills that only 22% of the workers of today possess (BEST, 2002). Therefore, unless females, minorities, and traditional males are encouraged to pursue STEM careers in larger numbers, the current trend will produce a major deficit in employees in the STEM fields in the United States of America. Reversing this trend is especially urgent considering that

currently a third of all STEM degrees at the master's and doctorate levels are awarded to international students (USGAO, 2005).

It is becoming increasingly apparent that the issue of underrepresentation of females in STEM fields is not just due to what has been termed the 'leaky pipeline', i.e., females leaving STEM fields at all levels, because in some STEM fields their participation has reached the critical mass for decades. The critical mass theory suggests that "once a definable group reaches a certain size within an organization, group interactions transform the organization's culture" (Andrade & Santiago, 2010, p. 1). The assumption is that when such a critical mass has been attained, then the participation of the new definable group will then be assured to continue in this pattern.

However, even in those STEM fields in which females have reached the critical mass in enrollment and graduation, they are not proportionally represented in tenure track and senior positions. For instance, 30% of the doctorates in social sciences and behavioral sciences and over 20% in the life sciences have been earned by females. Yet, at the top research institutions, only 15.4% of the full professors in the social and behavioral sciences and 14.8% in the life sciences are females. Again, even though females earned 66.1% of the Ph.D.'s in psychology between 1993 and 2002, only 45.4% of the assistant professors in psychology were females. These are the highest percentages of female representation within the STEM areas, and it is still not representative of the prevailing female talent pool (NAP, 2007; Nelson, 2007). Therefore, the problem with low numbers of female STEM faculty is not just the unavailability of qualified candidates, but it is a serious attitudinal issue within institutions and among diverse individuals.

Reasons for the Underrepresentation of Females in STEM Faculties

The causes attributed to the underrepresentation of females in STEM fields are so varied that a complex analysis is required in order to segregate and identify which causes are the most pervasive and how best to overcome them. The National Academy of Sciences' report *Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering* indicated that even though both males and females leave the STEM 'pipeline' during the process of preparation towards academic positions, major distinctions between the patterns of attrition between the genders happened at what they termed the transition points (NAP, 2007).

> Fewer high school girls intend to major in science and engineering fields, more alter their intentions to major in science and engineering between high school and college, fewer women science and engineering graduates continue on to graduate school, and fewer women science and engineering Ph.D.'s are recruited into the applicant pools for tenure-track faculty positions. (NAP, 2007, p. 51)

What factors influence a person's choice of a course of study? Personal factors of self-efficacy beliefs as well as competency assumptions, academic factors, and social factors are among the influencers for this trend. Assertions such as the one that proposes that females underperform in and as a result do not succeed in STEM majors and careers because of some inherent physiological lack, such as small brain sizes, have been proven baseless and unfounded. One major national study discovered that:

> Studies of brain structure and function, of hormonal modulation of performance, of human cognitive development, and of human evolution

> provide no significant evidence for biological differences between men and women in performing science and mathematics that can account for the lower representation of women in these fields. The dramatic increase in the number of women science and engineering Ph.D.s over the last 30 years clearly refutes long-standing myths that women innately or inherently lack the qualities needed for success; obviously, no changes in innate abilities could occur in so short a time. (CPGE, 2005, pp. 214-215)

However, most young people, both males and females, tend to view science as being masculine in nature, and therefore not suitable for women (Guidmond, 2004; Hill et al., 2010). The underrepresentation of females in STEM faculty is the result of a phenomenon that is pervasive and has persisted for a long time.

Personal Factors

There are several factors that influence a person's course of study and career choice. The foremost is self-efficacy, which is one's perception of the importance or relevance of the choice of profession as well as one's beliefs in the priorities of life roles and how to balance them. Self-efficacy is defined as a person's beliefs in their ability to perform successfully in a given task or behavior (Bandura, 1989). This belief in ability to perform a given task generally translates into success in actually performing that task. In a study conducted to measure the relationship between student's self-efficacy and performance, it was found that "students reporting relatively strong self-efficacy for technical/scientific educational subjects generally achieved higher grades and greater persistence in science and engineering majors than did those with low self-efficacy ratings" (Lent, Brown, & Larkin, 1987, p. 293).

In further studies Lent et al. (1987) found that self-efficacy was a strong predictor over and above objective ability and achievement in predicting students' future success and persistence in science and engineering majors. Thus, the higher a person's belief in their ability to perform well and succeed in a given STEM area, the higher the chances are that they will persist in that area. "Self-efficacy expectations may be important mediators of behavior and behavior change in the career domain in particular; percepts of personal efficacy are hypothesized to affect one's choice of behavioral settings, and activities, as well as degree of effort expenditure" (Bandura, 1989, p. 3).

In order to understand how self-efficacy beliefs can actually influence the choice of study or profession, one needs to understand how these concepts are constructed. Self-efficacy beliefs are formed through a person's efficacy expectations as well as the actual performance of a task. These efficacy expectations are derived from four major sources of information: performance accomplishments, vicarious experience, verbal persuasion, and physiological states (Bandura, 1977).

The first source of information that influences self-efficacy expectations is performance accomplishments. There is general agreement among major researchers that the successful completion of a task or behavior increases a person's expectation of success for the task or behavior in the future (Bandura, 1977; Guidmond, 2004; Hackett, & Betz, 1981; Lent, Brown, & Larkin, 1987). 'Success breeds success', while failure can lower expectation of future success. On the average, females tend to express lower self-efficacy in the areas of STEM than males. This is partly because males and females typically gain life experiences in different ways and in different locations, which in effect gives them different perceptions about the attribution of success. Whereas males typically

gain a lot of experience outside the home from an earlier age, most of the experiences of young females are limited to the home. Such broadened experiences by male children increase their abilities and perceived self-efficacy toward STEM subjects (Bandura, 1977; Guidmond, 2004; Hackett, & Betz, 1981; Lent, Brown, & Larkin, 1987).

Furthermore, Bandura (1977) explained that the extent to which the successful conclusion of a task impacts self-efficacy expectations depends in part on the extent to which the person attributes the success to internal factors (ability or effort) as opposed to external factors (task difficulty or luck). Though nearly similar in their attribution of success, several studies have found that men tend to attribute success more often to internal causes such as ability and effort, while women had more of a tendency to attribute success to external causes such as luck or difficulty of task (Travis, 1982). In many of the studies, the differences in causal attribution varied depending on the gender of the person making the attributions or on whether the task had a clear male sex link (Travis, 1982).

The second source of information in the development of self-efficacy expectation in individuals is the observation of others successfully completing a task. Seeing others of the same gender, race, physical ability, or socioeconomic status successfully complete a task can encourage others to attempt that task themselves (Bandura, 1977, 1989; Guidmond, 2004). Many of the self-efficacy beliefs are learned socially and are influenced by other people who model behaviors that are considered socially acceptable. People's concepts of what is real in society are greatly influenced by their lived experiences and by "what they see and hear – without direct experiential correctives" (Bandura, 1989, p. 334). With very limited portrayal of women as scientists, engineers,

carpenters, IT specialists, etc. in the media, in textbooks, and in real life, it is no wonder young women are unable to observe other women in these positions and are less likely to see themselves as doing the same. As a result, both male and female children tend to view STEM subjects as being masculine and thus reserved for boys. In addition, females tend to view these subjects as being concerned with things rather than people, particularly engineering, computing, and physics (Campbell, 1992; Cronin & Roger, 1999; Khale, 1983).

Linked to the issues of self-efficacy is a person's perception of and attitudes towards a particular subject; research has shown that girls, particularly teenage girls, often have poor attitudes toward STEM subjects. They view them as being impractical, boring, masculine, filled with facts to memorize, and this makes them feel stupid. Most girls who had studied science in their early to late teens reported that it failed to instill in them any feelings of success, confidence, or curiosity (Khale, 1983). These poor attitudes result in low enrollment and achievement in science. It must be noted that these poor attitudes do not originate from biological or genetic sources, but they are acquired by students within the educational community and larger society. When personal experiences have not been the best and there are no role models to point out, otherwise, it is easy for individuals to form wrong perceptions about any issue (Guidmond, 2004; Hackett & Betz, 1981).

Consequently, some experts have described the number of female faculty in STEM departments as "the single most important indicator of academic success for women undergraduates" (Trower & Chait, 2002, p. 34). Mentoring plays a key role in the participation of women and minorities in STEM fields. Bandura (1989) states that,

"humans have evolved an advanced capacity for observational learning that enables them to expand their knowledge and skills on the basis of information conveyed by modeling influences" (p. 21). Social learning occurs mostly through the observation of the actual behaviors of others; successful and attractive behaviors are emulated and can spread through the whole society. "Modeling influences can serve as instructors, motivators, inhibitors, disinhibitors, social facilitators, and emotion arousers" among learners (Bandura, 1989, p. 21). Models, by expressing emotions, are able to arouse in the observer levels of emotion that may not be present otherwise, which can lead to the examination of learned behaviors and subsequent changes in behaviors (Nelson, 2007).

Meanwhile, female students have a disproportionately lower number of female professors who can serve as role models in comparison to male students. In 2002, only 8.3% of mathematics faculty was female, but 48.2% of the students who graduated with a bachelors degree in mathematics were female. Therefore, it is possible that a female tenured professor never instructs many female students in their entire undergraduate years. Consequently, when female students observe the absence of females as instructors because of the disproportionate rate of hiring less females, as well as the unfair treatment of those hired in the allocation of resources, and in the tenure process, she may conclude that academia is not a place for females (Hill et al., 2010; Lucas, 2008; NAP, 2007; Nelson, 2007).

However, in the absence of female faculty or in collaboration with them, male faculty can become more active in encouraging and mentoring young females to enter academia. They can also assist by ensuring that their departments are perceived by female students as appealing (Ainley, 1990; NAP, 2007; Nelson, 2007).

Many female faculty admit that encouragement from a mentor was significant in their persistence and success in their chosen profession. It has been indicated that the lack of role models and mentors have had an adverse effect on females STEM education and career advancement (USGOA, 2005).

Additionally, subtle and overt influences of parents, teachers, and peers who steer girls away from informal technical activities, which are often thought of as male domains, can lead females to reject mathematics and science classes in school. In several studies, women acknowledged that they did not get the right guidance in career choice, and some guidance counselors directed them to 'female-oriented' courses (Blickenstaff, 2005).

Generally, student retention has been found to be significantly influenced by proper social and intellectual experiences that integrate students into institutional life. Isolation and incongruence are two factors that inhibit student integration. Isolation is a lack of sufficient interaction with others, particularly faculty, and incongruence occurs when students perceive themselves more substantially different from others in the institution (Tinto, 1993). Women's retention and graduation in STEM graduate programs have also been reported to be affected by their interaction with faculty, either positive or negative. When female graduate students feel isolated in their departments, they are more likely to leave than to persist (Ainley, 1990; Bandura, 1989; Byrne, 1993; USGOA, 2005).

However, the mere presence of female faculty within departments is not sufficient to bring about increases in enrollment and retention of female students. For modeling experiences to be effective in increasing efficacy expectations, these expectations should

be predefined and unambiguous, with clear-cut and measurable outcomes. This will ensure that when success is attained, it was intentional and did not occur by chance. When a task is observed to have been successfully completed, there is a better likelihood that vicarious learning has occurred due to the success of the attempt. According to Ainley (1990) and Bandura (1977), success is a better predictor of vicarious learning than failure.

A third source of information that influences self-efficacy expectations is emotional or physiological arousal (Hackett & Betz, 1981). Emotional arousal refers to the level of anxiety and vulnerability to stress. Some researchers are of the opinion that females score higher on anxiety measures than males and as a result are more susceptible to physiological responses that could lead to a decrease in their perceptions of self-efficacy (Guidmond, 2004; Hackett & Betz, 1981). Others like Bandura (1979) consider anxiety a co-effect rather than a cause of low self-efficacy expectation. To him, anxiety is induced when a person lacks expectation of self-efficacy towards a situation or behavior. Anxiety can then further decrease self-efficacy and success expectation of the task or behavior.

The fourth source of efficacy expectation, according to Bandura (1977), is verbal persuasion. This occurs when a person is affirmed, encouraged, and verbally urged to take on a task. A person is led through several suggestions that they can indeed cope successfully with something they had been unable to deal with in the past (Bandura, 1977). This is not as effective as personal experiences in engendering stronger efficacy expectations, since the learner has not actually tried the task or experienced the situation. Therefore, the slightest obstacle can deter the learner from trying the task out. In this

regard in addition, males have been found to receive more verbal encouragement on career pursuits than females. In many ways, males receive affirmation and obtain more suggestions that their choice of career is appropriate. For instance, when a male student typically tells people they are engineering majors, they are asked knowledge-based questions pertaining to what they are learning and what they want to do with it. On the other hand, a female student in a similar conversation will have the first response being surprise that a woman could study engineering, and the subsequent questions are more likely going to be how they are coping than knowledge based (Guidmond, 2004; Hackett & Betz, 1981).

A person needs to possess self-knowledge, knowing ones interests, skills, strengths, and weaknesses, in order to select careers that closely match such interests (Guidmond, 2004). Hackett and Betz (1981) developed a model to show the effects of traditional female socialization on career expectations. This model is made up of the four sources of efficacy information as described above, as well as the socialization experiences among females, and their effects on career related expectations. They concluded that traditional female socialization had the following result:

1. Higher self-efficacy with regard to domestic activities, and lower self-efficacy in most other domains, as a result of personal performance accomplishments
2. Higher self-efficacy with regards to traditional female roles and occupations, lower self-efficacy in non-traditional occupations, as a result of vicarious learning
3. Decrease in both generalized and specific self-efficacy as a result of high levels of anxiety; and finally

4. Lower self-efficacy expectations within several occupations and career options because they are not encouraged verbally to attempt non-traditional occupations (Guidmond, 2004; Hackett & Betz, 1981).

Social Factors

People are imbued with the ability to attend to situational cues that signal any threat to their physical, mental, or emotional well-being. A young child may not understand that fire burns, but once they have been scorched, the smell of smoke can signify a threat to them. In the same way, situational cues such as finding oneself in the minority in any place can signal a psychological threat of not being accepted or not treated as one of the majority. Most people are vulnerable to social identity threats, i.e., situations in which they believe they may be treated negatively or devalued in a way because of a particular social identity they possess. Research shows that when people find themselves in such situations they tend to identify more with the trait or identity that particularly make them stand out (Murphy, Steele, & Gross, 2007).

In an experiment conducted by Murphy et al. (2007), when women who had strong STEM affiliation were exposed to situational cues in a STEM environment in which women were a minority, they were less likely than their peers who were exposed to a more equitable scenario, to identify with and less eager to participate in that environment. In reality, the most balanced STEM environments have an average ratio of three males to one female. Textbooks, posters, and other media disproportionately depict personnel in STEM as white males. STEM educational departments and industry are dominated by men, so even when women succeed in entering, they are so uncomfortable

and constantly on guard that many do not last (Cronin & Roger, 1999; Murphy et al., 2007).

Still other people have suggested that women find it challenging to balance work pressures with other life roles, such as their desire to have and raise children. They assert that women are more interested in family than in careers. However, this assertion does not show the complete picture. In fact, society insists on predefined roles for people of different genders and disproportionately places responsibility that is more domestic on females. Many cultures place a large portion of the responsibility of reproduction and child rearing on females. While biologically females have the special privilege of carrying and nurturing young ones, their upbringing should not be their sole responsibility. Yet, this is what happens in many cases, causing many women to struggle in balancing their roles as mothers with working outside the home. If domestic roles were more equitably distributed, both genders would be able to better balance their roles in and out of the home for a more harmonious society (Bloch, 1978; Murphy et al., 2007; Nettles & Millett, 2006; Witt, 1997).

Furthermore, in the case of academia, the timeline for attaining tenure appears to coincide with female faculty members' timeline for having a family. There is a limited amount of time for the tenure process, which in many institutions involves the faculty member proving their mettle by producing important research, being published, as well as teaching. These years fall within the initial years of appointment, which for many women coincide with the years they are most likely to give birth and raise children. This provides a real conflict for many women in academic institutions, many of which do not offer support to women in fulfilling this equally important life role. One report revealed that

"women in graduate school cite the challenge of balancing career and family as one reason for a dwindling interest in pursuing careers in academia" (Lucas, 2008, p. 8). Lucas also found that some women, unable to cope with this challenge, chose to delay childbearing or chose not to have children at all, while others chose families over profession. Few men are ever faced with such a choice in life.

Consequently, some hiring committees make the decision to hire more male faculty on the basis that women are not a good investment because they take more time off to have children and care for their children. However, what they lose sight of is the fact that while this may be true during early career years, men are more likely to take sick leave than women are in middle age (Lucas, 2008; MIT, 2011; NAP, 2007). Again, if society recognizes the fact that the upbringing of the next generation should be a social responsibility and not a female responsibility, then women would not be penalized for taking time off to bear and rear the next generation of leaders. Rather, institutions will put in place more child care measures that will give both men and women the freedom and peace of mind to pursue careers. Providing child care will allowing both genders to continue to contribute to social growth even as they collaborate in raising and nurturing of the next generation of leaders for a better future (Bloch, 1978; Lucas, 2008; MIT, 2011; Witt, 1997).

In other instances, differential treatment of males and females in the work place can deter young females from wanting to enter these fields and discourage those who are in them from staying. In several institutions, females with comparable qualifications to males are paid less than their male counterparts. Access to resources such as laboratory space and interaction with outside agencies are generally biased in favor of male faculty.

Some of these actions are not overt in a way that can be numerically verified, but this does not disprove their existence either (Hill et al., 2010; Lucas, 2008; MIT, 2011).

Furthermore, compared to some professions such as law and business, employees within some STEM fields receive relatively low pay. Meanwhile, it takes longer to obtain a degree in many STEM fields, thus causing students to incur more tuition and general academic costs. Consequently, when some consider the apparent low return on such an investment, they switch majors or choose to work in other fields even after they graduate in a STEM field. Incidentally, data indicate that more males than females switch from their STEM majors for economic reasons. Again, most STEM courses and careers demand a higher level of academic and time commitment, hence people who are not prepared for such commitment, or are unable to cope, switch to others that are less demanding (NAP, 2007; Seymour, & Hewitt, 1997).

Academic/Institutional Factors

Several factors found within educational institutions and personnel also influence a student's choice of a course of study and consequent careers. Factors ranging from teacher attitudes, messages contained in texts, and peer influence within school settings all contribute to females' ability to persist or leave STEM majors and/or careers. Other factors in this realm include discrimination and differential treatment of faculty and institutional environments that are unappealing and inhospitable.

K-12 and above. Prominent among the academic factors that tend to turn girls away from STEM subjects at the postsecondary level are the quality of K-12 teachers and the level of science and mathematics classes taken by a student in secondary school (USGOA, 2005). Many students enrolled in STEM majors in college attributed their interest to K-12

teachers who made mathematics and science in high school interesting and exciting for them. As much as 22% of students in middle school English, mathematics, and science classes had teachers who were neither trained nor certified in these areas, also known as out-of-field teachers. Furthermore, about 30% to 40% of the middle-grade students in biology/life science, physical science, or English as a second language/bilingual education, and 17% of students enrolled in physics and 36% geology/earth/space science at the high school level were in classes instructed by out-of-field teachers. There is evidence to support the assertion that teachers who lack the necessary skills and knowledge to teach in a subject area can adversely affect what students learn in those areas and their desire to pursue further studies in those areas (USGOA, 2005).

Again, it has been established through research that students who take advanced placement (AP) mathematics, physics, etc., tend to do better in and are more likely to persist in STEM majors in college. In freshman college STEM classes, students who had opted out of calculus and other AP science and mathematics in high school found themselves lagging behind their classmates who had done so and were more likely to switch majors. Among the reasons given by several students who had switched from STEM majors in college was inadequate preparation in high school. In a study targeting such switchers, approximately 40% reported some problems related to high school science preparation. Most felt they were not well prepared because they did not understand calculus, lacked sufficient laboratory experience or exposure to computers, and had no introduction to theoretical material or analytic modes of thought (NAP, 2007; Khale, 1983; USGOA, 2005). *The National Action Plan for Addressing the Critical Needs of the U.S.A. STEM Education System* (NSF, 2007) reports that 30% of students in

their first year of college are forced to take remedial science and mathematics classes because they are not prepared to take college-level courses. In addition, international indicators such as the *Program for International Student Assessment* (PISA) continues to show students in the U.S.A. are behind their counterparts in other industrialized nations in STEM critical thinking skills (NSF, 2007).

On a national average, girls have been as likely as boys to complete Advance Placement (AP) and International Baccalaureate (IB) mathematics courses since 1994, and more likely to take AP or IB Biology and Chemistry, but not AP Physics. However, even though the numbers of girls who take AP and IB courses in science and mathematics are increasing, the percentage that go on to elect college STEM majors are still below their male counterparts (NAP, 2007).

Meanwhile, research indicates that there is a direct correlation between the number of hours of science and mathematics classes a student takes in high school and the probability they will study a related course in college. Because fewer female students than males elect to take advanced classes in physics and mathematics in high school, a corresponding number of fewer female students select STEM majors in college. This also accounts in part for the achievement differences between genders in those subject areas (Guidmond, 2004). For instance, Parker and Offer (1987) discovered from the results of a study conducted in Western Australia that when both male and female students were required to take an entire sequence of classes in mathematics and science, there were no differences in achievement levels between genders (as cited in Guidmond, 2004).

Moreover, some guidance counselors, teachers, and parents actively discourage girls from taking STEM classes. In a speech delivered at the American Chemical

Society's Presidential Symposium on Diversity, Colwell (2008) stated, "When I went to high school, girls simply were not allowed to take physics. More to the point, my high school chemistry teacher told me I would never make it in chemistry because women could not" (p. 1).

In other instances, differential treatment of students in the classroom tends to keep girls away from science classrooms. Boys and girls receive different levels of feedback, encouragement, and criticism in class. Boys receive more criticism in school about their work, both orally and in comments written on tests and assignments. Other studies found this not to be so, but some females who expect to be treated differently are unable to deal with higher education departments in which they were treated like one of the 'boys' (Strenta, 1994). In those instances, when boys do indeed receive more feedback, both negative and positive, they gain the impression that more is expected of them and also makes them more tolerant of future criticisms, thus helping them gain the confidence to experiment and make mistakes – a practice that is invaluable in science (BEST, 2005; Eccles, 1986). The lack of feedback and encouragement limits the number of females who feel confident to select STEM electives, and consequently the number of females who persist and progress to college and beyond.

Unappealing Departmental Environments: Colleges and university departments, like all other organizations, possess their own cultures that can guide individual and collective behaviors and shape the way they conduct everyday business. The organizational culture may also be referred to as the emotional "feel" of an institution, which is to some extent determined by other variables such as the size and type of institution (Bess & Dee, 2008; Trower & Chait, 2002). From the start of graduate school to early faculty probational

periods, new faculty members are exposed to and encouraged to adopt the social norms of the department by senior faculty. These norms include "collegiality, allegiance to disciplines, respect for faculty autonomy, and the sanctity of academic freedom" (MIT, 2011; Trower & Chait, 2002, p. 36). However, other less desirable social norms are also transmitted that undercut efforts at diversity. They include:

> Hierarchies of disciplines, gender- or race-based stereotypes, single-minded devotion to professional pursuits, and the relative value assigned to various elements of faculty work (for example, teaching versus research), to various forms of research (pure versus applied, quantitative versus qualitative), and to various outlets for research (refereed versus non-refereed, print versus electronic). (Trower & Chait, 2002, p. 36)

Some of these norms have been formed over several years by white male faculty and are transmitted through generations of faculty. Because faculty turnover is slow, many professors remain in one institution for several decades, ensuring that institutional norms are maintained over long periods. Many of the women and minorities who leave academic professions do so because the environment seems hostile and unfriendly to them (BEST, 2005; Colwell, 2002; Hill et al., 2010; Lukas, 2008; MIT, 2011; Nelson, 2007; Trower, & Chait, 2002). For example, Zubritsky (2000) wrote this about potential female chemistry faculty: "Women who are eligible for faculty positions have earned a Ph.D. in a chemistry department. They have absorbed the tone of that environment . . . and have decided they don't want any more of it" (p. 1). Again, in the words of another female scientist at the Institute for Research on Women and Gender, University of Michigan, "Many smart motivated women have cited isolation and marginalization as

reasons for moving out of science and engineering at major research institutions" (Steeh, 2001, p. 1).

Even though researchers have not observed differences in the productivity of male and female faculties in STEM fields, there have been significant differences observed between male and female students' productivity at the graduate and post-doctoral levels. This is particularly evident in outputs such as publication and professional participation, which is often a reflection of the quality of faculty-student interaction at these levels. Since there is a higher number of male faculty to act as mentors to male students, they tend to disproportionately get access to support and collaborations that lead to high productivity. In effect, males have the distinct advantage over females before they even apply for faculty positions. Among the factors given in the literature, as being influential to the success and persistence of females in STEM fields, was the presence of role models and mentors who actively encouraged them to pursue these subjects by building their self-efficacy beliefs in those areas. It was also found that females who find themselves in STEM fields or in institutions where a critical mass of females has already been attained in their selected STEM majors are more likely to persist in those areas (BEST, 2005; NAP, 2007).

Gender Discrimination: Females face real discrimination within male dominated educational institutions and departments such as STEM fields. In order to avoid social identity threats, many decide not to study STEM subjects or leave after they start. "Social identity threat is a broad threat that people experience when they believe that they may be treated negatively or devalued in a setting simply because of a particular social identity they hold" (Murphy, Steele, & Gross, 2007, p. 879). Many people see STEM fields as

being masculine, and so, in order for girls to feel that they are desirable and feminine they chose to study subjects outside of these areas (BEST, 2005).

Discrimination against females in STEM careers and departments is insidious and it is sometimes apparent, but at other times overt (Hill et al., 2010). Both men and women become so engrossed in assigned social and gender roles that they tend to look down on anyone who chooses to deviate from the norm. For example, there are certain negative stereotypes associated with men who teach kindergarten. In the same way, people have long since associated men with engineering, mathematics, computers, technology, and other physical sciences, so that when a woman enters such a field she is considered unusual (Bloch, 1978; MIT, 2011; NAP, 2007).

Some of these attitudes have been undergoing positive changes; one barely hears of anyone condemning a woman for studying a particular subject. However, comments such as ‘a woman engineer? Wow you must be very smart’ or ‘you must be exceptionally bright’ and so on, tend to give a woman the impression that she is doing something unusual (BEST, 2005; Colwell, 2002). Even though such comments in themselves are not necessarily negative, they can be embarrassing and bring too much pressure to bear on the woman to prove herself, which can be detrimental to their persistence. It can also make them the object of cruel jokes from both male and female classmates and co-workers who may be threatened by their abilities.

The following statement from the 1999 Massachusetts Institute of Technology (MIT) report on the *Status of Women Faculty in Science* gives a succinct synopsis of the problem.

> The key conclusion that one gets from the report is that gender discrimination in the 1990s is subtle but pervasive, and stems largely from unconscious ways of thinking that have been socialized into all of us, men and women alike. This makes the situation better than in previous decades where blatant inequities, sexual assault, and intimidation were endured but not spoken of. We can all be thankful for that. Nevertheless, the consequences of these more subtle forms of discrimination are equally real and equally demoralizing. (MIT, 1999, p. 3)

Despite discrimination however, there is evidence that women perform just as well, and in some cases even better than their male counterparts in STEM professions (Ainley, 1990; Blickenstaff, 2005). Women who play key leadership roles in research and STEM agendas both on the national and international levels evidence this. Some examples of women in scientific and technological leadership include, Cynthia Breazeal – a robot designer, Diane France – bone detective, Inez Fung – climate modeler, Heidi Hammel – outer planet expert, Shirley Ann Jackson – subatomic explorer, and Mimi Koehl – nature mechanic (NAS2009). Since the MIT 1999 report, several steps have been taken by that institution and decisive gains have been made in gender equity in faculty appointments and resource distribution (MIT, 2011).

Implications of the Underrepresentation of Females in STEM Fields

More than 50% of U.S.A. long-term growth over the last 50 years has been a direct result of the advances in technological innovations, which are largely driven by scientist, technologists, and engineers, who constitute just 5% of the total workforce (BEST, 2005). This particular sector of the workforce, though very small, is an

indispensable strategic asset to the nation because the professionals in it have a huge impact on scientific and technological advancements, which in turn drive economic growth and prosperity as well as national security. However, this critical sector of the nation lacks the diversity that is characteristic of the nation as a whole (BEST, 2005). Furthermore, BEST (2005) reports that over 50% of the technical workforce is over 40 years old, with a third of them over 50 years old. About 25% of the workers in this sector will reach retirement age by the year 2010. In addition, almost 75% of the technical workforce is male, and 80% is white. Newer sectors that are emerging within computer programming, specialized engineering, physical sciences, and mathematics are showing the same trend. It appears that there is not a lot of interest in these fields, and yet they are the critical fields for national development. At the same time, reliance on foreign skills in the workforce has been steadily increasing, moving from 11.2% in 1980 to 19.3% in 2000 (BEST, 2005). The levels have since tapered off in some of the key sectors due in part to stricter homeland security measures since September 11, 2001. As a result, more of the American work is being sent offshore where talent and skill are readily available at a reasonable price (BEST, 2005; Friedman, 2005).

Nelson (2007) quotes Nancy Hopkins of the Massachusetts Institute of Technology as saying: "Who can look at these numbers and not say that we as a faculty have failed—failed our students, our institution, and most of all, failed our nation?" (p. 7). Participation of women in STEM is needed to insure national security, economic superiority, and scientific leadership of the country. Current and future population forecasts indicate that women and minorities are becoming the majority in the U.S.A. population and, as such, future leadership of the nation will have many women and

minorities. Consequently, it is important to begin now to reverse the trend of underrepresentation of these groups at research universities, "because this is where the majority of our country's leaders will be educated" (Nelson, 2007, p. 2). This is important for students of both genders to observe, because all students are affected when they are deprived of the mentorship and talents of female faculty. When male students do not see female STEM faculties they get the impression that women do not belong in these environments and it is "acceptable for them to be marginalized, denied tenure, and given unequal resources" (Nelson, 2007, p. 2).

With the current unpredictable global economic situation, if nothing is done soon to address the critical needs of developing sufficient STEM skills required to sustain and improve the U.S.A. economy, there is the risk of eventually seeing a reduction in national innovation capabilities, which could be detrimental to the safety and prosperity of the nation. There will also be an increase in the migration of high-wage science and engineering jobs overseas, which is already happening on a large scale, but needs to be balanced with development of high-skilled personnel in country. Moreover, it is possible to derail the present economic gains if inflows of international talent are reduced significantly. Now, many international students are choosing to return to their home countries to work after they graduate from U.S.A. institutions, particularly when they can obtain employment with multinational corporations (BEST, 2005; Freidman, 2005). Finally, there is the possibility that public support for U.S.A. research and development will suffer great losses if founding institutions realize that they are not getting a good return on their investments (BEST, 2005; Freidman, 2005).

Efforts in Addressing the Underrepresentation of Females in STEM Fields

The factors discovered through this study will augment several efforts and initiatives that have been put in place to address the issues of low female participation in STEM. Several initiatives by governmental and non-governmental agencies point to the urgency of increased and equitable participation of Americans in STEM fields. Among the initiatives and actions being taken, or recommended, to ensure that America stays on top of global competition through the education of her youth within the critical areas of STEM include:

1. The federal government as an aggressive, long-term approach to keep America's leadership in science and technology strong and secure established *The American Competiveness Initiative (ACI) (2006)*. ACI provides funding in support of new and old innovative programs and actions that are geared toward increased scientific and technological advancement for economic growth and national competitiveness (ACI, 2006).

2. *A National Action Plan for Addressing the Critical Needs of The U.S.A. STEM Education System* (NSB, 2007) is a paper developed by the National Science Foundation in response to trends observed in the 2006 Science and Engineering Indicators. There are two critical issues that were addressed in this action plan: 1) The lack of coherence and coordination in the pre-kindergarten to college (P-20) STEM education, both within and between States, and 2) The shortage of highly qualified and adequately resourced STEM teachers. Several recommendations were made to ensure vertical and horizontal alignment of national, state, and local STEM programs, as well as to attract and maintain qualified STEM educators in the P-20 education system (NSB, 2007).

3. *Rising above the Gathering Storm, America's Pressing Challenge – Building A Stronger Foundation* (CPGE, 2005). This is a report issued by three eminent scientific groups in the U.S.A: The National Academy of Science, National Academy of Engineering, and the Institute of Medicine. These institutions formed a committee charged to answer the following questions:

> What are the top 10 actions, in priority order, that federal policymakers could take to enhance the science and technology enterprise so that the United States can successfully compete, prosper, and be secure in the global community of the 21st century? What strategy, with several concrete steps, could be used to implement each of those actions? (CPGE, 2005, p. 2)

The question was posed by members of the Senate Committee on Energy and Natural Resources and supported by members from the House Committee on Science. The paper provided critical recommendations to keep the U.S.A. strong in STEM innovation in the global economy. Among the most urgent recommendations was improving K-12 teacher recruitment, training, and decreasing turnover (CPGE, 2005).

This report was revisited in 2010 in an effort to provide an update of the global contexts and events in the five years since the original publication. According to the writers:

> Despite the many positive responses to the initial report, including congressional hearings and legislative proposals, America's competitive position in the world now faces even greater challenges, exacerbated by the economic turmoil of the last few years and by the rapid and persistent

> worldwide advance of education, knowledge, innovation, investment, and industrial infrastructure. Indeed the governments of many other countries in Europe and Asia have themselves acknowledged and aggressively pursued many of the key recommendations of Rising Above the Gathering Storm, often more vigorously than has the U.S.A. We also sense that in the face of so many other daunting near-term challenges, U.S.A. government and industry are letting the crucial strategic issues of U.S.A. competitiveness slip below the surface. (NAS2010, p. x)

4. *Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering* (NAP, 2007), a report that represents the consensus views and judgments of members of the Committee on Maximizing the Potential of Women in Academic Science and Engineering, was published by the National Academies. The committee was created to develop recommendations on how to maximize the large source of the nation's talent, i.e., women in academic science and engineering. Some of their findings included:

a) Women have the ability and drive to succeed in science and engineering

b) Women who are interested in science and engineering careers are lost at every educational transition

c) The problem is not simply the pipeline – the process from primary or secondary education to tertiary education and careers within STEM – since in several fields the pipeline has reached gender parity

d) Women are very likely to face discrimination in every field of science and engineering

e) A substantial body of evidence establishes that most people—men and women—hold implicit biases

f) Evaluation criteria contain arbitrary and subjective components that disadvantage women, academic organizational structures and rules contribute significantly to the underuse of women in academic science and engineering, and

g) The consequences of *not* acting will be detrimental to the nation's competitiveness. (NAP, 2007, pp. 2-4)

Other national initiatives that are directed toward increasing access to STEM include:

1. *NASA Means Business* competition in which college students compete in the design and development of promotional plans to encourage middle and high school students to study STEM subjects. It also aims to encourage professors to include their students in outreach initiatives that support and promote STEM education (Peter & Horn, 2005).

2. *Project Lead the Way* (PLTW) is a national non-profit educational program that promotes science and engineering for middle and high school students. This initiative employs a project-based learning philosophy, which uses hands-on, real-life projects that enable students to discover the relationships between the skills they are learning in the classroom and real world problems. PLTW also affords critical partnerships between

higher education institutions, public schools, and the private sector that foster coherence in learning at all levels and in the workplace.

3. *Engineering by Design* (EbD) is a standards-based model for teaching technological literacy for students K-12. It is built on the *Standards for Technological Literacy* (ITEEA, 2000), *Principles and Standards for School Mathematics* (NCTM, 2000), and *Project 2061, Benchmarks for Science Literacy* (AAAS, 1993). EbD is built on the constructivist pedagogy by using authentic, problem-based lessons to increase all students' achievement in STEM. It also has a distinctive STEM integration approach to teaching key concepts (ITEEA, 2010).

4. And on a smaller but more specialized scale is The National Consortium for Specialized Secondary Schools of Mathematics, Science and Technology (NCSSSMSST) (http://www.ncsssmst.org/), a group that supports specialized schools that are specifically set up to prepare students for leadership in STEM fields (Peter & Horn, 2005).

In addition to these, several states, educational institutions, and school districts have initiated programs that are also intended to increase access and retention of students in STEM fields. Notable among these are STEM Curriculum for K-12 Students - Halifax County, Virginia; Middle and Elementary School Mathematics and Science Programs – Prince William County, Virginia; STEM Elementary Schools - The Utica Community Schools, Michigan; and Elementary School Technology Program – Tempe, Arizona; to name a few. These and other initiatives employ innovative and aggressive practices to actively raise the awareness of STEM subjects among students and parents, to challenge and encourage more students, particularly girls and minorities, to enroll in STEM classes (Peter & Horn, 2005). These reports and initiatives are only a sample of the varied

attempts made by the federal government and private and public institutions to address the differences in participation of the genders within the STEM fields, which invariably has contributed to low participation in these sectors compared to others in the workforce.

Further Recommendations to Increase Female Participation in STEM

The nation has no choice but to increase female participation in STEM fields if the U.S.A. is to maintain its leadership in STEM innovation and global developments. Equal representation of females in STEM majors and careers will invariably result in further increases in male participation as well. There is the need to increase the number of female students who chose STEM electives in K-12, by improving the quality of teachers at that level and through other innovative ideas that will assist teachers to encourage females to select and remain in STEM majors.

Quality Teacher Preparation: A critical recommendation is to improve teacher quality in K-12 by boosting teacher effectiveness through pre-service and in-service teacher training targeting STEM pedagogy. Incentives should be created to attract and retain highly qualified teachers in the K-12 system. To this end, school districts and states should collaborate with industry and research institutions to ascertain the skill sets and knowledge that high school graduates need to succeed in STEM courses and professions. Additionally, funds should be made available to ensure that these skills are included in instruction so that students may acquire them. Some of these would require curriculum policy changes that may take time to be effected (BEST, 2005; NAP, 2007).

The National Science Board (NSF, 2006) recommends the award of merit-based scholarships aimed at recruiting 10,000 science and mathematics teachers every year. The board also calls for strengthening of 250,000 teachers to teach STEM subjects as well as

IB and AP science and mathematics classes in K-12. There should also be more activities instituted that can increase the interest of young girls in STEM fields right from kindergarten. Gender stereotypes are acquired at an early age and as a result, programs that would encourage early access are needed to raise the awareness of young girls and minorities so that they can participate in STEM courses and careers. The NSF (2006) report recommends mandatory courses in mathematics and science for students, K-12. It is believed that this can lead to increased student interest and preparation for STEM areas in college and beyond.

In the BEST report, four core set of principles defined programs that worked best at K-12 levels. They were programs that had outstanding goals with predetermined outcomes, were persistent even in the face of failure, were designed to suit the particular target of students being served, and contained challenging content, such as Engineering by Design (ITEEA, 2009). The National Science Board called for an increase in the number of students who enter the STEM pipeline through incentives that would increase the corresponding number of students who take and pass AP and IB mathematics and science in high school. Inquiry-based learning is recommended as one such way to arouse and maintain students' interest in STEM fields (BEST, 2005; NAP, 2007).

Improve Participation and Persistence. Multi-faceted innovative approaches are required to keep females in STEM majors once they enroll in them, and in STEM professions once they are hired. Institutional leadership must be apparent to the regular members of the institution through targeting and recruiting the best and brightest students and faculty from underrepresented groups such as women. All faculty members should be made aware of and encouraged to promote such a vision for diversity, by ensuring that

their classrooms and labs are welcoming and attractive to minorities and females. Faculty members should make the effort to mentor and provide individual time to all students, but to minorities in particular since they may be struggling but cannot speak out for fear of becoming even more conspicuous. Students should be guided and encouraged to provide support to each other through group projects and studies. Such group activities can break down boundaries and forge real collegiality among classmates. Furthermore, student learning should be made more real and authentic by expanding projects outside the classroom to include real world experiences through internships and work programs (BEST, 2005; NSF, 2007).

The federal and state governments can enhance their roles in STEM education by "providing more effective leadership through developing and implementing a national agenda for STEM education and increasing federal funding for academic research by providing funds to support students trained at the doctoral level in the sciences, technology, engineering, and mathematics" (BEST, 2005, p. 10). The time to act is now. All institutions and concerned individuals need to contribute to the creation of an environment that is conducive to attract and retain females to STEM majors and professions (NAP, 2007).

Participation of international students and visiting scientists must also be a priority. *Rising Above the Gathering Storm* (CPGE, 2005) recommends improvements in international student and scholar visa processing to make the process less complex. Currently, it takes international students at least one year from the time they apply to an institution until the time they obtain documents, tests, and a visa to come to the United States of America to study. However, it takes only about three months for the same

process in United Kingdom (U.K.) and other European Union (E.U.) countries. The National Science Board also recommends an automatic Visa extension for international doctoral graduates in the STEM fields and other high need fields, so they can look for employment in the U.S.A. At the moment, an international student has up to 60 days after graduation to leave the U.S.A., if they have not been employed or have not applied for the one year Optional Practical Training (OPT). Furthermore, the National Science Board recommends a skills-based preferential immigration in which a doctoral degree in a STEM discipline substantially increases an H-1B visa applicant's success of obtaining the visa (CPGE, 2005).

The Committee on Women in Science and Engineering, Office of Scientific and Engineering Personnel of the National Research Council (1991), produced the report *Women in Science and Engineering: Increasing Their Numbers in the 1990s: A Statement on Policy and Strategy.* In it, they called for the development of reliable outcome measures to assess the specific contribution of programs that enhance the flow of women into science and engineering careers. Women should be involved in all of these measures to ensure that their inputs are not left out (NRC, 1991).

Furthermore, among efforts in the workplace to increase female participation, BEST (2005) suggests that employers must make inclusiveness a norm rather than the exception. The initiation of diversity programs and initiatives has been in progress in many companies and government agencies since the early 1990s, and it is gradually being replicated in academic institutions. BEST (2005) discovered that organizations with "exemplary recruiting practices create a competitive advantage by investing in long-term relationships with institutions that serve minorities, women, and persons with disability"

(p. 7). They go further to ensure retention by creating open and inclusive work environments by instituting "transparent policies and procedures" (p. 7); maintaining equity in compensation and promotions; career development and support; and work-life programs that provide support for family needs.

Such institutions also provide level playing fields for underrepresented groups by providing mentoring opportunities, training and development programs, actively identifying employees with potential, and developing such potential for growth within the organization. They go even further to forge partnerships and initiate outreach events aimed at influencing other organization and their community for capacity building in the educational supply chain (BEST, 2005).

Summary

Chapter II presented a literature review backing the underrepresentation of females in STEM, the reasons for this state of affairs, impacts and significance for this phenomenon, and efforts being made to address it. The underrepresentation of females in STEM classrooms and fields is a pervasive phenomenon in many countries, particularly in the Western Hemisphere (Cronin & Roger, 1999). The factors that have brought about this trend are diverse and complexly interrelated. Several personal, social, academic/institutional factors are known to contribute to a person's ability to either persist or leave a STEM field. However, the extent to which any one factor can singularly affect such a choice is still not known.

Meanwhile, the underrepresentation of females in STEM fields continues to deprive nations of critical talent in those fields that are critical for technological and scientific innovation and growth. Consequently, several efforts have been made to change

the trend, and it appears to be yielding some results as evidenced in the increase in the number of females graduating with bachelor degrees in various STEM fields. However, compared to the overall female educational attainment and as a ratio of the percentage of males getting higher education degrees and professional positions in STEM fields, females are still disproportionately underrepresented and more needs to be done to facilitate the move to bridge the gap between the male and females in STEM fields.

Chapter III discusses the method and instruments used to discover the factors that have helped some women to persist and succeed in their STEM academic careers. The Delphi technique, a method of consensus building, was selected as an appropriate methodology for female faculty in selected STEM departments to share their opinions about factors they believed to be influential to their success and persistence. Also discussed in Chapter III is a description of the study population and sample, the method of selecting the sample, and the statistical tools selected for analyzing the data collected.

CHAPTER III

METHODS AND PROCEDURES

Chapter III outlines the methods and procedure used for gathering and analyzing data. It also provides a description of the research technique employed, the data collection methods, instruments used, an explanation of the data analysis methods, as well as a summary of the above.

The purpose of this study was to determine factors that female faculty in post-secondary science, technology, engineering, and mathematics (STEM) fields perceive as being influential in their ability to successfully persist in their chosen professions. A search of existing literature revealed several research methods, which could be used in this study to gather from the participants' factors they perceive as being influential to their successful persistence in STEM higher education. The Delphi technique was selected as the most suitable data gathering method for obtaining consensus among a group of experts on issues that are considered subjective in nature. It has been defined as "a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem" (Linstone & Murray, 2002, p. 3).

Research Technique

The Delphi technique had several advantages for this study. Rowe and Wright (1999) outlined four key features of a classical Delphi technique, which make it suitable for this study. First, group anonymity among Delphi participants allows the participants to express their opinions freely without undue social pressures to conform to others in the group. Decisions are evaluated on their merit, rather than on who proposed the idea.

Secondly, iteration of questionnaire over a number of rounds allows the participants to alter or refine their views in light of the progress of the group's work from round to round. Thirdly, controlled feedback is used to inform the participants of the other participant's perspectives and provide the opportunity for Delphi participants to clarify or change their views. Finally, statistical aggregation of group response allows for a quantitative analysis and interpretation of data. Another objective of the Delphi technique that makes it suitable for this study is the fact that it allows access to the positive attributes of the interacting group while using group anonymity to remove negative aspects that may arise because of social, political, or personal conflicts. The method also allows for input from a larger number of participants than could be possible in a group setting or a committee of experts, especially when they are dispersed over a wide geographic area (Rowe & Wright, 1999).

Helmer and Dalkey of the Rand Corporation developed the Delphi technique in the 1950's. It was intended to gather, "expert opinion to the selection, from the point of view of a Soviet strategic planner, of an optimal U.S. industrial target system and to the estimation of the number of A-bombs required reducing the munitions output by a prescribed amount" (Linstone & Turoff, 2002, p. 10). The Delphi technique has since been modified and expanded for use in various sectors as well as in several parts of the world.

According to Skulmoski et al. (2007), the Delphi technique is particularly useful when the goal of the research is to improve the understanding of problems, solutions, or develop forecasts on a given topic. It is used to obtain the most reliable statistical summary of the group response, usually consensus of a group of experts. It employs an

iterative process that uses a series of questionnaires interspersed with feedback to collect and collate expert opinions on a given issue. Questionnaires are used to gather the judgments of experts and these are then analyzed and processed to identify problems, solutions to problems, or to make forecasts about certain phenomena.

There are four distinct phases in a typical Delphi research process. During the first phase, there is an exploration of the subject under discussion, typically by the use of open-ended questions so that each individual contributes information he/she feels is pertinent to the issue. The second phase is used to gather information about how the members in the group view the issue under discussion. Significant disagreements in the second phase is explored in the third phase in order to uncover the underlying reasons for the differences and possibly to evaluate them. The fourth and final phase is used to analyze and evaluate the information obtained for forecasting or other considerations (Linstone & Turoff, 2002). A three-phase modified Delphi technique was used in this study. The modification begins with participants being provided categories of factors for which they were required to contribute. A typical Delphi technique would have had participants come up with a list with little or no prompting. Additionally, the online data collection application, Survey Monkey, was used in Rounds 2 and 3. This prevented the individual responses of participants in Round 2 to be sent back to them in Round 3, so they could compare their responses with the groups'. Finally, only three rounds were used in this study instead of the traditional four-round. This is because no forecasting was intended for this study.

However, like every other type of research method, there are some drawbacks to using the Delphi technique. Some of the disadvantages of the Delphi technique include:

1. Information comes from a selected group of people and may not be representative of the larger population
2. The tendency to eliminate extreme positions and force a middle-of-the-road consensus
3. It is more time-consuming than some other group process methods
4. It requires skill in written communication, and
5. It requires adequate time and participant commitment (Brill et al., 2006; Fink & Kosecoff, 1985; Linstone & Murray, 2002; Rowe & Wright, 1999; Skulmoski et al., 2007; Yang, 2003).

Study Population

The integrity of the Delphi technique as a research technique is based on the use of a panel of experts. According to Skulmoski et al., (2007) there are four requirements for classifying "expertise". First, the participants should possess knowledge and experience on the issues under investigation. In this instance, nobody could be more knowledgeable about factors that help female faculty succeed in their chosen STEM careers than female faculty members within those fields. They have not only experienced this situation for themselves, but they have also observed their female students and colleagues in diverse situations. Second, participants must possess the capacity and willingness to participate. Third, there should be sufficient time to participate in the Delphi. Finally, participants must possess good communication skills. It is fair to assume that individuals who have attained positions at such a high collegiate level are completely qualified, possessed the necessary communication skills to articulate their reasoning effectively, and expressed opinions.

The target population for this study was female faculty members in STEM departments in universities in the United States labeled as DocSTEM by the Carnegie classification of institutions. Since expert opinion was being sought, a purposive but convenient sample was used, with participants selected not to represent the general population, but rather for their expert ability to answer the research questions (Fink, & Kosecoff, 1985). The female faculty included in this study had attained the rank of associate professor or higher, indicating their expertise and ability in answering questions about persistence within their professional lives.

According to Lucas (2007), the proportion of female faculty in STEM departments decreases as one moves up the 'ladder' of institutional prestige, e.g., two-year versus four-year, and teaching versus research. In order to obtain a sample from the least represented level, the convenient sample of female STEM faculty were selected from 4-year institutions labeled as DocSTEM in the Carnegie classification. These educational institutions offer doctoral degrees with a dominant STEM focus. A majority of the institutions labeled as DocSTEM also offer professional education at the doctoral level or in fields such as law and medicine.

However, within this category, only public institutions were selected to ensure they had similar experiences in their academic career to share. Since many private institutions have strong religious or philosophical inclinations, faculty members in such institutions may have experiences that are significantly different from their colleagues in public institutions.

Furthermore, among these public institutions only those with faculty Emails posted on their institutional/departmental websites were included in this study. The

departments selected from each institution were determined by whether female faculty and their Emails were listed on its website. The researcher went through the list of DocSTEM institutions and chose the ones that satisfied the criteria set above. From these institutions, all female faculty, at least those whose names clearly indicated their gender, were selected to participate in the study. According to literature, a typical Delphi technique has 15 to 35 experts on the panel, but considerably larger or smaller numbers of expert panelists have been used in several studies and were acceptable. What is common is that the Delphi technique is readily adapted to suit the circumstance and research question (Skulmoski et al., 2007).

Data Collection Methods and Instruments

As is typical in all Delphi studies, this study was conducted in phases or rounds. Figure 1 is a flow chart of the Delphi rounds and the processes entailed in each round. After obtaining Email addresses of potential participants from public DocSTEM institutional departmental websites, the participants were contacted by Email and invited to participate in the study. This initial Email contained a brief synopsis of the study and the criteria used to select participants. See Appendix A for a copy of this Email. Recipients were encouraged to reply if they were interested in participating in the study. Those who responded constituted the population for the Delphi panel for this study.

Once the panel was identified, a second Email was sent thanking participants for their willingness to participate. This Email contained directions about the Round 1 questionnaire, with the questionnaire itself included as an attachment. The attached questionnaire had two parts; first, open-ended items asking participants to list factors they

perceived as being influential to their success and persistence as faculty members in STEM fields.

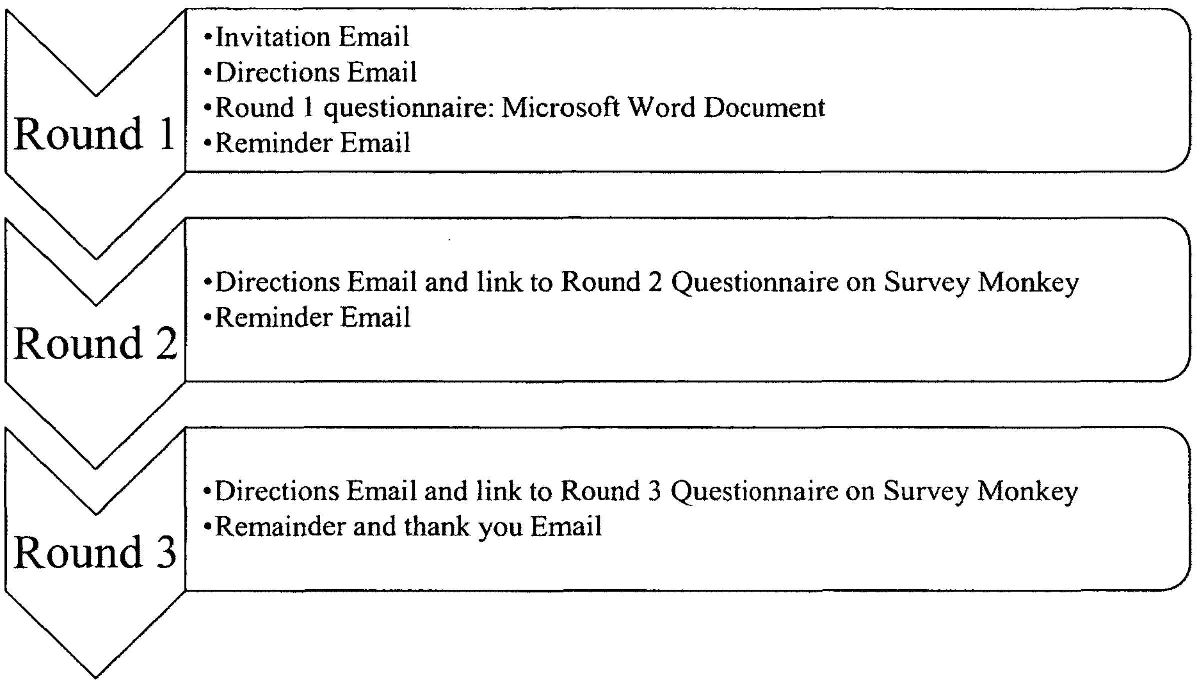

Figure 1. Flow chart of the modified Delphi rounds

Secondly, the Round 1 questionnaire contained items intended to gather demographic and professional information from participants. The open-ended questions were grouped under three pre-determined categories obtained from the literature: personal, academic/institutional, social, with an 'other' option to solicit possible new categories from participants. See Appendixes B and C for copies of the Round 1 directions Email and the initial questionnaire. The initial questionnaire was pilot tested using a convenient sample of six female faculty members in STEM selected from chemistry, biology, technology education, mathematics, and engineering. There were no major modifications to the questionnaire after the pilot test.

A large sample was purposely selected for the initial round to ensure a reasonably fair representation across the STEM fields as well as a geographic distribution of universities. However, the actual sample that was used in the study was made up of those who responded to the invitational Email indicating their willingness to participate. In Round 1 of the study, participants were given a response period of two weeks. This was intended to give panel members enough time to answer, but short enough that those tempted to do so would not procrastinate.

Subsequently, a third Email was sent at the end of the first week of this study to thank participants and to remind those who had not yet responded to do so (See Appendix D for a copy of this Email). The Round 1 questionnaire was again attached to this Email for the convenience of those who had not downloaded it from the previous Email. This Email also reminded participants that a subsequent questionnaire would be Emailed to them for their consensus feedback on the factors emerging from Round 1. At the end of two weeks, all the responses obtained in Round 1 were analyzed using both qualitative and quantitative statistical methods.

Round 2 of the Delphi study sought to identify levels of agreements among participants about which factors they collectively consider important to their successful persistence. This round used a new questionnaire based upon a four-point Likert scale generated from the factors listed in Round 1. By using the four-point Likert scale with no neutral option, the tendency of some participants choosing the undecided category was eliminated, thus minimizing social desirability bias, i.e., respondents giving answers they perceive to be acceptable to society (Garland, 1991; Matell & Jacoby, 1972). The Round 2 questionnaire asked participants to indicate whether they agreed or disagreed that the

factors obtained from Round 1 were important to their success and persistence in their chosen STEM careers in academia. Respondents were not required to include comments in Round 2; however, they were encouraged to provide feedback.

The Round 2 survey instrument was developed online using Survey Monkey, and a link to this instrument was included in an instructional Email that was sent to those participants who had sent in responses to Round 1 (See Appendix E for a copy of this Email and Appendix G for Round 2 questionnaire). The Email also contained an attachment of the demographic information of the participants. Participants were given ten days to return their responses. Five days after sending the instructional Email for Round 2, an Email reminder was sent to all participants, encouraging those who had not yet responded to do so. This Email contained the link to the study for the convenience of participants (See Appendix F for a copy of the Round 2 reminder Email). At the end of ten days, Round 2 was closed and the results analyzed using quantitative statistical techniques to generate a list of the factors participants deemed important to their successful persistence as STEM faculty members.

In Round 3, a final list of factors was sent to participants to be refined. To this end, an Email was sent to the participants thanking them for their continued participation in the study. The result of the statistically analyzed Round 2 questionnaires was included in this Email as an attachment. The intent was that participants would change or retain their individual responses based on the group response to each item. Since Round 2 was conducted online, individual responses to the items were unknown to the researcher. Therefore, in Round 3 participants were only given the group frequencies and means of the items in Round 2, so they could re-scale their responses appropriately. This Email

also contained a link to Round 3 questionnaire, which again asked participants to indicate whether they agreed or disagreed with the refined list of factors agreed on by the panel in Round 2 (See Appendix H for a copy of this correspondence). After six days, an Email was sent to thank participants for their continued support and to remind those who had not submitted Round 3 responses to do so (See Appendix I for a copy of this Email). At the end of ten days, Round 3 was closed and the responses were statistically analyzed to determine which factors participants agreed were important to their successful persistence.

Statistical Analysis

One of the key objectives of the Delphi technique is to obtain consensual and consistent opinions from a group of experts through agreements and feedback rounds. In order to do so, both qualitative and quantitative methods needed to be used to analyze data obtained for this study. The qualitative analysis was conducted with assistance of a panel of three female STEM faculty from an institution that was not included in this study. Conceptual ordering using the Grounded Theory method was first conducted on the data obtained from the uncategorized open-ended questions in Round 1 to consolidate them into categories that can easily be analyzed (Strauss & Corbin, 1998). Conceptual ordering is "a method of organizing data into discrete categories by assessing the data's properties or underlying meanings and using these meanings to categorize the data into groups" (Given, 2008). This is the first step in developing themes from the portion of the questionnaire under other factors. The themes emerging were then compared with factors uncovered in the literature review for further categorization. Factors that had no links to those found in literature were grouped together and given headings as appropriate.

After ordering the factors given by participants into appropriate categories, all the resulting factors and demographic data were then subjected to quantitative statistical analysis. Descriptive statistics were used to analyze the demographic data to obtain the frequency distributions: modes and means where appropriate were used for the following: age, race/ethnicity, sibling gender, mother's occupation, father's occupation, children, STEM field, length of time taken to obtain tenure, and number of years in profession. In order to show participants a brief synopsis of the people involved in the study, this. demographic distribution was made available to them at the beginning of Round 2. It was anticipated that this will encourage a sense of belonging among participants (Rotundi & Gustafson, 1996).

In relation to the data obtained in Round 2, statistical aggregation of the participants' responses to the Likert scale items was used to measure consensus for the individual items. Measures of both central tendency and variability may be used to establish a consensus in the Delphi, data obtained from a Likert scale item, measures of both central tendency and variability were used (Wilhelm, 2001). The frequency, mode, median, standard deviation, and the coefficient of variation for each of the answers to the Likert scale items were obtained. This information was communicated to the participants in Round 3, so they could see how their responses differed from the groups' responses.

The analysis of Round 3 included the same statistical aggregation measures as used in the analysis of Round 2. All data were included in the final report. In order to attain consistency, the coefficient of variation was used in this study to determine if consensus had been reached on each individual item (Yang, 2003). A coefficient of 0.5 or lower shows a strong agreement among participants, and thus indicating that consensus

has been attained. Thus, consensus was considered to be attained for an item with a coefficient of variation of 0.5 or less.

Furthermore, the items with a mean score of 3 or higher (on a 4-point Likert scale where 4 was Strongly Agree, 3 was Agree, 2 was Disagreed, and 1 was Strongly Disagree) were included in the final list of factors that female faculty in STEM perceive as being influential to their success. These resulting factors were grouped under similar headings and summarized, and copies sent to participants who had indicated a desire to see the outcome of the study.

Summary

The purpose of this study was to determine factors that female faculty in science, technology, engineering, and mathematics (STEM) fields perceive as being influential in their ability to successes and persist in their chosen professions. Chapter III described the study sample, the research methodology employed in the study, as well as the statistical instruments used to gather and analyze the data obtained. A modified Delphi technique was used to gather data through Emails, so that a number of female faculty in STEM from different DocSTEM institutions could participate. Using statistical analysis, frequency, the mode, median, and the coefficient of variation for the factors listed by participants were obtained to provide a final list of factors that they perceived as being influential to their successful persistence. Three Delphi rounds were used in this modified study: in Round 1, participants were asked to provide a list of factors they perceive as being influential to their successful persistence. The factors given by participants were categorized to obtain a comprehensive list. Then in Round 2, the lists obtained from Round 1 were used to generate a Likert scale questionnaire. This round was intended to

establish that participants agreed or disagreed that the factors listed were important to their successful persistence. This list was refined in Round 3 with another Likert scale survey. Participants were encouraged to change their minds or not based on the cumulative group responses, in order to establish a consensus on what factors they as a group considered important to their success and persistence in their chosen STEM academic professions.

In Chapter IV, the findings of the study are presented. These findings include the responses to the open-ended questions in Round 1, and the mode, median, standard deviation, and coefficient of variation of each of the responses from Rounds 2 and 3.

CHAPTER IV

FINDINGS

The purpose of this research was to discover factors that female faculty in STEM university programs considered influential to their success and persistence in their chosen STEM careers. Data from research (Bandura, 1989, 1977; Lent et al., 1987), indicate certain factors that are considered important for success and persistence. Some of them are categorized under personal, social, and academic/institutional factors. A modified Delphi technique was used to collect and refine a list of factors that a selected panel of female faculty in STEM education considered influential to their success and persistence in higher education. Three Delphi rounds were used to collect the opinions of these women who had successfully persisted in their STEM faculty careers and attained the level of Associate Professor or higher.

This chapter presents the findings of the Delphi survey data collection. It describes resulting data from each round of the study. In addition, it describes the process of gathering and refining the data to arrive at an agreeable list of factors that apply to a majority of the participants.

Panel Participants

The acceptance of the Delphi technique as a preferred research method is based largely on the use of a panel of experts in the subject matter being studied. The panel of experts for this study was selected from public tertiary institutions in the U.S.A., which are labeled as DocSTEM by the Carnegie Classification of Institution. Twenty-eight institutions were identified in this category, but only 26 had faculty Emails published on departmental websites and were thus included in the study. Four hundred and forty-seven

(447) female faculty in various STEM departments were identified and invited to participate in this study. Table 1 identifies a list of STEM departments from which participants were selected.

Table 1

STEM Fields Represented in Study

Science	**Areas/Fields**	*N(43)*
	Agriculture	1
	Agronomy	2
	Astrobiology	1
	Bio-Chemistry	1
	Biology	9
	Biological Sciences	1
	Botany	2
	Chemistry	8
	Clinical Hematology	1
	Computer Science	4
	Ecology	3
	Evolution	1
	Forestry	1
	Geochemistry	1
	Geology	2
	Geosciences	1
	Horticulture	3

Table 1 (continued)

Science	**Fields/Areas**	*N(43)*
	Insect Science	1
	Limnology	1
	Marine Biology	1
	Medical Laboratory Science	1
	Micro Biology	1
	Molecular Biology	1
	Physics	1
	Plant Pathology	2
	River Hydro Ecology	1
	Soil Science	1
	Wildlife Biology	1
	Wildlife Conservation	1
	Zoology	3
Technology	**Areas/Fields**	
	Apparel and Textiles Science	1
	Bioinformatics	1
	Environmental Communication	1
	Environmental Studies	1
	Material Science	1
	Outdoor Recreation Management	1
	Textile Design	2

Table 1 (continued)

Engineering	**Areas/Fields**	*N(43)*
	Aerospace Engineering	1
	Agricultural Engineering	1
	Bimolecular Engineering	1
	Biological Engineering	1
	Biomedical Engineering	1
	Chemical Engineering	4
	Electrical Engineering	2
	Environmental Engineering	1
	Mechanical Engineering	2
Mathematics	**Areas/Fields**	
	Applied Mathematics	1
	Mathematics	7

Of the 447 female STEM faculty identified, 73 (17.4%) responded to the invitation Email to indicate their willingness to participate, while five responded to decline. Forty-three (58.9%) of the 73 who gave a positive response completed the Round 1 questionnaire and thus constituted the sample. Furthermore, 38 (88.4%) of the 43 panel sample completed Rounds 2 and 3. One participants dropped from the study after Round 1 when she realized she did not fit the stated educational requirements. Table 2 shows the demographic distribution of the participants. In addition, Figures 2, 3, and 4 show the areas in which participants received their bachelors, masters, and doctoral degrees. The

Round 1 questionnaire asked participants to provide demographic information in addition to the open-ended questions. Demographic data were intended to:

1. Be compared with literature to see if participants were representative of the general population;
2. Demonstrate participant's qualifications as experts for the study; and
3. Compare responses to the questionnaire with participants' self-identified characteristics.

Table 2

Demographic Distribution of Participants from Round 1

Category	**Characteristic**	***N(43)***
Age	30 – 40	3
	40 – 50	15
	50 – 60	18
	60 and over	7
Race/Ethnicity	White	41
	Black	0
	Hispanic	1
	Islander	0
	American Indian	1

Table 2 (continued)

Category	**Characteristic**	***N(43)***
Marital Status	Married	36
	Single	3
	Divorced	4
	Separated	0
Do you have Children?	Yes	36
	No	7
	Boys	32
	Girls	32
Were you Counseled in High School?	Yes	17
	No	25
Were you Counseled in College?	Yes	24
	No	19
Have you been Mentored	Yes	33
	No	10

Table 2 (continued)

Category	Characteristic	*N(43)*
Have you Served as a Mentor	Yes	40
	No	3

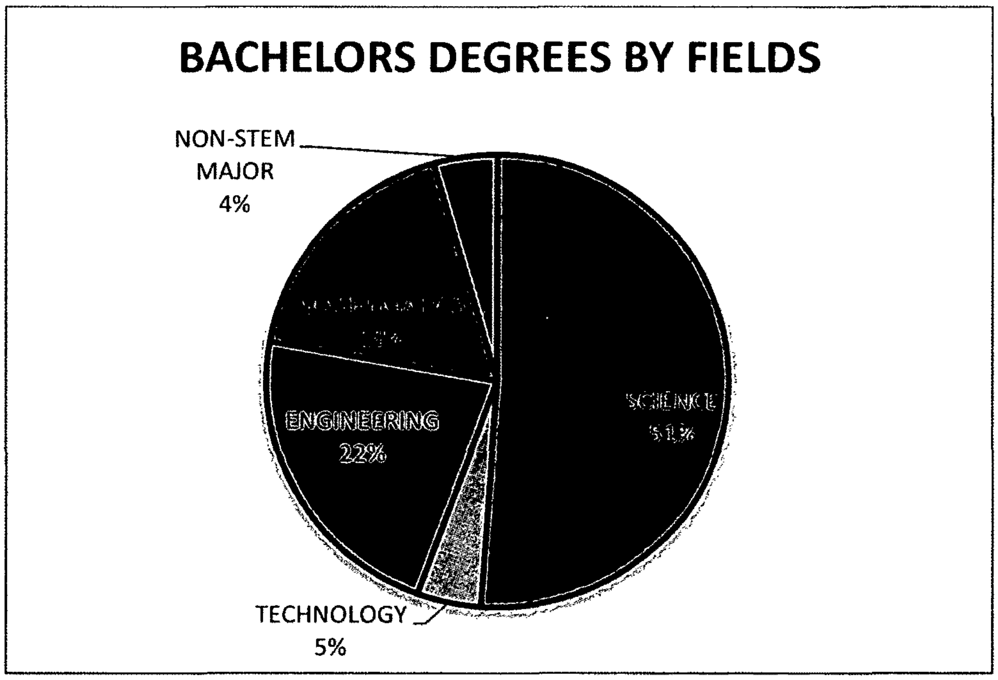

Figure 2. This figure shows the distribution of bachelors degree attained as self-identified by participants in Round 1.

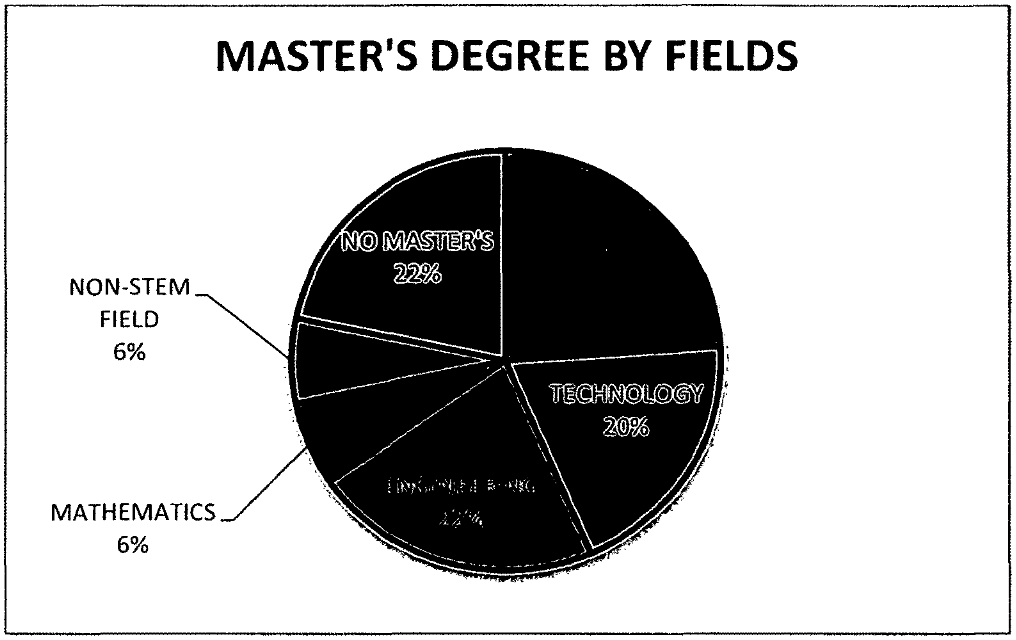

Figure 3. This figure shows the distribution of master's degree attained as self-identified by participants in Round 1.

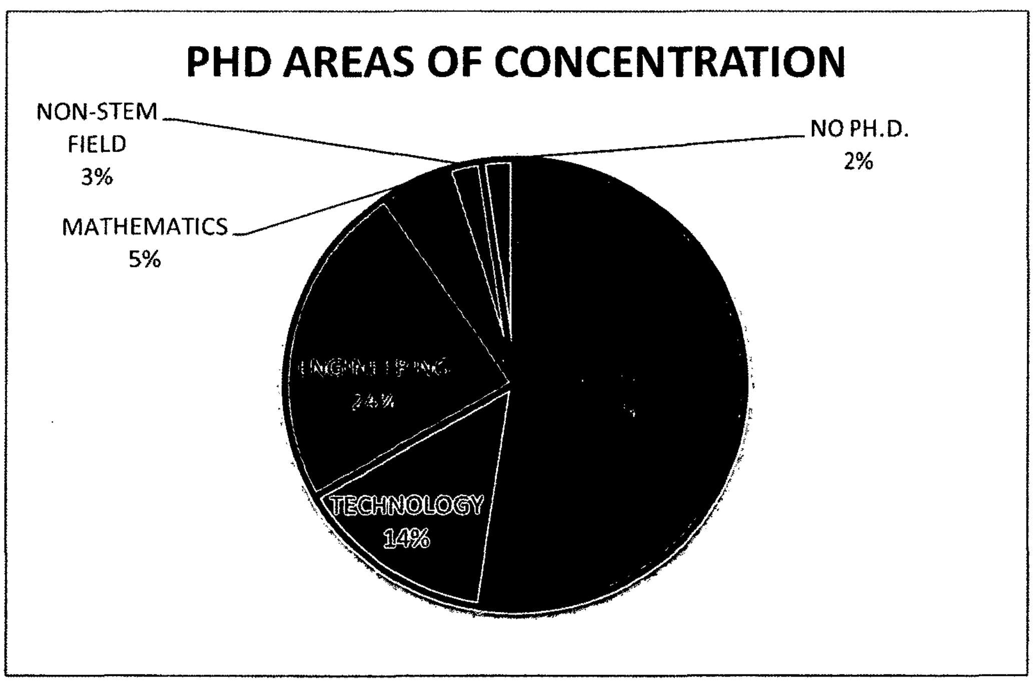

Figure 4. This figure shows the distribution of doctoral degrees attained as self-identified by participants in Round 1.

The Non-STEM major item in the degree attainment at the three levels pertained to different participants at each level and so did not disqualify any participant. This means that every participant had at least one STEM degree in the three levels and is currently teaching in a STEM field. For example, one participant had received a B.Sc. in chemistry, B.Ed. in Chemistry Education, and a Ph.D. in Organic Chemistry.

The demographic data also indicated that the average age of the participants was 53, with 36 or 84% married with children. In addition, 41 or 95% of the respondents self-identified their race as White and this is consistent with the findings from studies such as Trower and Chait's (2002) report *Faculty Diversity.* In that study, it was reported that 94% of full professors in science and engineering departments in American universities were White.

Round 1 Results

The aim of Round 1 was to provide participants of this study an opportunity to begin an exploration of the topic by allowing them to present with a personal list of factors that they perceived to be influential to their success. Each participant received an Email that contained an attached questionnaire that had four open-ended questions in addition to the request for demographic information. The questions in Round 1 asked participants to provide a list of personal, social, academic/institutional, and other factors they perceived as influential to their success and persistence in their chosen STEM careers.

The narrative responses to Round 1 were compiled, analyzed, and sorted to find common themes. The Grounded Theory method was used in a sequential manner for this analysis. The response of each participant, for every question was compiled into a large

single document. These were then analyzed line by line for common themes for the factors provided (Charmaz, 2006). These themes were not simply labels, but they were chosen based on common analytic characteristics (Glaser & Strauss, 1967). Duplicate factors such as stubbornness, hard headedness, etc. became simply stubborn. These were consolidated to generate a refined list. However, because several of the sub-themes were so individualized, the factors were retained in the list format in the Rounds 2 and 3 questionnaires for further consensus. The themes were only applied to the final list of factors after Round 3.

In qualitative research analysis, triangulation is often used to enhance the credibility of the process of coding and finding categories. This is a method of using an impartial panel to provide separate analysis of the data as indicated in the previous paragraph, and then combining the resultant analysis to generate themes from a list of narrative responses (Patton, 2002). Three female STEM faculty from an institution that was not included in this study were used to provide analyst triangulation in the review of the findings of the Round 1 qualitative data. They reviewed the data, codes, themes, and emerging factors and proposed alternative views. The assistance of these professional educators reduced researcher bias in the analysis of the data. The output of Round 1 yielded 580 narrative responses in total; 189 responses for Question 1, 157 for Question 2, 148 for Question 3, and 86 for Question 4. A review of the data that arose from this study follows.

Research Question 1

Please list up to five personal factors you believe have helped you to succeed and persist in your chosen career as a STEM faculty member. Personal factors are those that

originate from within – a person's perception of themselves and their abilities to handle situations in their environment. Examples of personal factors include self-efficacy, tenacity of purpose, and intrinsic motivation.

Several personal factors emerged from the responses to Question 1. Among the most cited personal factors were positive personality traits, positive mental attitude, intrinsic motivation, positive self-esteem, and self-efficacy in STEM. Twenty-five (58%) participants mentioned several personality traits that they believed have been influential to their success and persistence. Twenty-three (53%) participants also stated that a positive mental attitude was a personal factor that assisted in their success and persistence. At the same time, 27 (63%) of the 43 respondents mentioned intrinsic motivation and 25 (58%) cited positive self-esteem as being influential to their success and persistence. Furthermore, eight (19%) mentioned self-efficacy in STEM or in a specific STEM field as being important to their successful persistence.

The most cited personal factors are personality traits, positive mental attitude, and intrinsic motivation. Personality traits are those that are closely associated with an individual's temperament and habits, many of which result in a positive mental attitude and motivation. Participants contributed 44 (23%) statements for each for these three factors. Among the most cited personality traits were "Stubbornness or contrariness" stated by at least10 (23%) of 43 participants. Twelve (6%) of the personality trait statements identified participants as stubborn. Other personality statements given by participants included the following: "Sense of humor" 2 (1%), "Curiosity" 4 (2%), "Logical thinker" 1 (0.5%), "Flexibility and adaptability to diverse situations" 3 (1.6%), "Rebellious nature" 1 (0.5%), and "Competitiveness" 3 (1.6%).

Intrinsic motivation is the ability of an individual to rise above obstacles and stay on course no matter how much time or effort is required to successfully complete a given task (Lent et al., 1989). Forty-four (23%) of the189 responses from 43 participants stated or alluded to intrinsic motivation. Some of the statements indicating strong intrinsic motivation included "Motivation and Intrinsic motivation" 10 (5.3%), "Determination" 4 (2%), and "Focused, yet effective at multi-tasking" 3 (1.6%). Others also said "Tenacity of purpose (e.g., moving forward despite "it can't be done" or "we're not interested in what you do" because I believe it is important) " 9 (4.8%), and "Ability to stay focused and strategic over long time scales, 5 years or more" 1 (0.5). Some also said, "Drive in the absence of support" 1 (0.5%) and "My ability to be energized and have my drive reinforced when I encountered obstacles" 1 (0.5%).

Self-efficacy is defined as a person's belief in their ability to perform successfully in a given task or behavior (Bandura, 1989). Self-Efficacy in STEM, which is an individual's belief in their ability to succeed in STEM or a STEM field, also came out clearly from eight (19%) participants in eight (4%) responses. Some of the self-efficacy statements provided by participants included: "Self-efficacy" 7 (3.7%), "Natural inclination toward math and science" 1 (0.5%), "I found my field extremely interesting. It was math originally but I gradually gravitated to computer science" 1 (0.5%), "Strong abilities in STEM area" 1 (0.5%), "Intelligence/creativity within science" 1 (0.5%), "Love of science and research" 1 (0.5%), "Enjoyment of and skilled in mathematics" 9 (4.8%), and "Confidence in my STEM abilities, especially in mathematical skills" 1(0.5).

Positive self-esteem, which is a positive view of one's self and abilities (Bandura, 1989) is another key personal factor that emerged in Round 1. Eight (19%) of

respondents cited self-esteem in eight (4%) of the statements. One (0.5%) participant wrote, “Optimism and confidence in eventual success (e.g., self-efficacy)” 1 (0.5%). Others stated: “Self-Confidence” 10 (5.8%), “Efficiency” 4 (2%) , “High intelligence” 5 (2.6%), “Strong time-management skills” 2 (1%), “Competence” 3 (1.6%), “Good Organizational skills” 7 (3.7%), “Good personal work ethic” 6 (3.2%), “Good communication skills (written and oral presentation) ” 3 (1.6%), and “Ability to work with people on multiple levels” 2 (1%).

Some of the other personal factors mentioned by participants in Round 1 were “Good public presentation ability” 1 (0.5%), “Need to have a steady paycheck”1 (0.5%), “Appreciation of the prestige associated with my profession” 1 (0.5%), and “Good Interpersonal skills/ability to collaborate” 2 (1%).

Research Question 2

Please list up to five social factors you believe have helped you to succeed and persist in your chosen career as a STEM faculty member. Social factors are those that are situated outside an individual's internal control, but exist in their environment or the larger society. Social factors include limitations and/or expectations placed on a person as a result of expected social norms and cultural practices. The assignment of gender roles by society and role models or mentors are examples of social factors.

Social factors are the ones situated outside the individual's personal locus of control. Participants outlined several social factors such as affirmation and encouragement from family, friends, and colleagues, mentors and mentoring relationships, supportive/enabling environments, collaboration and networking

opportunities, availability of infrastructure and funds, and the economic and social advantages of a career in STEM.

Overwhelmingly, participants cited the affirmation and encouragement of family and friends as being influential to their success and persistence. In all, 35 (81%) of the 43 participants indicated the importance of affirmation and encouragement from various individuals and entities in 59 (38%) of their responses to Question 2. Twenty-seven (63%) of the participants said the support of their family members such as parents, siblings, and children were important factors for their successful persistence. One respondent wrote, "Liberal father who told me I could be anything I wanted" 1 (0.6%). Other individual narratives indicated support in the home and included: "Supportive parents" nine (5.7%). There were also 19 (12.1%) narratives that showed support from the family and home, such as "Supportive family" 1 (0.6%), "Strong support system at home" 1 (0.6%), "Support in time management from my immediate family (husband, children)" 1 (0.6%). Others were "Expectations from my parents that I would have a successful career" 1 (0.6%), and "Support from a close circle of female friends" 1 (0.6%).

Similarly, 22 (51%) participants attributed their success in part to the support of their spouses. This is consistent with the demographic data which showed that 36 (84%) of the 43 respondents said they were married. Some of the participants' description of spousal support included: "I dated and married a man with a strong mother and who was also developing a career in STEM" 1 (0.6%) and "A husband who has been very encouraging of seeking and taking on new challenges" 1 (0.6%). Other individual participants each wrote: "A spouse who supported me and sacrificed his career for me" 1 (0.6%), "Unending encouragement and support from my husband" 1 (0.6%), "A spouse

who stayed home to raise our children" 1 (0.6%), and "A spouse willing to put his career second to mine for relocation" 1 (0.6%). This factor is also consistent with recommendations in the literature, such as Murphy et al., (2007), that equitable treatment of men and women in domestic roles, allocation of resources, and provision of opportunities to advance, can help females to succeed and persist in any profession, especially in the STEM fields.

Participants also cited mentors and mentoring relationships as being influential to their success and persistence in their STEM professions. Thirty (19%) of the responses to Question 2 mentioned mentors or role models as being important to successful persistence. Some of the single participant narratives also included: "Supportive mentor (coworker) on the first faculty I joined after my post doc" 1 (0.6%). Others also wrote: "Willingness of men to be mentors" 1 (0.6%), "Excellent mentors" 1 (0.6%), "Excellent mentors later in life, including lending advice and networking" 1 (0.6%), "Many supportive department colleagues who acted as informal mentors" 1 (0.6%), "Mentors/etc. helped make opportunities available" 1 (0.6%), and "Above-average proportion of women students and faculty mentors in biology" 1 (0.6%).

Significant among the mentoring/role modeling relationships that emerged in Round 1 was family members as STEM mentors or role models. At least seven (16%) of the participants indicated such a mentor or role model was important to their successful persistence. Among the specific individual narratives were: "Father/mother were both STEM Ph.D.s" 1 (0.6%), "Suggestion of an engineering major by my older brother, who is an engineer" 1 (0.6%), "My father is an engineer" 1 (0.6%), and "There are a lot of engineers in my extended family" 1 (0.6%).

However, not only were the presence and/or availability of mentors and role models important success and persistence indicators for participants, but also their own capabilities and positions as mentors and role models in STEM were evident. The demographic data revealed that while 33 (77%) admitted to having had a mentor in their educational and professional careers, 40 (93%) have mentored others. The average number of mentees or protégés was 17 with several of them stating 50 or more. This is how some participants shared this factor in their answers: "Desire to provide alternative role model for my daughters" 1 (0.6%), and ["Desire to prove that women are as good as men"] 1 (0.6%).

Another key social factor that participants listed was a supportive, enabling environment. Fifteen (35%) participants listed several supportive and enabling factors in their STEM fields that have contributed to their successful persistence. One participant wrote: ["Supportive mathematics organizations"] 1 (0.6%), and "A work environment that makes you feel part of a team and value your contributions" 1 (0.6%). Others expressed: "Opening of education opportunities for females to enroll in engineering schools in early 1970's" 1 (0.6%), "Mutual respect of department members" 1 (0.6%), "Positive interaction with students" 1 (0.6%), and "Low incidence of gender-based discrimination" 1 (0.6%).

Additionally, participants considered affirmative and equity policies at federal, state, and institutional levels as influential to their successful persistence. With an average age of 53, the majority of the respondents for the study were entering college and selecting majors close to the pinnacle of the Women's Rights Movement in the United States of America. Some participants wrote: "Legal movement towards equality for

women in business" 1 (0.6%), "Opening of education opportunities for females to enroll in engineering schools in early 1970's" 1 (0.6%), "Started my training/career in the 70's-80's when women were given a chance" 1 (0.6%), and "Ability to defy social norms, particularly the ones in academia" 1 (0.6%). The availability of funding opportunities for education in STEM was also an important economic consideration for some participants. Yet another stated, "Financial aid through government programs allowed me to attend college" 1 (0.6%).

In addition, some participants considered the economic gains and prestige associated with their chosen STEM profession as incentives to succeed and persist in those fields. Five (12%) respondents included the economic advantage of a career in STEM in the social factors they considered influential to their success and persistence. One participant wrote the "need to support family" 1 (0.6%). Another wrote, "Engineers earn good salaries" 1 (0.6%), and another offered "Career opportunities and job market abound" 1 (0.6%). Yet another said, "High popularity of biology as a degree" 1 (0.6%) and "Increased job availability" 1 (0.6%).

Furthermore, participants considered the opportunity of networking and collegiality in their STEM departments an influential social factor for their success and persistence. Eight (19%) indicated this in nine (6%) of their responses. One of them stated, "Networking with other female science-oriented friends" 1 (0.6%). Others also wrote, "Networks built at women faculty/minority faculty workshops" 1 (0.6%), ["At one institution, there were no factors that helped other than an informal network of other female faculty"] 1 (0.6%). Further narratives included: "Having a colleague who also has

a family and considers it important as I do" 1 (0.6%) and "Having a peer group in my department (young assistant professors)" 1 (0.6%). .

Finally, participants attributed their ability to succeed and persist partially to other social factors such as family and social expectations of attaining a higher degree, the desire to contribute to society, and luck. One wrote "The expectation in my family of achieving a college education" 1 (0.6%). Others stated: "High educational expectations at home" 1 (0.6%), "Mother's importance of receiving a "good" education" 1 (0.6%), "Need for improvement in the quality of lives of people and families was perceived by me at an early age" 1 (0.6%).

Research Question 3

Please list up to five academic/institutional factors you think helped you to succeed in and persist in your chosen career as a STEM faculty member. Institutional factors are events, practices, and procedures within institutions, as well as the people involved in those institutions, that affects a person's choices. Examples include presence or absence of career counselors, gender cues and biases in instruction, and active and intentional equity approach to teaching and learning, and institutional life.

Firstly, the majority of the academic/institutional factors participants listed encompassed a supportive, enabling environment. Thirty (70%) of the 43 participants gave statements and narratives indicating the importance of a supportive enabling, environment in their institutions to their successful persistence. At least 49 (33%) of the 148 responses to Question 3 was related to a supportive, enabling environment. Some of the statements given by participants were: "Small class sizes" 1 (0.7%), "Flexible schedule" 1 (0.7%), "Senior faculty/department head supportive of junior colleagues'

needs" 1 (0.7%), "Freedom to determine individual research priorities and service roles" 1 (0.7%), "Institution encouraged students to give talks and engage with the professional community early in our academic careers" 1 (0.7%). Others also stated "Faculty/advisor/supervisor, gender sensitive and supportive" 1 (0.7%), "Support in graduate school encouraging my career path" 1 (0.7%), and "Expectation of mutual respect on all levels in my department/institution" 1 (0.7%).

Secondly, 16 (37%) of the respondents indicated that the availability of financial aid and research opportunities played a key role in their successful persistence. Twenty-two (15%) of the responses showed participant's opinion about this factor. Some of the narratives to support the preceding factors were: "Extensive lab experiences in undergraduate and graduate research opportunities increased my desire to go further in STEM" 1 (0.7%), "Availability of financial support (grants, scholarships, assistantships, and fellowships)" 1 (0.7%). Some also stated that "Opportunity to do top-quality research (infrastructure present)" 1 (0.7%), "Support in graduate school for my research" 1 (0.7%), and "Support for travel to meetings and conferences" 1 (0.7%) were influential to their success and persistence.

Additionally, participants wrote that an attitude of collegiality in their departments and institutions has contributed to their successful persistence. Eleven (26%) respondents indicated through 14 (9%) statements that this factor was important to them. Some of the participants wrote: "Great collegiality in my department and institution" 1 (0.7%), "Faculty voice held authority" 1 (0.7%), "Expectation of mutual respect on all levels in my department/institution" 1 (0.7%), and "Well-respected colleagues who are collegial in attitude" 1 (0.7%).

Furthermore, participants also mentioned mentoring and mentoring relationships as being influential to their successful persistence. Ten (23%) participants mentioned 13 (10%) ways in which mentoring and mentoring relationships were important to them. Some of the individual narratives were as follows: "Mentors (both while in school and when teaching) that modeled behaviors that inspired me" 1 (0.7%), ["Mentoring by faculty who allowed me to be successful in the federal grant arena (Critical to STEM success)"] 1 (0.7%), "Mentors appeared at the right time!" 1 (0.7%), and "My Ph.D. advisor was extremely supportive of my career" 1 (0.7%).

Again, several participants stated that they had been associated with institutions that had institutional level policy and programs towards affirmative action and equity and this was influential to their successful persistence. Participants' statements about the affirmative/equity policies for students and faculty demonstrate this importance of this factor. Seven (16%) of the respondents provided 13 (9%) statements about institutions that were intentional about gender equity (e.g., equity by-laws written down).

Some of the narratives pertaining to the importance of affirmative and equity policies included: "Equity in teaching and research responsibilities on campus", "Equal opportunities for teaching assistant assistance" 1 (0.7%) and "Equity during the promotion and tenure process" 1 (0.7%). Others were "Equal opportunities for research funding from the institution" 1 (0.7%), and "Equal opportunities for on-campus training (including sexual harassment training which was required by all employees)" 1 (0.7%).

Additionally, some participants thought that institutions with a clear system for rewards and achievements (e.g., toward tenure) were conducive to their success and persistence. Such institutions employed transparent systems that allowed for maximum

input from all stakeholders. At least six (14%) respondents concurred with the preceding statements through eight (5%) narratives. Some of them stated: "Clearly written expectations for tenure/promotion" 1 (0.7%), and "My first institution had a very well developed new faculty development program" 1 (0.7%). Others also stated "Annual tenure review and feedback" 1 (0.7%), and "Career advancement clearly documented and achievable" 1 (0.7%).

Some of the other academic/institutional factors given by participants included opportunities to serve on boards and committees, departmental/institutional environment that was gender neutral, and presence of other female faculty in their departments. Following are some of the narratives from participants. One (0.7%) participant stated:

> I was asked to serve on committees and governing bodies (board of directors for my national professional organization) because they wanted female representation and there was little-to-no competition for that role (I was the first and only female faculty in my department for my first 3 years there). While this was a double-edged sword (it did take time from other duties), it also exposed me to my discipline and gave me an inside look at funding/granting agencies/advancement/etc.

Another participant also stated:

> Being included in NSF and similar agencies review panels (thanks to guidelines to include researchers from both genders and diverse ethnical groups in the same). Being part of a review panel gives you an insider perspective on what the agency in expecting in a project and the criteria used to judge proposals.

Finally, some participants believed that the flexibility of an academic career, which allows for a healthy home/work environment, was an incentive for them to persist in their chosen STEM academic professions. One of them stated: "Academic careers usually offer more flexibility in terms of family related commitments than industry positions. Faculty members can push themselves to be very good performers while maintaining a good life-work balance which is more difficult to attain in an industrial setting".

Research Question 4

Please list any other factors you think helped you to succeed in and persist in your chosen STEM faculty career that does not fall under any of the above categories.

Even though Question 4 asked for other factors, it became apparent that only those respondents who felt they were not able to exhaust their list of factors for Research Questions 1, 2 and 3 were the ones who answered Question 4. Furthermore, several of them repeated the same statements they had given in the previous questions. As shown in Appendix J, none of the answers to Question 4 merited another category other than the three given to participants: personal, social, and academic/institutional.

Round 1 Summary

The output of Round 1 yielded 580 narrative responses; 189 responses for Research Question 1, 157 for Research Question 2, 148 for Research Question 3, and 86 for Research Question 4. These are the answers of 43 respondents to four open-ended questions. Participants were asked to provide a list of personal, social, academic/institutional, and other factors they perceived as being influential to their success. Some factors were repeated by participants in all four questions, such as the

importance of mentors and role models. All the factors given in Question 4, the 'other' section, could be categorically placed within the first three questions. As a result, the Round 2 questionnaire had only three questions. Appendix J contains a table of all the narratives responses of participants to the Round 1 open-ended questions, as well as figures summarizing the demographic data resulting from Round 1. Table 3 shows a summary of the narrative responses in Round 1 and the frequencies with which they were mentioned.

Table 3

Summary of Round 1 Findings

No.	Round 1 Question 1 – Personal Factors	*F*
1.	Stubbornness/contrariness	10
2.	Natural inclination for STEM	1
3.	Tom-boy	1
4.	Got along better with males than females	1
5.	Preferred sports to dolls	1
6.	Enjoyment and/or enthusiasm for work (STEM)	11
7.	Determination in the face of challenges/adversity	4
8.	Self-confidence	10
9.	Ability to work independently	3

Table 3 (continued)

No.	Round 1 Question 1 – Personal Factors	*F*
10.	Acceptance of being different	1

11.	High expectation of myself	1
12.	Willingness to sacrifice self to get a job done	1
13.	Self-motivation or intrinsic motivation (drive in the absence of support)	10
14.	Curiosity	4
15.	Efficiency	1
16.	Ability to multi-task	3
17.	Intelligence	5
18.	Flexibility or ability to adapt to diverse situations	3
19.	Kindness	1
20.	Exercise	1
21.	Ability to keep things in perspective	1
22.	Clear personal goals/goal oriented	5
23.	Making plans for professional achievement	1
24.	Sense of purpose	1
25.	Strong time-management skills	2
26.	Focused	3
27.	Recognized a great job opportunity	1
28.	Wanted to do something other than be a mom	1
29.	Self-efficacy (belief in self ability to accomplish any task)	7
30.	Desire, commitment to, and passion to learn	1

Table 3 (continued)

No.	**Round 1 Question 1 – Personal Factors**	*F*
31.	Persistence (ability to stay focused and strategic over time)	7

32.	Positive attitude - ability to see beyond current crisis	1
33.	Ability to scavenge physical resources and build connections/network	1
34.	Ambition	1
35.	Competence	3
36.	Good organizational skills	7
37.	Competitiveness	3
38.	Good interpersonal skills/ability to collaborate	3
39.	Hard worker	3
40.	High standards of acceptable work quality and quantity	1
41.	Tenacity (moving forward despite "it can't be done" or "we're not interested in what you do" because I believe it is important)	9
42.	Optimism	1
43.	My belief that I could make a difference for other female scientists like myself	1
44.	Good personal work ethic	4
45.	Rebellious nature	1
46.	Serious sense of humor	2
47.	Skeptical about everything	1
48.	Intuitive sense of "productive" path	1
49.	Strong abilities in STEM area	1

Table 3 (continued)

No.	Round 1 Question 1 – Personal Factors	*F*
50.	Type A personality	1

51.	Good mentors	1
52.	Maintain distance from students - they tend to make female faculty into surrogate mothers or girl friends	1
53.	Need to prove myself	2
54.	I like challenge	1
55.	Being able to let go of those few times as a grad student when a male faculty member suggested that this might not be the career for me	1
56.	Ability to tolerate frustration	1
57.	Creativity within STEM	1
58.	Good emotional stability	1
59.	Math efficacy	2
60.	Science efficacy	1
61.	Proud of my accomplishments STEM	1
62.	Appreciate the prestige associated with my profession	1
63.	Communication skills	2
64.	Don't mind being alone in the middle of a group	1
65.	High personal self-esteem	1
66.	Striving for excellence	1
67.	Capacity for working long hours	2
68.	Willingness to take on new challenges	1

Table 3 (continued)

No.	**Round 1 Question 1 – Personal Factors**	***F***
69.	Willingness to take credit AND responsibility for my actions	1

70.	Ability to shake off minor insults or problems and move on	1
71.	Personal integrity	1
72.	Technical grasp of broad issues	1
73.	Ability to work with people on multiple levels	1
74.	Love learning new things	1
75.	Love to figure things out	1
76.	Logical thinker	1
77.	Good writer	1
78.	I like challenges	1
79.	Determination to succeed in chosen endeavors	1
80.	Strong willed in general	1
81.	Patience- recognition that it is a "long game"	1
82.	Desire to achieve	1
83.	At peace with decisions	1
84.	Desire for knowledge	1
85.	Persistent feeling of inadequacy (sure, I accomplished this, but it was too easy because I am a big fish in a small pond)	1
86.	Enjoy making a difference in students' lives	1
87.	Need to have a steady paycheck	1
88.	The love of learning about new technology and new scientific phenomena	1

Table 3 (continued)

No.	**Round 1 Question 1 – Personal Factors**	***F***
89.	Talent	1

90.	Refusal to allow oneself to fail	1
91.	I don't think other fields have as much value to society	1
92.	Effort to keep up in the field	1
93.	Good technical/academic skills	1
94.	Problem-solver	1
95.	Question-driven	1
96.	Good public presentation ability	1
97.	Critical thinking skills	1
98.	Idea-oriented	1
99.	My own desire to do my best in all that I do	1
100.	Kind of a loner and liked to read a lot	1

No.	Round 1 Question 2 – Social Factors	*F*
1.	Family members as role-models	7
2.	Supportive family (parents, siblings, children, etc.)	27
3.	Supportive faculty (male and female) at undergraduate and graduate level	8
4.	Good teachers and professors	1
5.	Supportive mentor(s), male and female	17
6.	Need to support my family	1
7.	Opening of education opportunities for female to enroll in engineering schools in early 1970's	4

Table 3 (continued)

No.	Round 1 Question 2 – Social Factors	*F*
8.	Ability to defy social norms, particularly the ones in academia	1

9.	Supportive spouse	22
10.	Positive female role models (in STEM and other fields)	8
11.	Positive male role models	3
12.	Positive effect of gender roles: Being a women in a male dominated field – more opportunities for women	1
13.	Negative effect of gender roles: difficulty in interacting with male faculty members at times	1
14.	Networking with other female science-oriented friends	10
15.	High educational expectation	5
16.	Ignoring societal expectations	1
17.	Mutual respect of department members and/or support from colleagues	10
18.	Positive interaction with students	1
19.	Low incidence of gender-based discrimination	2
20.	Supportive friends who encouraged me	7
21.	I never bought into the gender roles very much. As a child I liked "boy" toys like models and building kits and my mother provided them instead of trying to talk me out of it.	1
22.	Kind of a loner and liked to read a lot	1
23.	Legal movement towards equality for women in business	3
24.	Availability of excellent schools	2

Table 3 (continued)

No.	Round 1 Question 2 – Social Factors	*F*
25.	Supportive and/or gender neutral/affirmative minded supervisors/bosses	5

26.	Work in a professional organization that is highly diverse	2
27.	Family Position (first born)	1
28.	Age at beginning of degree program – 33	1
29.	Job experience at beginning of degree program (5 yrs in industry)	1
30.	Poverty	1
31.	Societal respect for higher learning	2
32.	Desire to provide alternative role model for my daughters	1
33.	Desire to "prove" that women are as good as men	2
34.	Good support group	2
35.	Success encourages more success	2
36.	Good daycare options (but none on campus back when I needed it)	1
37.	High earning/pay in my STEM field	2
38.	Luck	2
39.	Industrial applicability of my research area	1
40.	Need for improvement in the quality of lives of people and families was perceived by me at an early age	1
41.	Career opportunities and job market abound in STEM	2
42.	Knowledgeable friends	1
43.	Society's expectation of a contribution from its members	1
44.	Supportive professional organization(s)	1

Table 3 (continued)

No.	**Round 1 Question 2 – Social Factors**	*F*
45.	Recognition that "being smart" is "good" by most people	1

46.	[Child was older (5 years) when entered academia]	1
47.	Non-tenure track position was a good fit	1
48.	Academically competitive brothers and sisters	2
49.	Financial aid through government programs allowed me to attend college	1
50.	Opportunities for empowerment - High school sports for girls, Girl Scouts	1
51.	Women's Rights Movement	1
52.	I was raised without much TV/influence from popular culture	1
53.	Determination to go against the tide and prove that minority can succeed	1
54.	My background (immigrant, first generation to complete graduate education, in me)	1

No.	**Round 1 Question 3 – Academic/Institutional Factors**	***F***
1.	Enabling work environment	2
2.	Desire to be a role model to my kids and others	1
3.	I have been lucky not to encounter the kind of in-your-face discrimination that many women have to put up with	1
4.	Availability of excellent equipment for research	1
5.	Culture for research integrated into undergraduate years	1
6.	Acceptance and support by male colleagues in my department	1
7.	I felt no gender bias from my academic institution at any level	1

Table 3 (continued)

No.	**Round 1 Question – Academic/Institutional Factors**	***F***
8.	Opportunity to serve on boards and committee	1

9.	Being a minority representation on committees and boards	2
10.	Pressure on institutions to increase gender equity in STEM	1
11.	Grants and funds geared towards gender equity in my field	3
12.	Unrestricted curriculum that allowed coursework in women's studies as undergrad and grad student	1
13.	Small class sizes	1
14.	Hands-on lab experiences	1
15.	Undergraduate and graduate research opportunities increased desire to go further in STEM	3
16.	Relevant work-study opportunities as undergraduate	1
17.	Equity in teaching and research responsibilities on campus	3
18.	Equal opportunities for teaching assistant assistance	2
19.	Equity during the promotion and tenure process	2
20.	Equal opportunities for research funding from the institution	3
21.	Equal opportunities for on-campus training (including sexual harassment training which was required by all employees)	2
22.	Institution that was intentional about gender equity (Equity by-laws written down)	6
23.	Awareness of institutional policies sexual harassment training (this from industry, not academia)	1

Table 3 (continued)

No.	**Round 1 Question – Academic/Institutional Factors**	***F***
24.	Flexible schedule	2

25.	Respect for individual strengths among colleagues	2
26.	Senior faculty/department head supportive of junior colleagues' needs	6
27.	Freedom to determine my own research priorities and service roles	1
28.	Networking and collaboration opportunities	2
29.	Encouraging and supportive teacher's and faculty	1
30.	Desire to be a role model	1
31.	Institutional expectations of success fit my expectations of performance	1
32.	High expectation of academic excellence in my department	1
33.	Institutional mentoring opportunities	3
34.	Institution had a neutral/laissez fair approach to faculty development	1
35.	An ill-defined part-time position that allowed me considerable freedom	1
36.	A campus environment that was somewhat ready for change	1
37.	Small Ph.D. program	1
38.	Availability of financial support (grants, scholarships, assistantships, and fellowships)	2
39.	Flexible Ph.D. track	1
40.	Institution moved students who entered the undergraduate program through it as a cohort, which generated a sense of camaraderie and provided a supportive environment in my studies and outside of classroom	1

Table 3 (continued)

No.	Round 1 Question – Academic/Institutional Factors	*F*
41.	Presence of female faculty in undergraduate/graduate institutions	3

42.	Institution encouraged students to give talks and engage with the professional community early in our academic careers	1
43.	Undergraduate faculty expected women to perform as good as men	1
44.	Exposure to and interaction with women in STEM in various ways during undergraduate/graduate school	1
45.	Graduate school participation in women Ph.D. and MD student group	1
46.	Faculty/advisor/supervisor was sexist and racist, which made me all the more determined to succeed	1
47.	University allowed me to submit my first R01 without having an appointment anywhere	1
48.	Positive feedback from students	2
49.	Faculty/advisor/supervisor gender sensitive and supportive	4
50.	Great collegiality with colleagues	3
51.	Positive feedback from colleagues	3
52.	Presence of other female professionals in my department and institution	3
53.	Ability to do top-quality research (infrastructure present)	1
54.	Protection from excess service obligations as an untenured faculty	1
55.	Lowered teaching load as an untenured faculty	1
56.	Institutional commitment to increasing female faculty presence and success on campus	1

Table 3 (continued)

No.	Round 1 Question 3 – Academic/Institutional Factors	*F*
57.	Institutional commitment to assisting with dual-career situations	1

58.	Institutional support for request for extension of tenure clock for child-birth	1
59.	My current university employer actively sought to retain me when I received a competing job offer	1
60.	[Programs/events that exposed me to STEM and STEM professionals in elementary and/or high school made a lasting impact]	1
61.	ADVANCE program	2
62.	WISE group	1
63.	Departmental incentives for funded research	1
64.	High gender bias suffered in industry prepared me for the less overt and often subtle forms in academia	1
65.	Career advancement clearly documented and achievable	1
66.	Faculty voice held authority	1
67.	Clear system for rewards and achievements (e.g., toward tenure)	2
68.	Networking and open communication with administration	1
69.	Support in graduate school for my research	1
70.	Support in graduate school encouraging my career path	1
71.	Institutional meritocracy -- good work is what matters	2
72.	Willingness of academic institution to consider alternate career pathways	1
73.	Expectation of mutual respect on all levels	1

Table 3 (continued)

No.	**Round 1 Question 3 – Academic/Institutional Factors**	***F***
74.	Departmental coffee pot gathering every day	1

75.	Participation in continuing education courses for industry	1
76.	Support for travel to meetings	1
77.	Well-respected colleagues who are collegial in attitude	1
78.	Tacit assumption that being a professor with a lab was the epitome of being a scientist	1
79.	Ability to negotiate terms of employment, work, & resource distribution	1
80.	Great advising office	1
81.	Faculty/supervisors (male/female) encouraged/mentored both male and female students to succeed in STEM	2
82.	Male mentors/professors who did not have a gender bias (because they had successful wives or daughters)	1
83.	Department had a culture of teaching excellence	1
84.	As a student, willingness by faculty to accept (at least in part) female students	1
85.	Promotion tenure committee selected for each faculty member	1
86.	And having another female on that committee	1
87.	Well developed new faculty development program	1
88.	Involvement with student organization	1
89.	Determination to succeed as a role model to students	1
90.	Faculty position is flexible and promotes good work family balance	1

Table 3 (continued)

No.	**Round 1 Question 3 – Academic/Institutional Factors**	***F***
91.	Incorporation of workshops/round tables regarding best teaching	1

	practices	
92.	Inclusion institutional, local, regional, and/or national agencies' review panels	1
93.	Student-organized discussion groups/seminar series	1
94.	International opportunities (courses, workshops, post-doc)	1

No.	**Round 1 Question 4 – Other Factors**	
1.	I am independent	1
2.	Enjoy STEM	1
3.	Risk taker	1
4.	Naïveté	1
5.	Funding for interesting projects	1
6.	Need to provide a stable environment for my children	1
7.	Good, solid, and rewarding experience in industry before academia	1
8.	Proving myself in graduate school (overcoming biases and other difficulties)	1
9.	Finding interests in new areas of research	1
10.	Networking and collaboration with like-minded people	2
11.	Not having determined yet where my next career will be (Stuck in rut?)	1
12.	Unconventional learning experience outside the USA	1
13.	Ability to take advantage of opportunities when they appear	1

Table 3 (continued)

No.	**Round 1 Question 4 – Other Factors**	***F***
14.	Working on high profile events in my field (e.g., planning research	1

	conferences)	
15.	I enjoy contributing to the success and advancement of my students	1
16.	Awareness the society judges mothers differently than fathers is necessary	1
17.	Knowing and believing in yourself gets you through the tough times	1
18.	I am never bored!	1
19.	I feel that my abilities are well-suited for the job	1
20.	Stable marriage (26 years) to a non-scientist	1
21.	Dealing with stress/workload proactively	1
22.	Exposure to multiple lab environments because of job experience and internships during Ph.D.	1
23.	Being able to talk and observe female scientists who came from abroad (Germany, Russia) who had focused work ethic and similar stories of difficulties that women scientists have internationally	1
24.	Seeing other women in field give up on their dreams made me more determined	1
25.	Seeing other women in my field change who they are to suit the dominant male culture made me determined to succeed and be myself	1

Table 3 (continued)

No.	**Round 1 Question 4 – Other Factors**	*F*
26.	Having male colleagues compete with me (in fair and unfair ways) at critical times in my career using rules that I was not familiar with (to my detriment but also important in helping me realizing what it would take to compete in a male-dominated profession)	1
27.	I applied for, and got travel money to attend many scientific meetings starting as an undergraduate and continuing to this day as I try to finish my career without any funding	1
28.	I was a pioneer in the new field of Bioinformatics	1
29.	Personal gratification and satisfaction in knowing that my research, designs, and/or discoveries are making a significant difference in the world	1
30.	I was proactive in developing research collaborations outside of my institution and internationally	1
31.	I was fortunate to recruit quality graduate students	1
32.	Willingness to sacrifice personal time to accomplish job-related goals	1
33.	Timing of childbearing	1
34.	Local, national, and international network of collaborators	2
35.	Off-campus research	1
36.	I did not want the expense and time needed to retrain in other fields	1
37.	Passion for passing on knowledge and skills	1
38.	Financial stability for my family	1

Table 3 (continued)

No.	Round 1 Question 4 – Other Factors	*F*
39.	The community/network of practicing professionals, throughout state, nation, and world	1
40.	Significant work experience from industry	1
41.	STEM is life-focused - purpose for life, not just a job	1
42.	Felt I could contribute because I think like a scientist	1
43.	Overcoming hurdles and obstacles made me more tenacious	1
44.	Grandmother (family member) wanted to be a scientist and could not, so I felt I could do this for her	1
45.	Family role models	1
46.	Grew up with five brothers which made me able to navigate a male-dominated field	1
47.	Family situation required that I keep a job - major breadwinner for a period of time	1
48.	Wanted to help fill job shortage in STEM	1
49.	Wanted to contribute to my country's socio-economic development and advancement through STEM	1
50.	Academic position gives me opportunity to reach out to the larger community and impact them	1
51.	Prestige and respect that comes with the position	1
52.	Good earning	1

Round 2 Results

The purpose of Round 2 was to give participants an opportunity to study the factors given by the whole panel and to indicate their agreements or disagreements for these factors. The Round 2 questionnaire was constructed and placed online at the Survey Monkey site. See Appendix E for the direction Email containing a link to the Round 2 questionnaire that was sent to all the 43 participants who had responded to Round 1. The Email also contained an attachment showing summaries of the demographic data from Round 1. Round 2 contained three Likert scale questions that asked participants to indicate if they strongly agreed, agreed, disagreed, or strongly disagreed with the statements given. The three questions were

1. Please indicate whether you agree or disagree that the following personal factors (statements) have been influential to your success and persistence as a female faculty member in a STEM field.
2. Please indicate whether you agree or disagree that the following social factors (statements) have been influential to your success and persistence as a female faculty member in a STEM field.
3. Please indicate whether you agree or disagree that the following institutional and or academic factors (statements) have been influential to your success and persistence as a female faculty member in a STEM field.

Question 1 contained 95 items, Question 2 contained 62 items, and Question 3 contained 86 items. All inputs from the questionnaire were converted into numeric data, which was then entered into a spreadsheet for further analysis. The response of Strongly Agree was converted to a 4, Agree was converted to a 3, Disagree to a 2, and Strongly

Disagree to a 1. The mode, median, mean, standard deviation, and coefficient of variation were calculated for each Likert scale response.

Of the 43 participants who responded to the Round 1 questionnaire, 38 (88%) sent in responses to Round 2. Question 1 in Round 2 stated: Please indicate whether you agree or disagree that the following personal factors (statements) have been influential to your success and persistence as a female faculty member in a STEM field. Question 1 contained 95 statements or narratives of personal factors for which participants were to indicate their agreement or disagreement. Participants agreed that 85 (90%) of the statements in Question 1 were important to their success and persistence as STEM female faculty. They showed strong agreement for 23 (24%) items. This is indicated by items with a median score of 4. Sixty-two (66%) of Question 1 items had a median score of 3, indicating participants' agreement that they were important to their successful persistence. They disagreed with nine (9%) of the items and strongly disagreed with 1 (1%); these had median scores of 2 and 1 respectively. The item they strongly disagreed with was Item 94, which stated: "Grew up with (five) brothers which made me able to navigate a male-dominated field". It is obvious that the personal nature of this statement made it unique to the participant who wrote it. The coefficient of variation for Question 1 ranged from 0.1 to 0.5 indicating a strong consensus among participants concerning their agreement or otherwise with the items.

The participants were less enthusiastic about the statements in Question 2: Please indicate whether you agree or disagree that the following social factors (statements) have been influential to your success and persistence as a female faculty member in a STEM field. Question 2 contained 62 statements/narratives of social factors for which

participants were again required to show their agreement or disagreement. Participants only showed strong agreement for one (2%) and agreed with 34 (55%) of the statements. The one factor that resonated with the majority of participants to Question 2 was Item 3 – "Supportive spouse". Twenty-two (57.9%) participants strongly agreed and 9 (23.7%) agreed with this statement, which is fairly representative of the 36 (84%) respondents who had indicated that this was an important social factor to their STEM success and persistence in Round 1. The coefficient of variation for Item 3 was 0.3, also indicating strong consensus among participants on its importance. Participants disagreed with 27 (43%) of the statements, yet none of them found a statement to which they strongly disagreed. Overall, there was a strong consensus about participants' views of the statements under Question 2; the coefficient of variation for Question 2 ranged from 0.2 to 0.5.

The third and last question in Round 2 was: Please indicate whether you agree or disagree that the following institutional and/or academic factors (statements) have been influential to your success and persistence as a female faculty member in a STEM field. Question 3 contained 86 statements/narratives of academic/institutional factors that participants had indicated individually as being important to their successful persistence as STEM faculty members. Collectively, the panel of participants agreed with 44 (51%) of the statements; these had a median score of 3 or higher. They strongly agreed with 1 (1%) (median score of 4), and agreed with 43 (50%) (median score of 3) statements in Question 3. Statement 20 – "Freedom to determine individual research priorities and service roles" was important to the majority of participants 35 (92%). Twenty-two (58%) strongly agreed with this item, while 13 (34%) agreed that it was influential to their

successful persistence as STEM faculty members. The panel of experts disagreed with 36 (42%) of the factors in Question 3, and strongly disagreed with six (7%). A careful review of the answers indicated that the factors participants had a strong disagreement with are ones that are highly personalized and individual in nature. They included statements such as ["University allowed me to submit my first R01 without having an appointment anywhere"], and "ADVANCE program". While it may be true that these factors can be influential in increasing success and persistence, participants were asked to indicate their agreement or disagreement that the statements were true for them personally. Consequently, many of them had to disagree.

In addition to the Likert scale questions, participants were given the option for other comments, which two participants used to inquire about a 'Not Applicable' or 'Neutral' category for the Likert scale items. It was however explained to them that a 'Neutral' option would defeat the purpose of building consensus among participants. The coefficient of variation for Question 3 ranged from 0.2 to 0.6, showing that there were items in this question for which participants did not come to a clear consensus at this point. Table 4 is a summary of Round 2 results with the mode, median, mean, standard deviation, and coefficients of variation.

Round 2 Summary

Table 4

Summary of Round 2 Results

No.	**Round 2 Question 1 – Personal Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
1.	Stubbornness/contrariness	4	3	3.1	1.0	0.33
2.	Natural inclination for STEM	4	4	3.5	0.5	0.14

Table 4 (continued)

No.	Round 2 Question 1 – Personal Factors	Mod	*Mdn*	*M*	*SD*	CV
3.	Tom-boy – have better relations with males & enjoyed hobbies & pastimes traditionally considered masculine	3	3	2.5	0.8	0.28
4.	Enjoyment and/or enthusiasm for work (STEM) (I am never bored)	4	4	3.6	0.5	0.14
5.	Determination in the face of challenges/adversity	4	4	3.6	0.7	0.20
6.	Self-confidence	4	3	3.2	0.8	0.24
7.	Ability to work independently	4	4	3.6	0.5	0.15
8.	Acceptance of being different	4	4	3.3	0.8	0.23
9.	High expectation of myself to succeed	4	4	4	0.5	0.12
10.	Willingness to sacrifice self to get a job done	4	4	3.5	0.6	0.19
11.	Intrinsic motivation (personal drive in the absence of external support)	4	4	3.7	0.5	0.13
12.	Curiosity	4	4	3.6	0.6	0.17
13.	Efficiency	3	3	3.3	0.6	0.19
14.	Ability to multi-task	3	3	3.3	0.7	0.21
15.	High intelligence	3	3	3.2	0.7	0.20
16.	Flexibility (ability to adapt to diverse situations)	4	4	3.6	0.5	0.14
17.	Kindness	3	3	2.7	0.6	0.22

Table 4 (continued)

No.	Round 2 Question 1 – Personal Factors	Mod	*Mdn*	*M*	*SD*	CV
18.	Exercise – physical and as well as mental exercises to get work done and keep my mind alert	3	3	2.7	0.7	0.25
19.	Ability to keep things in perspective	3	3	3.3	0.7	0.21
20.	Goal-oriented	3	3	3.4	0.5	0.16
21.	Strong sense of purpose	3	3	3.3	0.6	0.19
22.	Strong time-management skills	3	3	3.3	0.7	0.20
23.	Focused	3	3	3.4	0.6	0.17
24.	Recognized my STEM field as a great opportunity for a satisfying profession/job	3	3	3.1	0.8	0.28
25.	Wanted to do and be something other than be a mom	2	3	2.4	1.0	0.37
26.	Self-efficacy (belief in self ability to accomplish any task)	4	3	3.2	0.8	0.24
27.	Desire, commitment to, and passion to learn	4	4	3.6	0.5	0.13
28.	Persistence (ability to stay focused and strategic over time)	4	4	3.7	0.6	0.18
29.	Positive attitude - ability to see beyond current crisis	3	3	3.3	0.6	0.18
30.	Resource mobilization and improvisation skills	3	3	3.1	0.6	0.21

Table 4 (continued)

No.	**Round 2 Question 1 – Personal Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
31.	Ambition	3	3	2.9	0.7	0.25
32.	Competence	3	3	3.4	0.5	0.15
33.	Good organizational skills	3	3	3.4	0.6	0.19
34.	Competitiveness	3	3	2.9	0.9	0.33
35.	Good interpersonal skills/ability to collaborate	3	3	3.4	0.8	0.23
36.	Hard worker	4	4	3.7	0.5	0.15
37.	Tenacity (moving forward despite “it can’t be done” or “we’re not interested in what you do” because I believe it is important)	4	4	4.2	0.6	0.18
38.	Risk taker	3	3	3.0	0.7	0.25
39.	The thrill of being a pioneer or trailblazer in my STEM field	3	3	2.6	0.8	0.31
40.	Optimistic	3	3	3.1	0.7	0.21
41.	Belief that I could make a difference for other female scientists like myself	3	3	2.6	0.8	0.31
42.	Good personal work ethic	4	4	3.4	0.6	0.19
43.	Rebellious nature	2	2	2.5	0.9	0.39
44.	A sense of humor	3	3	3.2	0.8	0.25
45.	Skeptical about everything	2	3	2.7	0.8	0.32
46.	Great intuition (sense of right or production choice in a given situation)	3	3	2.9	0.6	0.22

Table 4 (continued)

No.	**Round 2 Question 1 – Personal Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
47.	Type A personality	3	3	2.9	0.9	0.31
48.	Maintain distance from students - they tend to make female faculty into surrogate mothers or girl friends	2	2	1.9	0.8	0.45
49.	Ability to tolerate frustration	3	3	3.1	0.7	0.25
50.	Creativity within STEM	3	3	3.0	0.6	0.20
51.	Emotional stability	3	3	3.2	0.7	0.24
52.	Mathematics-Efficacy (believe that I am good at Math and can excel in it)	3	3	3.0	0.7	0.25
53.	Science-Efficacy (believe that I am good in science and can excel in it)	3	3	3.4	0.6	0.19
54.	Pride and gratification in knowing that my accomplishments in STEM [are] making a difference	3	3	2.8	0.7	0.25
55.	Appreciate the prestige associated with my profession	3	3	2.6	0.8	0.28
56.	Good communication skills (written and oral presentation)	4	4	3.4	0.6	0.16
57.	Don't mind being alone in the middle of a group	3	3	2.8	0.8	0.28
58.	High personal self-esteem	3	3	2.8	0.8	0.29

Table 4 (continued)

No.	**Round 2 Question 1 – Personal Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
59.	Capacity for working long hours	3	3	3.3	0.6	0.18
60.	Willingness to take on new challenges	3	3	3.5	0.6	0.16
61.	Willingness to take credit and responsibility for my actions	3	3	3.3	0.6	0.20
62.	Ability to shake off minor insults, resistance, biases, or problems and move on	3	3	3.3	0.6	0.18
63.	Personal integrity	4	4	3.5	0.6	0.16
64.	Technical grasp of broad issues	3	3	3.3	0.6	0.17
65.	Ability to work with people on multiple levels	4	4	3.4	0.6	0.16
66.	Love to figure things out	4	4	3.6	0.6	0.15
67.	Logical thinker	4	4	3.4	0.5	0.13
68.	Good writer	3	3	3.3	0.7	0.21
69.	Strong willed	4	4	3.2	0.8	0.24
70.	Patience- recognition that it is a "long game"	3	3	3.2	0.8	0.26
71.	At peace with decisions	3	3	2.9	0.8	0.30
72.	Persistent feeling of inadequacy (sure, I accomplished this, but it was too easy because I am a big fish in a small pond)	2	2	2.2	0.9	0.44
73.	Enjoy making a difference in students' lives	3	3	3.3	0.7	0.21
74.	Passion for passing on knowledge and skills	3	3	3.4	0.8	0.23
75.	Need to have a steady paycheck	3	3	2.8	0.9	0.33

Table 4 (continued)

No.	**Round 2 Question 1 – Personal Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
76.	Talent	3	3	2.9	0.7	0.23
77.	Refusal to allow myself to fail	3	3	2.9	0.8	0.27
78.	I don't think other fields have as much value to society	2	2	1.9	0.7	0.41
79.	Need to keep up in my STEM field	3	3	2.7	0.8	0.29
80.	Problem-solver	4	4	3.4	0.5	0.14
81.	Independent	3	3	3.4	0.7	0.20
82.	Question-driven	3	3	3.2	0.6	0.19
83.	Critical thinking skills	4	4	3.6	0.5	0.12
84.	Idea-oriented	3	3	3.3	0.5	0.16
85.	Kind of a loner and liked to read a lot	3	3	2.7	0.9	0.35
86.	Naiveté – not being aware initially of the dearth of females in my STEM field	3	3	2.5	1.0	0.44
87.	Dealing with stress/workload proactively	3	3	3.0	0.7	0.22
88.	Seeing other women in field give up on their dreams made me more determined to persist	2	2	2.0	0.8	0.44
89.	Seeing other women in my field change who they are to suit the dominant male culture made me determined to succeed and be myself	2	2	2.1	1.0	0.48
90.	Do not want the expense and time needed to retrain in other fields	1	2	2.0	0.8	0.46

Table 4 (continued)

No.	**Round 2 Question 1 – Personal Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
91.	Academic position gives me opportunity to reach out to the larger community and impact them	3	3	2.7	0.8	0.31
92.	Wanted to contribute to my country's socio-economic development and advancement through STEM	2	2	2.4	0.9	0.36
93.	Wanted to help fill job shortage in STEM	2	2	2.0	0.7	0.35
94.	Grew up with five brothers which made me able to navigate a male-dominated field	1	1	1.6	0.9	0.53
95.	Significant work experience from industry	2	2	2.1	1.1	0.50
No.	**Round 2 Question 2 – Social Factors**					
1.	Family members as role-models	3	3	2.7	1.0	0.38
2.	Stable marriage	4	3	2.9	1.1	0.38
3.	Supportive spouse	4	4	3.3	1.0	0.31
4.	Supportive family (parents, siblings, children, etc.)	4	3	3.1	1.0	0.31
5.	Supportive faculty (male and female) at undergraduate and graduate level	3	3	3.0	0.8	0.27
6.	Good and influential teacher(s) and professor(s)	3	3	3.3	0.8	0.25
7.	Supportive female mentor(s)	2	2	2.3	1.0	0.44

Table 4 (continued)

No.	**Round 2 Question 2 – Social Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
8.	Supportive male mentor(s)	3	3	2.8	1.0	0.36
9.	Need to support my family	3	2.5	2.4	1.0	0.41
10.	Timing of child bearing	2	2	2.2	0.9	0.41
11.	Need to provide a stable environment for my children	2	2	2.3	1.0	0.45
12.	Opening of education opportunities for females to enroll in engineering schools in early 1970's	2	2	2.1	1.0	0.47
13.	Defying social norms, particularly the ones in academia	1	2	2.2	1.1	0.49
14.	Positive female role models (in STEM and other fields)	3	2	2.4	1.0	0.41
15.	Positive male role models	3	3	2.9	0.8	0.29
16.	Positive effect of gender roles: Being a woman in a male dominated field – more opportunities for women	3	2.5	2.4	1.0	0.40
17.	Negative effect of gender roles: difficulty in interacting with male faculty members at times	2	2	2.1	0.8	0.38
18.	Networking with other female science-oriented friends	3	2	2.4	0.9	0.39
19.	Ignoring societal expectations	3	3	3.0	0.8	0.27

Table 4 (continued)

No.	**Round 2 Question 2 – Social Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
20.	Mutual respect of department members and or support from colleagues	3	3	2.9	0.9	0.32
21.	Positive interaction with students	3	3	3.3	0.7	0.21
22.	Low incidence of gender-based discrimination	3	3	2.5	1.0	0.41
23.	Supportive friends who encouraged me	3	3	2.9	0.8	0.28
24.	Legal movement towards equality for women in business	2	2	2.1	0.9	0.41
25.	Availability of excellent schools	3	3	2.9	1.0	0.33
26.	Supportive and/or gender neutral/affirmative minded supervisors/bosses	3	3	3.0	0.8	0.25
27.	Work in a professional organization that is highly diverse	3	2	2.4	0.9	0.38
28.	Family position (first born)	2	2	2.2	1.0	0.45
29.	Age at beginning of degree program	2	2	2.3	1.0	0.42
30.	Job experience at beginning of degree program	2	2	2.3	0.9	0.41
31.	Poverty	2	2	1.8	0.8	0.45
32.	Societal respect for higher learning	3	3	2.8	0.9	0.32
33.	Desire to provide alternative role model for my daughters	2	2	2.2	1.1	0.49

Table 4 (continued)

No.	Round 2 Question 2 – Social Factors	Mod	*Mdn*	*M*	*SD*	CV
34.	Desire to "prove" that women are as good as men	2	2	2.2	1.0	0.47
35.	Good support group	3	3	2.6	0.9	0.33
36.	Success encourages more success	3	3	3.0	0.7	0.23
37.	Good daycare options (but none on campus back when I needed it)	3	2	2.3	1.1	0.46
38.	High earning/pay in my STEM field	3	3	2.4	1.0	0.41
39.	Luck	3	3	2.9	0.8	0.27
40.	Industrial applicability of my research area	2	2	2.1	0.9	0.44
41.	Need for improvement in the quality of lives of people and families was perceived by me at an early age	2	2	2.2	0.8	0.38
42.	Career opportunities and job market abound in STEM	3	3	2.7	1.0	0.39
43.	Knowledgeable friends	3	2.5	2.5	0.6	0.26
44.	Society's expectation of a contribution from its members	2	2	2.3	0.7	0.29
45.	Supportive professional organization(s)	2	2	2.6	0.8	0.30
46.	Recognition that "being smart" is "good" by most people	3	3	2.8	0.7	0.24
47.	Age of child/children when I entered academia	1	2	2.1	1.0	0.48

Table 4 (continued)

No.	**Round 2 Question 2 – Social Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
48.	Non-tenure track position was a good fit	1	1.5	1.8	0.9	0.49
49.	Academically competitive brothers and sisters	2	2	1.8	0.8	0.45
50.	Financial aid through government programs allowed me to attend college	1	2	2.1	1.1	0.54
51.	Opportunities for empowerment - High school sports for girls, Girl Scouts	1	2	2.1	1.1	0.53
52.	Women's Rights Movement	3	3	2.6	0.9	0.36
53.	I was raised without much TV/influence from popular culture	2	2	2.1	0.9	0.42
54.	[Determination to go against the tide and prove that the minority can succeed]	2	2	2.3	1.0	0.42
55.	My background (immigrant, first generation to complete graduate education, in me)	1	1.5	2.1	1.2	0.57
56.	Enabling work environment	3	3	2.8	0.8	0.27
57.	Desire to be a role model to my kids and others	3	3	2.6	0.9	0.34
58.	I have been lucky not to encounter the kind of in-your-face discrimination that many women have to put up with	3	2.5	2.4	1.0	0.42
59.	Availability of excellent equipment for research	3	2.5	2.5	0.8	0.33

Table 4 (continued)

No.	**Round 2 Question 2 – Social Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
60.	Culture for research integrated into undergraduate years	3	3	2.6	0.9	0.35
61.	Acceptance and support by male colleagues in my department	3	3	2.8	0.9	0.32
62.	Exposure to unconventional learning experiences (inside and outside the USA)	3	2	2.4	0.9	0.39
No.	**Round 2 Question 3 – Academic/Institutional Factors**					
1.	I felt no gender bias from my academic institution at any level	2	2	2.4	0.8	0.35
2.	Opportunity to serve on boards and committees	3	3	2.9	0.8	0.28
3.	Being a minority representation on committees and boards	2	2	2.1	0.9	0.41
4.	Pressure on institutions to increase gender equity in STEM	3	3	2.7	0.7	0.28
5.	Grants and funds geared towards gender equity in my field	2	2	2.0	0.9	0.42
6.	Unrestricted curriculum that allowed coursework in women's studies as undergrad and grad student	1	1	1.5	0.6	0.40
7.	Small class sizes	3	2	2.2	0.9	0.41

Table 4 (continued)

No.	**Round 2 Question 3 – Academic/Institutional Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
8.	Extensive lab experiences in undergraduate and graduate research opportunities increased my desire to go further in STEM	3	3	2.8	1.0	0.37
9.	Relevant work-study opportunities as undergraduate	3	3	2.6	1.2	0.45
10.	Equity in teaching and research responsibilities on campus	3	3	2.5	0.9	0.37
11.	Equal opportunities for teaching assistant assignment to faculty members	3	2	2.4	0.8	0.34
12.	Equity during the promotion and tenure process	3	3	2.9	0.9	0.31
13.	Equal opportunities for research funding from the institution	3	3	2.9	0.9	0.30
14.	Equal opportunities for departmental or institutional training (including sexual harassment training which was required by all employees)	3	2.5	2.4	0.9	0.36
15.	Institution that was intentional about gender equity (Equity by-laws written down)	2	2	2.4	0.9	0.37

Table 4 (continued)

No.	**Round 2 Question 3 – Academic/Institutional Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
16.	Awareness of institutional policies and sexual harassment training (this from industry, not academia)	2	2	2.1	0.9	0.43
17.	Flexible schedule	3	3	3.2	0.7	0.23
18.	Respect for individual strengths among colleagues	3	3	3.1	0.8	0.27
19.	Senior faculty/department head supportive of junior colleagues' needs	3	3	3.1	0.7	0.24
20.	Freedom to determine individual research priorities and service roles	4	4	3.4	0.8	0.23
21.	Networking and collaboration opportunities	3	3	3.1	0.7	0.21
22.	Encouraging and supportive teacher's and faculty	3	3	3.0	0.8	0.25
23.	Opportunity to be a role model	3	3	2.8	0.9	0.33
24.	Institutional expectations of success fit my expectations of performance	3	3	3.1	0.7	0.24
25.	High expectation of academic excellence in my department	3	3	2.9	0.8	0.26
26.	Institutional mentoring opportunities	3	2	2.3	0.8	0.35

Table 4 (continued)

No.	**Round 2 Question 3 – Academic/Institutional Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
27.	The institution had a neutral or laissez fair approach to faculty development	2	2	2.3	0.9	0.38
28.	An ill-defined part-time position that allowed me considerable freedom	1	1	1.6	0.8	0.49
29.	A campus environment that was somewhat ready for change	2	2	2.3	0.9	0.38
30.	Small Ph.D. program	2	2	1.8	0.8	0.45
31.	Availability of financial support (grants, scholarships, assistantships, and fellowships)	3	3	2.9	1.0	0.33
32.	Flexible Ph.D. track	2	2	2.2	1.0	0.47
33.	Institution moved students who entered the undergraduate program through it as a cohort, which generated a sense of camaraderie and provided a supportive environment in my studies and outside of classroom	2	2	2.2	1.0	0.48
34.	Presence of female faculty in undergraduate/graduate institution	1	2	2.1	1.1	0.52
35.	Institution encouraged students to give talks and engage with the professional community early in our academic careers	3	3	2.5	1.1	0.46

Table 4 (continued)

No.	**Round 2 Question 3 – Academic/Institutional Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
36.	Undergraduate faculty expected women to perform as well as men	3	3	2.9	1.0	0.32
37.	Exposure to and interaction with women in STEM in various ways during undergraduate/graduate programs	3	2	2.2	1.0	0.46
38.	Graduate school participation in women Ph.D. and MD student group.	2	2	2.1	1.1	0.51
39.	Faculty/advisor/supervisor was sexist and racist, which made me all the more determined to succeed	1	1	1.8	1.1	0.60
40.	University allowed me to submit my first R01 without having an appointment anywhere	1	1	1.2	0.6	0.48
41.	Positive feedback from students	3	3	3.0	0.8	0.25
42.	Faculty/advisor/supervisor gender sensitive and supportive	3	3	2.8	1.0	0.35
43.	Great collegiality in my department and institution	3	3	2.9	0.8	0.28
44.	Positive feedback from colleagues	3	3	3.0	0.6	0.21
45.	Presence of other female professionals in my department and institution	3	2	2.3	1.0	0.42

Table 4 (continued)

No.	**Round 2 Question 3 – Academic/Institutional Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
46.	Opportunity to do top-quality research (infrastructure present)	3	3	2.7	0.9	0.32
47.	Protection from excess service obligations as an untenured faculty	2	2	2.4	1.0	0.42
48.	Lowered teaching load as an untenured faculty	3	2	2.3	1.1	0.46
49.	Institutional commitment to increasing female faculty presence and success on campus	3	3	2.7	1.0	0.38
50.	Institutional commitment to assisting with dual-career situations	1	2	2.0	1.0	0.48
51.	Institutional support for request for extension of tenure clock for child-birth	2	2	2.1	1.0	0.49
52.	My current university employer actively sought to retain me when I received a competing job offer	1	1	1.8	1.0	0.58
53.	Programs/events that exposed me to STEM and STEM professionals in elementary and or high school made a lasting impact	1	2	2.1	1.1	0.51
54.	ADVANCE program	1	2	2.1	1.0	0.50
55.	WISE group	1	2	1.8	1.0	0.54
56.	Departmental incentives for funded research	1	2	2.2	1.1	0.50

Table 4 (continued)

No.	**Round 2 Question 3 – Academic/Institutional Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
57.	Career advancement clearly documented and achievable	3	3	2.6	1.0	0.39
58.	Faculty voice held authority	3	2.5	2.4	0.9	0.39
59.	Clear system for rewards and achievements (e.g., toward tenure)	3	3	2.9	0.9	0.32
60.	Networking and open communication with administration	2	2	2.4	0.9	0.38
61.	Support in graduate school for my research	3	3	3.1	0.8	0.25
62.	Support in graduate school encouraging my career path	3	3	2.9	0.7	0.26
63.	Institutional meritocracy -- good work is what matters	3	3	3.5	1.4	0.39
64.	Willingness of academic institution to consider alternate career pathways	2	2	2.2	1.0	0.47
65.	Expectation of mutual respect on all levels in my department/institution	3	3	2.7	0.9	0.32
66.	Departmental coffee pot gathering every day	1	1	1.5	0.7	0.48
67.	Equal opportunities for continuing education and professional development	3	3	2.5	0.8	0.34
68.	Support for travel to meetings and conferences	3	3	2.7	0.9	0.34

Table 4 (continued)

No.	**Round 2 Question 3 – Academic/Institutional Factors**	Mod	*Mdn*	*M*	*SD*	CV
69.	Well-respected colleagues who are collegial in attitude	3	3	3.0	0.9	0.30
70.	Tacit assumption that being a professor with a lab was the epitome of being a scientist	2	2	2.3	0.9	0.38
71.	Opportunity to negotiate terms of employment, work, and resource distribution	2	2	2.2	1.0	0.43
72.	Great advising office	2	2	1.7	0.7	0.40
73.	Faculty/supervisors (male/female) encouraged mentored both male and female students to succeed in STEM	3	3	2.7	1.1	0.40
74.	Male mentors/professors who did not have a gender bias (because they had successful wives or daughters)	3	3	3.0	0.9	0.31
75.	Department had a culture of teaching excellence	3	3	2.9	0.8	0.29
76.	As a student, willingness by faculty to accept (at least in part) female students	3	3	3.1	0.7	0.24
77.	Promotion tenure committee selected for each faculty member, and having another female on that committee	1	2	2.2	1.1	0.52

Table 4 (continued)

No.	**Round 2 Question 3 – Academic/Institutional Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
78.	Well developed new faculty development program	1	2	1.9	0.9	0.48
79.	Involvement with student organization	2	2	1.9	0.9	0.44
80.	Faculty position is flexible and promotes good work family balance	3	3	2.8	1.0	0.35
81.	Incorporation of workshops/round tables regarding best teaching practices	2	2	2.1	0.9	0.41
82.	Inclusion on institutional, local, regional, and or national agencies' review panels	3	3	3.0	0.9	0.30
83.	Student-organized discussion groups/seminar series	2	2	2.1	0.9	0.44
84.	International opportunities (courses, workshops, post-doc)	1	2	2.4	1.1	0.48
85.	Equal opportunities for funding projects	3	3	3.0	0.8	0.27
86.	Working on high profile events in my field (e.g., planning research conferences)	3	3	2.8	1.0	0.35

Round 3 Results

Round 3 was intended to validate the factors participants had given and indicated their agreement for Round 1 and 2 factors and to establish a final consensus of those factors. An Email containing a link to the Round 3 questionnaire and an attachment showing the frequencies and percentages of all the responses to the questions in Round 2 was sent to the 42 of the 43 participants who had responded to Round 2. See Appendix H for a copy of the Round 3 directions email. This was because one of the participants had emailed the researcher to indicate that they could no longer participate. Additionally, since the Round 2 survey was conducted completely online, it was impossible to know which individual participants had completed it. Participants were given the group means and frequencies for the Round 2 to compare with their own answers and modify items they wished to in light of the group response. However, because it was not possible to determine individual responses online, the researcher was unable to send individual responses back to participants.

The Round 3 questionnaire contained the same items as Round 2. Participants were directed to compare their own responses in Round 2 with the group response and confirm or change their responses in light of the group response. The mode, median, mean, standard deviation, and coefficient of variation were calculated for each of the Round 3 responses. All items with a mean score of 3 or higher and a coefficient of variation less than 0.5 were included in the final list of factors. Table 5 below is a summary of Round 3 responses.

Table 5

Summary of Round 3 Responses

No.	**Round 3 Question 1 – Personal Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
1.	Stubbornness/contrariness	4	3	3.1	0.9	0.30
2.	Natural inclination for STEM	4	4	3.5	0.7	0.21
3.	Tom-boy – have better relations with males and enjoyed hobbies and pastimes traditionally considered masculine	3	3	2.5	0.9	0.34
4.	Enjoyment and/or enthusiasm for work (STEM) (I am never bored)	4	4	3.6	0.5	0.15
5.	Determination in the face of challenges/adversity	4	4	3.6	0.5	0.15
6.	Self-confidence	4	3	3.2	0.8	0.24
7.	Ability to work independently	4	4	3.6	0.5	0.15
8.	Acceptance of being different	3	3	3.3	0.8	0.23
9.	High expectation of myself to succeed	4	4	3.6	0.5	0.13
10.	Willingness to sacrifice self to get a job done	4	4	3.5	0.6	0.16
11.	Intrinsic motivation (personal drive in the absence of external support)	4	4	3.7	0.5	0.13
12.	Curiosity	4	4	3.6	0.5	0.14
13.	Efficiency	4	3	3.3	0.7	0.20
14.	Ability to multi-task	4	3.5	3.3	0.8	0.23
15.	High intelligence	3	3	3.2	0.5	0.16

Table 5 (continued)

No.	**Round 3 Question 1 – Personal Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
16.	Flexibility (ability to adapt to diverse situations)	4	4	3.6	0.6	0.16
17.	Kindness	3	3	2.7	0.8	0.31
18.	Exercise – physical and as well as mental exercises to get work done and keep my mind alert	3	3	2.7	0.7	0.24
19.	Ability to keep things in perspective	3	3	3.3	0.6	0.19
20.	Goal-oriented	4	3	3.4	0.6	0.19
21.	Strong sense of purpose	4	3	3.3	0.7	0.20
22.	Strong time-management skills	4	3	3.3	0.7	0.22
23.	Focused	4	3.5	3.4	0.6	0.19
24.	Recognized my STEM field as a great opportunity for a satisfying profession/job	3	3	3.1	0.8	0.26
25.	Wanted to do and be something other than be a mom	3	2	2.4	1.0	0.41
26.	Self-efficacy (belief in self ability to accomplish any task)	4	3	3.2	0.9	0.29
27.	Desire, commitment to, and passion to learn	4	4	3.6	0.6	0.15
28.	Persistence (ability to stay focused and strategic over time)	4	4	3.7	0.5	0.14

Table 5 (continued)

No.	**Round 3 Question 1 – Personal Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
29.	Positive attitude - ability to see beyond current crisis	3	3	3.3	0.6	0.19
30.	Resource mobilization and improvisation skills	3	3	3.1	0.7	0.23
31.	Ambition	3	3	2.9	0.7	0.24
32.	Competence	4	3	3.4	0.6	0.18
33.	Good organizational skills	3	3	3.4	0.6	0.17
34.	Competitiveness	3	3	2.9	0.8	0.27
35.	Good interpersonal skills/ability to collaborate	4	4	3.4	0.7	0.20
36.	Hard worker	4	4	3.7	0.5	0.14
37.	Tenacity (moving forward despite "it can't be done" or "we're not interested in what you do" because I believe it is important)	4	4	4.2	3.2	0.77
38.	Risk taker	3	3	3.0	0.8	0.28
39.	The thrill of being a pioneer or trailblazer in my STEM field	2	2	2.6	0.8	0.31
40.	Optimistic	3	3	3.1	0.8	0.27
41.	Belief that I could make a difference for other female scientists like myself	3	3	2.6	0.9	0.34
42.	Good personal work ethic	4	3.5	3.4	0.8	0.22

Table 5 (continued)

No.	**Round 3 Question 1 – Personal Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
43.	Rebellious nature	2	2	2.5	0.9	0.36
44.	A sense of humor	3	3	3.2	0.8	0.24
45.	Skeptical about everything	3	3	2.7	0.7	0.25
46.	Great intuition (sense of right or production choice in a given situation)	3	3	2.9	0.7	0.24
47.	Type A personality	3	3	2.9	0.8	0.28
48.	Maintain distance from students - they tend to make female faculty into surrogate mothers or girl friends	2	2	1.9	0.9	0.46
49.	Ability to tolerate frustration	3	3	3.1	0.6	0.21
50.	Creativity within STEM	3	3	3.0	0.6	0.21
51.	Emotional stability	3	3	3.2	0.6	0.20
52.	Mathematics-efficacy (believe that I am good at Math and can excel in it)	3	3	3.0	0.8	0.27
53.	Science-Efficacy (believe that I am good in science and can excel in it)	3	3	3.4	0.5	0.15
54.	Pride and gratification in knowing that my accomplishments in STEM is making a difference	3	3	2.8	0.9	0.31
55.	Appreciate the prestige associated with my profession	3	3	2.6	0.9	0.35

Table 5 (continued)

No.	**Round 3 Question 1 – Personal Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
56.	Good communication skills (written and oral presentation)	3	3	3.4	0.6	0.16
57.	Don't mind being alone in the middle of a group	3	3	2.8	0.8	0.29
58.	High personal self-esteem	3	3	2.8	0.9	0.30
59.	Capacity for working long hours	3	3	3.3	0.6	0.19
60.	Willingness to take on new challenges	3	3	3.5	0.5	0.15
61.	Willingness to take credit and responsibility for my actions	3	3	3.3	0.6	0.18
62.	Ability to shake off minor insults, resistance, biases, or problems and move on	3	3	3.3	0.6	0.17
63.	Personal integrity	4	4	3.5	0.6	0.16
64.	Technical grasp of broad issues	3	3	3.3	0.6	0.17
65.	Ability to work with people on multiple levels	3	3	3.4	0.5	0.16
66.	Love to figure things out	4	4	3.6	0.5	0.14
67.	Logical thinker	3	3	3.4	0.5	0.15
68.	Good writer	3	3	3.3	0.6	0.17
69.	Strong willed	4	3	3.2	0.9	0.27
70.	Patience- recognition that it is a "long game"	3	3	3.2	0.7	0.22
71.	At peace with decisions	3	3	2.9	0.8	0.26

Table 5 (continued)

No.	**Round 3 Question 1 – Personal Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
72.	Persistent feeling of inadequacy (sure, I accomplished this, but it was too easy because I am a big fish in a small pond)	2	2	2.2	0.8	0.38
73.	Enjoy making a difference in students' lives	3	3	3.3	0.7	0.20
74.	Passion for passing on knowledge and skills	3	3	3.4	0.6	0.19
75.	Need to have a steady paycheck	3	3	2.8	1.0	0.34
76.	Talent	3	3	2.9	0.7	0.22
77.	Refusal to allow myself to fail	3	3	2.9	0.7	0.24
78.	I don't think other fields have as much value to society	2	2	1.9	0.9	0.50
79.	Need to keep up in my STEM field	3	3	2.7	0.7	0.24
80.	Problem-solver	3	3	3.4	0.5	0.15
81.	Independent	3	3	3.4	0.6	0.16
82.	Question-driven	3	3	3.2	0.6	0.18
83.	Critical thinking skills	4	4	3.6	0.5	0.14
84.	Idea-oriented	3	3	3.3	0.6	0.19
85.	Kind of a loner and liked to read a lot	3	3	2.7	0.8	0.31
86.	Naiveté – not being aware initially of the dearth of females in my STEM field	2	2.5	2.5	1.0	0.39
87.	Dealing with stress/workload proactively	3	3	3.0	0.5	0.18

Table 5 (continued)

No.	**Round 3 Question 1 – Personal Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
88.	Seeing other women in field give up on their dreams made me more determined to persist	2	2	2.0	0.8	0.42
89.	Seeing other women in my field change who they are to suit the dominant male culture made me determined to succeed and be myself	2	2	2.1	1.0	0.46
90.	Do not want the expense and time needed to retrain in other fields	2	2	2.0	0.8	0.42
91.	Academic position gives me opportunity to reach out to the larger community and impact them	3	3	2.7	0.8	0.28
92.	Wanted to contribute to my country's socio-economic development and advancement through STEM	2	2	2.4	1.0	0.39
93.	Wanted to help fill job shortage in STEM	2	2	2.0	0.9	0.43
94.	Grew up with five brothers which made me able to navigate a male-dominated field	1	1	1.6	0.8	0.51
95.	Significant work experience from industry	1	2	2.1	1.1	0.53
No.	**Round 3 Question 2 – Social Factors**					
1.	Family members as role-models	3	3	2.8	1.0	0.35
2.	Stable marriage	4	3	3.1	1.0	0.32

Table 5 (continued)

No.	**Round 3 Question 2 – Social Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
3.	Supportive spouse	4	4	3.5	0.9	0.25
4.	Supportive family (parents, siblings, children, etc.)	4	4	3.4	0.8	0.24
5.	Supportive faculty (male and female) at undergraduate and graduate level	3	3	3.1	0.8	0.25
6.	Good and influential teacher(s) and professor(s)	3	3	3.4	0.6	0.16
7.	Supportive female mentor(s)	2	2	2.4	1.0	0.43
8.	Supportive male mentor(s)	3	3	2.9	0.7	0.25
9.	Need to support my family	3	3	2.6	1.0	0.40
10.	Timing of child bearing	2	2	2.4	1.0	0.44
11.	Need to provide a stable environment for my children	3	2	2.3	1.0	0.42
12.	Opening of education opportunities for females to enroll in engineering schools in early 1970's	2	2	2.3	1.0	0.43
13.	Defying social norms, particularly the ones in academia	2	2	2.6	1.0	0.38
14.	Positive female role models (in STEM and other fields)	3	3	2.6	0.9	0.37
15.	Positive male role models	3	3	2.8	0.9	0.31

Table 5 (continued)

No.	**Round 3 Question 2 – Social Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
16.	Positive effect of gender roles: Being a woman in a male dominated field – more opportunities for women	3	3	2.6	0.8	0.30
17.	Negative effect of gender roles: difficulty in interacting with male faculty members at times	2	2	2.2	0.8	0.36
18.	Networking with other female science-oriented friends	3	2.5	2.5	0.8	0.33
19.	Ignoring societal expectations	3	3	2.9	0.8	0.28
20.	Mutual respect of department members and or support from colleagues	3	3	2.9	0.9	0.30
21.	Positive interaction with students	3	3	3.2	0.6	0.18
22.	Low incidence of gender-based discrimination	3	3	2.6	0.9	0.34
23.	Supportive friends who encouraged me	3	3	2.8	0.8	0.27
24.	Legal movement towards equality for women in business	2	2	2.4	0.8	0.34
25.	Availability of excellent schools	3	3	2.9	0.8	0.28
26.	Supportive and/or gender neutral/affirmative minded supervisors/bosses	3	3	3.0	0.8	0.26

Table 5 (continued)

No.	**Round 3 Question 2 – Social Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
27.	Work in a professional organization that is highly diverse	3	2.5	2.5	0.8	0.34
28.	Family position (first born)	2	2	2.4	1.1	0.45
29.	Age at beginning of degree program	2	2	2.3	1.0	0.43
30.	Job Experience at beginning of degree program	2	2	2.3	1.0	0.43
31.	Poverty	2	2	1.8	0.9	0.50
32.	Societal respect for higher learning	3	3	2.9	0.7	0.26
33.	Desire to provide alternative role model for my daughters	2	2	2.0	0.9	0.46
34.	Desire to "prove" that women are as good as men	2	2	2.3	1.0	0.45
35.	Good support group	3	3	2.7	0.7	0.28
36.	Success encourages more success	3	3	2.9	0.6	0.20
37.	Good daycare options (but none on campus back when I needed it)	3	2	2.2	1.0	0.47
38.	High earning/pay in my STEM field	3	3	2.5	0.9	0.38
39.	Luck	3	3	2.8	0.7	0.26
40.	Industrial applicability of my research area	2	2	2.0	0.9	0.43

Table 5 (continued)

No.	**Round 3 Question 2 – Social Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
41.	Need for improvement in the quality of lives of people and families was perceived by me at an early age	2	2	2.3	0.9	0.39
42.	Career opportunities and job market abound in STEM	3	3	2.6	1.0	0.36
43.	Knowledgeable friends	3	3	2.5	0.8	0.32
44.	Society's expectation of a contribution from its members	2	2	2.4	0.8	0.34
45.	Supportive professional organization(s)	3	2.5	2.5	0.9	0.36
46.	Recognition that "being smart" is "good" by most people	3	3	2.8	0.8	0.27
47.	Age of child/children when I entered academia	2	2	2.4	1.1	0.46
48.	Non-tenure track position was a good fit	1	1	1.7	1.0	0.57
49.	Academically competitive brothers and sisters	1	2	1.8	0.9	0.51
50.	Financial aid through government programs allowed me to attend college	1	2	2.2	1.2	0.53
51.	Opportunities for empowerment - High school sports for girls, Girl Scouts	3	3	2.4	1.0	0.41

Table 5 (continued)

No.	**Round 3 Question 2 – Social Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
52.	Women's Rights Movement	3	3	2.6	1.0	0.37
53.	I was raised without much TV/influence from popular culture	2	2	2.2	0.9	0.39
54.	[Determination to go against the tide and prove that the minority can succeed]	2	2	2.3	1.0	0.46
55.	My background (immigrant, first generation to complete graduate education, in me)	1	1.5	2.0	1.2	0.59
56.	Enabling work environment	3	3	2.8	0.8	0.30
57.	Desire to be a role model to my kids and others	3	3	2.5	1.1	0.42
58.	I have been lucky not to encounter the kind of in-your-face discrimination that many women have to put up with	3	3	2.7	1.1	0.40
59.	Availability of excellent equipment for research	3	3	2.6	0.8	0.33
60.	Culture for research integrated into undergraduate years	3	3	2.8	0.9	0.32
61.	Acceptance and support by male colleagues in my department	3	3	2.9	0.9	0.31
62.	Exposure to unconventional learning experiences (inside and outside the USA)	3	2.5	2.5	1.0	0.39

Table 5 (continued)

No.	**Round 3 Question 3 – Academic/Institutional Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
1.	I felt no gender bias from my academic institution at any level	2	2	2.2	0.8	0.37
2.	Opportunity to serve on boards and committees	3	3	2.8	0.9	0.32
3.	Being a minority representation on committees and boards	2	2	2.2	0.9	0.40
4.	Pressure on institutions to increase gender equity in STEM	3	3	2.4	0.9	0.38
5.	Grants and funds geared towards gender equity in my field	2	2	2.1	0.9	0.42
6.	Unrestricted curriculum that allowed coursework in women's studies as undergrad and grad student	1	1	1.7	0.9	0.54
7.	Small class sizes	3	3	2.5	0.9	0.37
8.	Extensive lab experiences in undergraduate and graduate research opportunities increased my desire to go further in STEM	3	3	2.8	0.9	0.31
9.	Relevant work-study opportunities as undergraduate	2	2	2.5	1.1	0.46

Table 5 (continued)

No.	Round 3 Question 3 – Academic/Institutional Factors	Mod	*Mdn*	*M*	*SD*	CV
10.	Equity in teaching and research responsibilities on campus	3	3	2.5	0.9	0.36
11.	Equal opportunities for teaching assistant assignment to faculty members	3	3	2.5	0.9	0.36
12.	Equity during the promotion and tenure process	3	3	2.8	0.8	0.30
13.	Equal opportunities for research funding from the institution	3	3	2.7	0.9	0.32
14.	Equal opportunities for departmental or institutional training (including sexual harassment training which was required by all employees)	3	2	2.3	0.9	0.37
15.	Institution that was intentional about gender equity (Equity by-laws written down)	2	2	2.3	0.9	0.40
16.	Awareness of institutional policies and sexual harassment training (this from industry, not academia)	3	2	2.1	0.9	0.43
17.	Flexible schedule	3	3	3.3	0.8	0.24
18.	Respect for individual strengths among colleagues	3	3	3.0	0.5	0.18

Table 5 (continued)

No.	**Round 3 Question 3 – Academic/Institutional Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
19.	Senior faculty/department head supportive of junior colleagues' needs	3	3	3.0	0.9	0.29
20.	Freedom to determine individual research priorities and service roles	4	4	3.4	0.7	0.19
21.	Networking and collaboration opportunities	3	4	3.7	0.7	0.20
22.	Encouraging and supportive teacher's and faculty	3	3	3.1	0.6	0.20
23.	Opportunity to be a role model	3	3	2.6	1.0	0.39
24.	Institutional expectations of success fit my expectations of performance	3	3	2.9	0.8	0.28
25.	High expectation of academic excellence in my department	3	3	3.0	0.8	0.28
26.	Institutional mentoring opportunities	2	2	2.3	0.8	0.36
27.	The institution had a neutral or laissez fair approach to faculty development	2	2	2.6	0.8	0.32
28.	An ill-defined part-time position that allowed me considerable freedom	1	1	1.5	0.7	0.49
29.	A campus environment that was somewhat ready for change	2	2	2.3	1.0	0.42
30.	Small PhD program	2	2	1.9	0.8	0.43

Table 5 (continued)

No.	**Round 3 Question 3 – Academic/Institutional Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
31.	Availability of financial support (grants, scholarships, assistantships, and fellowships)	3	3	3.1	1.0	0.31
32.	Flexible PhD track	1	2	2.1	1.1	0.51
33.	Institution moved students who entered the undergraduate program through it as a cohort, which generated a sense of camaraderie and provided a supportive environment in my studies and outside of classroom	1	2	2.2	1.1	0.49
34.	Presence of female faculty in undergraduate/graduate institution	1	2	2.1	1.1	0.50
35.	Institution encouraged students to give talks and engage with the professional community early in our academic careers	3	3	2.6	1.1	0.41
36.	Undergraduate faculty expected women to perform as well as men	3	3	3.2	0.8	0.27
37.	Exposure to and interaction with women in STEM in various ways during undergraduate/graduate programs	3	2	2.5	1.1	0.46
38.	Graduate school participation in women PhD and MD student group	1	2	2.1	1.1	0.53

Table 5 (continued)

No.	**Round 3 Question 3 – Academic/Institutional Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
39.	Faculty/advisor/supervisor was sexist and racist, which made me all the more determined to succeed	1	1	1.5	0.8	0.53
40.	University allowed me to submit my first R01 without having an appointment anywhere	1	1	1.3	0.8	0.57
41.	Positive feedback from students	3	3	2.9	1.0	0.34
42.	Faculty/advisor/supervisor, gender sensitive and supportive	3	3	2.9	0.8	0.26
43.	Great collegiality in my department and institution	3	3	2.8	1.1	0.40
44.	Positive feedback from colleagues	3	3	2.9	0.8	0.28
45.	Presence of other female professionals in my department and institution	2	2	2.4	1.0	0.41
46.	Opportunity to do top-quality research (infrastructure present)	3	3	2.8	0.9	0.33
47.	Protection from excess service obligations as an untenured faculty	3	2.5	2.4	1.1	0.44
48.	Lowered teaching load as an untenured faculty	2	2	2.3	1.0	0.46

Table 5 (continued)

No.	**Round 3 Question 3 – Academic/Institutional Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
49.	Institutional commitment to increasing female faculty presence and success on campus	3	3	2.5	0.9	0.37
50.	Institutional commitment to assisting with dual-career situations	1	2	2.2	1.1	0.50
51.	Institutional support for request for extension of tenure clock for child-birth	1	2	1.9	1.0	0.53
52.	My current university employer actively sought to retain me when I received a competing job offer	1	1	1.7	0.9	0.52
53.	Programs/events that exposed me to STEM and STEM professionals in elementary and or high school made a lasting impact	2	2	2.2	0.9	0.42
54.	ADVANCE program	2	2	2.1	1.0	0.48
55.	WISE group	1	2	1.9	1.0	0.52
56.	Departmental incentives for funded research	3	2	2.3	0.9	0.40
57.	Career advancement clearly documented and achievable	3	3	2.7	1.0	0.36
58.	Faculty voice held authority	3	3	2.4	0.9	0.39

Table 5 (continued)

No.	**Round 3 Question 3 – Academic/Institutional Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
59.	Clear system for rewards and achievements (e.g., toward tenure)	3	3	2.7	0.9	0.32
60.	Networking and open communication with administration	2	2	2.6	0.9	0.37
61.	Support in graduate school for my research	3	3	3.1	0.9	0.28
62.	Support in graduate school encouraging my career path	3	3	3.1	0.8	0.26
63.	Institutional meritocracy -- good work is what matters	3	3	2.9	0.9	0.31
64.	Willingness of academic institution to consider alternate career pathways	2	2	2.2	1.0	0.46
65.	Expectation of mutual respect on all levels in my department/institution	3	3	2.7	0.9	0.35
66.	Departmental coffee pot gathering every day	1	1.5	1.6	0.8	0.46
67.	Equal opportunities for continuing education and professional development	2	2	2.4	0.9	0.38
68.	Support for travel to meetings and conferences	3	3	2.5	0.9	0.38
69.	Well-respected colleagues who are collegial in attitude	3	3	3.0	0.8	0.26

Table 5 (continued)

No.	**Round 3 Question 3 – Academic/Institutional Factors**	**Mod**	***Mdn***	***M***	***SD***	**CV**
70.	Tacit assumption that being a professor with a lab was the epitome of being a scientist	2	2	2.4	0.9	0.38
71.	Opportunity to negotiate terms of employment, work, and resource distribution	2	2	2.1	0.8	0.39
72.	Great advising office	2	2	2.0	0.9	0.45
73.	Faculty/supervisors (male/female) encouraged mentored both male and female students to succeed in STEM	3	3	2.8	0.8	0.30
74.	Male mentors/professors who did not have a gender bias (because they had successful wives or daughters)	3	3	2.7	1.0	0.35
75.	Department had a culture of teaching excellence	3	3	2.7	0.9	0.32
76.	As a student, willingness by faculty to accept (at least in part) female students	3	3	3.1	0.8	0.27
77.	Promotion tenure committee selected for each faculty member, and having another female on that committee	3	2	2.3	1.0	0.44
78.	Well developed new faculty development program	2	2	2.1	1.0	0.45

Table 5 (continued)

No.	Round 3 Question 3 – Academic/Institutional Factors	Mod	*Mdn*	*M*	*SD*	CV
79.	Involvement with student organization	2	2	2.0	0.9	0.44
80.	Faculty position is flexible and promotes good work family balance	3	3	2.8	0.9	0.33
81.	Incorporation of workshops/round tables regarding best teaching practices	3	2	2.3	0.9	0.38
82.	Inclusion on institutional, local, regional, and or national agencies' review panels	3	3	3.0	0.9	0.31
83.	Student-organized discussion groups/seminar series	2	2	2.1	0.8	0.40
84.	International opportunities (courses, workshops, post-doc)	1	2	2.1	1.0	0.46
85.	Equal opportunities for funding projects	3	3	2.9	0.8	0.28
86.	Working on high profile events in my field (e.g., planning research conferences)	3	3	2.7	1.0	0.38

Round 3 Summary

Some participants changed their responses to several items in Round 3 as indicated in the variation in participants' cumulative responses in Round 2 and Round 3. For Question 1, participants changed their responses on 13 Items – 8, 14, 23, 25, 35, 39, 42, 56, 65, 67, 69, 80, and 86. For example on Item 8, "Acceptance of being different",

18 (47%) participants said they strongly agreed in Round 2, but 16 (43%) participants strongly agreed in Round 3. At the same time 13 (34%) participants agreed in Round 2, and 16 (43%) agreed in Round 3. Furthermore, even though seven (18%) participants disagreed in Round 2 compared to five (13%) participants in Round 3, none of the participants indicated they strongly disagreed in Round 2, but one did in Round 3. Similarly, for Item 25 that stated: "Wanted to do and be something other than be a mom", eight (21%) participants strongly agreed and 11 (29%) participants agreed in Round 2. However, six (16%) participants strongly agreed and 12 (32%) participants agreed in Round 3. On the same item, 14 (37%) participants disagreed, while five (13%) participants strongly disagreed in Round 2 compared to 12 (32%) participants who disagreed and seven (18%) participants who strongly disagreed in Round 3.

In addition, on Question 2, participants varied their responses on 13 items – 4, 9, 14, 16, 18, 27, 43, 45, 48, 51, 58, 59, and 62. Only one of the changes on the items in this question was in the negative direction – Item 48 – Non-tenure track position was a good fit. Two (5%) participants strongly agreed to Item 48 in Round 2, six (16%) participants agreed, six (16%) participants disagreed, and 13 (34%) participants strongly disagreed. On the other hand, 17 (45%) participants strongly agreed to the same item in Round 3, four (11%) participants agreed, zero (0%) disagreed, while 20 (53%) participants strongly disagreed.

Finally, on Question 3, participants varied their responses to eight items – 7, 9, 11, 14, 21, 47, 58, 66, and 67. Item 9, "Relevant work-study opportunities as undergraduate", was one item that had its level of agreement change significantly from Round 2 to Round 3. In Round 2, 10 (26%) participants strongly agreed, 11 (29%)

participants agreed to the item, while nine (25%) participants strongly agreed and eight (22%) participants agreed in Round 3. Conversely, seven (18%) participants disagreed and 10 (26%) strongly disagreed in Round 2, while 10 (28%) disagreed and nine (25%) participants strongly disagreed in Round 3.

Consensus

According to Yang (2003), a coefficient of variation of 0.5 or lower indicates a strong agreement on a Likert scale item. The majority of the answers to all three questions received strong consensus among participants. This means that participants were united in their agreement or disagreement of them as being important to their success and persistence. The mean coefficient of variation for Question 1 was 0.25 in Round 2 and 0.24 in Round 3, showing that participants did not make any significant changes to their answers in Round 2. Similarly, the mean coefficient of variation for Questions 2 changed slightly from 0.38 to 0.36 in Round 2 and 3, while the mean remained the same for Question 3 in both Round 2 and 3 at 0.38.

In Round 3, participants had greater consensus on the items in Question 1 – personal factors, than Questions 2 and 3. Ninety-three (98%) of the responses in Question 1 had coefficient of variation equal to or less than 0.50, while 41 (92%) of the items in Question 2 and 78 (91%) of the items in Question 3 had coefficients of variation less than 0.50. See Tables 6, 7, and 8 for a distribution of the coefficient of variation for all items.

Table 6

Distribution of Coefficients of Variation for Question 1

Range	*N*	**%**
0.11 - 0.15	16	17
0.16 - 0.20	27	28
0.21 - 0.25	18	19
0.26 - 0.30	13	14
0.31 - 0.35	8	8
0.36 - 0.40	4	4
0.41 - 0.45	4	4
0.46 - 0.50	3	3
0.51 - 0.55	2	2

Table 7

Distribution of Coefficients of Variation for Question 2

Range	*N*	**%**
0.11 - 0.15	0	0
0.16 - 0.20	2	4
0.21 - 0.25	0	0
0.26 - 0.30	10	22
0.31 - 0.35	9	20
0.36 - 0.40	8	18

Table 7 (continued)

Range	***N***	**%**
0.41 - 0.45	7	16
0.46 - 0.50	5	11
0.51 - 0.55	2	4
0.56 - 0.60	2	4

Table 8

Distribution of Coefficients of Variation for Question 3

Range	*N*	%
0.11 - 0.15	0	0
0.16 - 0.20	4	5
0.21 - 0.25	1	1
0.26 - 0.30	13	15
0.31 - 0.35	14	16
0.36 - 0.40	23	27
0.41 - 0.45	12	14
0.46 - 0.50	11	13
0.51 - 0.55	7	8
0.56 - 0.60	1	1

Results

The final lists of factors according to participants' responses are those whose mean score in Round 3 was 3 or higher. The initial three factors, personal, social, academic/institutional, were selected from literature. These have been reported among the reasons why females are less likely than their male counterparts to succeed in STEM endeavors. When participants submitted their answers for Round 1, a panel of three female faculty in STEM who do not teach in a DocSTEM institution were contacted for their assistance in analyzing the data. They helped in categorizing Question 4, the 'other' option, to see if any new categories emerged. It was discovered that no new broad category emerged since the factors given for Question 4 could be placed under the original three categories provided. Even though this panel also summarized the factors in Questions 1, 2, and 3 into broad categories, it was decided that all the individual narratives would be included in the subsequent rounds, since many of them were unique to the individuals who provided them. This would afford the group an opportunity to see all the factors others had given, so they could show their agreement or disagreement to them. At the end of Round 3, two of the three panel members assisted the researcher in sorting and categorizing the consensus list as shown in Table 9.

Table 9

Round 3-Consensus List of Factors

Question 1 – Personal Factors			
Factors	**Category Mean**	**Descriptors**	**M**
Personality Traits	3.4	Stubbornness/contrariness	3.1

Table 9 (Continued)

Question 1 – Personal Factors			
Factors	**Category Mean**	**Descriptors**	**M**
Personality Traits	3.4	Ability to multi-task	3.3
		Flexibility (ability to adapt to diverse situations)	3.6
		Resource mobilization and improvisation skills (resourceful)	3.1
		Good interpersonal skills/ability to collaborate	3.4
		Willingness to sacrifice self to get a job done	3.5
		Curiosity	3.6
		Hard worker	3.7
		Risk taker	3.0
		Strong willed	3.2
		Problem-solver	3.4
		Independent	3.6
		Question-driven	3.4
Self-Efficacy in STEM	3.3	Self-efficacy (belief in self ability to accomplish any task)	3.2
		Natural inclination for STEM	3.5
		Creativity within STEM	3.0

Table 9 (Continued)

Question 1 – Personal Factors			
Factors	**Category Mean**	**Descriptors**	**M**
Self-Efficacy in STEM	3.3	Mathematics-efficacy (believe that I am good at math and can excel in it)	3.0
		Science-efficacy (believe that I am good in science and can excel in it)	3.4
		Technical grasp of broad issues	3.3
		Critical thinking skills	3.6
		Idea oriented	3.3
Positive Mental Attitude	3.3	Enjoyment and/or enthusiasm for work (STEM) (I am never bored)	3.6
		Acceptance of being different	3.3
		Goal-oriented	3.4
		Strong sense of purpose	3.3
		Desire, commitment to, and passion to learn	3.6
		Ability to tolerate frustration	3.1
		Ability to shake off minor insults, resistance, biases, or problems and move on	3.3
		Passion for passing on knowledge and skills	3.4
		Dealing with stress/workload proactively	3.0
		Optimistic	3.1
		Ability to keep things in perspective	3.3

Table 9 (Continued)

Question 1 – Personal Factors			
Factors	**Category Mean**	**Descriptors**	**M**
Positive Mental Attitude	3.3	A sense of humor	3.2
		Enjoy making a difference in students' lives	3.3
		Patience – recognition that it is a "long game"	3.2
		Positive attitude – ability to see beyond current crisis	3.3
		Willingness to take credit and responsibility for my actions	3.3
		Willingness to take on new challenges	3.5
		Emotional stability	3.2
		Love to figure things out	3.6
Intrinsic Motivation	3.4	Determination in the face of challenges/adversity	3.6
		Ability to work independently	3.6
		Intrinsic motivation (personal drive in the absence of external support)	3.7
		Focused	3.4
		Persistence (ability to stay focused and strategic over time)	3.7
		Capacity for working long hours	3.3

Table 9 (Continued)

Question 1 – Personal Factors			
Factors	**Category Mean**	**Descriptors**	**M**
Intrinsic Motivation	3.4	Recognized my STEM field as a great opportunity for a satisfying profession/job	3.1
		Tenacity (moving forward despite "it can't be done" or "we're not interested in what you do" because I believe it is important)	3.6
Positive Self-Esteem	3.4	Self-confidence	3.2
		High expectation of myself to succeed	3.6
		Efficiency	3.3
		High intelligence	3.2
		Strong time-management skills	3.3
		Good organizational skills	3.4
		Good personal work ethic	3.4
		Competence	3.4
		Good communication skills (written and oral presentation)	3.4
		Personal integrity	3.5
		Ability to work with people on multiple levels	3.4
		Logical thinker	3.4
		Good writer	3.3

Table 9 (Continued)

Question 2 – Social Factors			
Factors	**Category Mean**	**Descriptors**	**M**
Affirmation & Encouragement	3.3	Supportive faculty (male and female) at undergraduate and graduate level	3.1
		Supportive family (parents, siblings, children, etc.)	3.4
		Supportive spouse	3.5
		Supportive [and/or] gender neutral/affirmative minded supervisors/bosses	3.0
Mentoring	3:4	Good and influential teacher(s) and professor(s)	3.4
Supportive/Enabling Environment	3.2	Stable marriage	3.1
		Positive interaction with students	3.2
Question 3 – Academic/Institutional Factors			
Supportive/Enabling Environment	3.2	Flexible schedule	3.3
		Senior faculty/department head supportive of junior colleagues' needs	3.0
		Freedom to determine individual research priorities and service roles	3.4
		Support in graduate school encouraging my career path	3.1

Table 9 (Continued)

Question 3 – Academic/Institutional Factors			
Factors	**Category Mean**	**Descriptors**	**M**
Supportive/Enabling Environment	3.2	Undergraduate faculty expected women to perform as well as men	3.2
		As a student, willingness by faculty to accept (at least in part) female students	3.1
Affirmative/Equity policies	3.1	Encouraging and supportive [teachers] and faculty	3.1
Financial Aid and Research opportunities	3.1	Availability of financial support (grants, scholarships, assistantships, and fellowships)	3.1
		Support in graduate school for my research	3.1
Networking and Collaboration	3.4	Respect for individual strengths among colleagues	3.0
		Networking and collaboration opportunities	3.7
Institutional Expectation of Excellence	3.4	High expectation of academic excellence in my department	3.0
Collegiality	3.0	Well-respected colleagues who are collegial in attitude	3.0
Service Opportunities	3.0	Inclusion on institutional, local, regional, and or national agencies' review panels	3.0

Summary

The purpose of this research was to discover factors that female faculty in STEM fields perceived as influential to their success and persistence in their chosen profession. The study began with a review of literature to understand the representation of females in STEM academic positions and the hindrances or obstacles they face. A panel of female faculty from STEM departments in public institutions labeled as DocSTEM by the Carnegie classification was selected to share their success and persistence factors and to consider factors given by their peers for agreement and inclusion in the final list of factors. A three round modified Delphi technique was selected for this study, using a panel of 43 female faculty selected from the category of institutions outlined before.

In Round 1 of the modified Delphi study, participants were presented with four open-ended questions to elicit personal, social, academic/institutional, and other factors they perceived had been influential to their personal success and persistence as STEM professionals in academia. Round 1 also included questions that sought to establish the demographic make-up of participants. The narrative data were analyzed using grounded theory methodology. This qualitative analysis was reviewed by three female STEM faculty.

The resulting data from the Round 1 open-ended questions was used to design a Likert scale questionnaire to seek participant's consensus on the resultant Round 1 data in Round 2. The Round 2 data were analyzed using descriptive statistics to calculate the mode, median, mean, standard deviation, and coefficient of variation for each item. The results of this data were summarized and made available to participants in Round 3.

In Round 3 participants were given the same questionnaire they had received in Round 2 and asked to review their responses in light of the group means and medians. They were asked to modify their response if they felt so inclined after seeing the group response. Round 3 responses were analyzed using descriptive statistics. The mode, median, mean, standard deviation, and coefficient of variation were calculated for each item. Because the coefficients of variation were within the range considered a strong consensus, the study concluded with Round 3. The final list of factors were those that had a mean score of 3 or higher. These factors also had a coefficient of variation less than 0.5 indicating that majority of participants agreed that they were important to their success and persistence.

This chapter presented the findings of the Delphi study data collection. It described the data analysis for each of the three rounds of the study. Chapter V contains the conclusions and recommendations based on the data analyzed in this chapter.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this study was to determine factors that female higher education faculty in select science, technology, engineering, and mathematics (STEM) fields perceive as influential to their success and persistence in their chosen professions. A modified Delphi technique was used to gather data from selected female faculty on factors they perceived as influential to their success and persistence in higher education STEM institutions. The participants in the study were selected from public institutions labeled as DocSTEM in the Carnegie classification of institutions. The Delphi technique was an appropriate data collection method for this study because participants were located over a wide geographic area, and their personal opinions were being solicited anonymously.

Summary

In order to achieve the objective for this study, four research questions were formulated as a guide. They were:

> RQ_1: What personal factors affect females' ability to successfully persist in STEM faculty positions?
>
> RQ_2: What academic factors affect females' ability to successfully persist in STEM faculty positions?
>
> RQ_3: What social factors affect females' ability to successfully persist in STEM faculty positions?
>
> RQ_4: What other notable factors affect females' ability to successfully persist in STEM faculty positions?

A three round modified Delphi technique was used to obtain a consensus list of factors from participants. Round 1 contained open-ended questions designed to solicit a list of personal, social, academic/institutional, and other factors that individual participants perceived as being influential to their success. In Round 2, the list given by participants were collated, and then sent back to all participants for them to indicate their agreement or disagreement to the listed factors. Finally, Round 3 was used to validate the resulting list of factors.

Although over the last few decades, females have progressively gained greater success than males in attaining postsecondary education, they are underrepresented in science, engineering, computer science, and physical science majors and careers (NCES, 2007). Females are underrepresented in the upper echelons of tertiary education teaching faculties, especially in the areas of STEM. This is in spite of the fact that they have received a greater number of doctorates in several fields in the past few decades. In 2006, females composed only 14.8% of full professors in the life sciences despite the fact that they had received over 30% of all doctorates in the preceding 30 years (NAP, 2007).

The Literature revealed several factors that contribute to women's low participation and low persistence in STEM fields. These factors may be categorized into the following broad groups: personal, social, and academic/institutional. The factors are intricately interrelated and tend to exist together in their effects on academic and career persistence (Bandura, 1977). Tinto (1993) also found that lack of career goals and lack of motivation were two factors often cited for low student retention or persistence. While several women switch from their STEM majors, and fewer females than males tend to

enroll in STEM majors, some females have been able to persist and succeed to achieve prestigious positions within several STEM professions, including academia.

The purpose of this study was to ask some of the women who have succeeded what set them apart from those who chose to leave their STEM endeavors, or not to enter into STEM careers at all. Four hundred and seventy-seven (477) female faculty were identified and contacted, however the population for the study was made up of the 73 who responded to the inquiry Email indicating their interest in the study. The sample was composed of the 43 (59%) who responded to the Round 1 questionnaire. From the sample of 43 experts, 38 (88%) maintained their participation through Rounds 2 and 3. The final panelists represented departments from all the four STEM areas and had at least attained Associate Professor status. They had also gained their bachelor, masters, and doctoral degrees in institutions within the United States of America.

As stated before, three Delphi rounds were conducted to meet the objective of this study. The aim of Round 1 was for participants to explore the topic and develop their own personal list of factors. The purpose of Round 2 was to begin identifying the levels of agreement among participants, and Round 3 was the validation phase of the study.

Round 1 was preceded by an invitation Email detailing the kind of study being conducted, the method of data collection, and proposed time span for participation in the study. In Round 1, the 73 participants who had indicated an interest in, and willingness to participate in the study, were sent an Email containing directions for the Round 1 questionnaire. The Email also contained the Round 1 questionnaire as a Microsoft Word document attachment. The questionnaire contained four open-ended questions concerning the type of factors participants were to list. These questions were designed to encourage

participants to contribute their own list of factors. Participants were also asked to provide demographic information in Round 1. Forty-three participants completed the Round 1 questionnaire.

The Round 1 demographic data were analyzed using descriptive statistics, while data obtained from the open-ended questions were analyzed using the grounded theory method of qualitative analysis. The narrative data were coded and grouped into categories. The 580 responses received in Round 1 were condensed into 243 items for the Likert scale questionnaire for Round 2. The demographic data showed some interesting facts about the sample. Forty-one (95%) self-identified themselves as white, which is consistent with the demographic characteristics of faculty in American universities. It has been reported that 90% of all science and engineering faculty in America are white, while 87% of full-time faculty members are white (Trower & Chait, 2002). Thirty-six (84%) of the participants were married with children, and 55% had siblings in STEM professions. All of these demographics were consistent with participants' perception of factors that have been influential to their successful persistence. These factors include support from spouse and other family members, as well as family members as mentors and role models.

Round 2 was intended to ascertain levels of agreement among participants about the factors that had emerged from Round 1. Consequently, a 4-point Likert scale questionnaire was developed and deployed online, asking participants to indicate whether they strongly agreed, agreed, disagreed, or strongly disagreed with each factor or narrative. The Round 2 instrument was deployed online on Survey Monkey. All the 43 participants who had completed Round 1 received an Email containing directions for the

Round 2 questionnaire and a link to the survey website. The Round 2 instruments contained three questions with a total of 243 items. Question 1 contained a list of personal factors and had 95 items. Question 2 contained a list of social factors and had 62 items. Finally, Question 3 contained a list of academic/institutional factors and had 86 items. Of the 43 participants who received the Round 2 questionnaire, 38 (88%) completed it. The quantitative data for this round were analyzed by calculating the mode, median, mean, standard deviation, and the coefficient of variation of each Likert scale response. The results of this analysis were communicated to participants in Round 3.

Round 3 was aimed at validating the list of factors that had so far been generated in Rounds 1 and 2. Forty-two of the 43 participants who had completed Round 1 received a summary of the Round 2 responses as an Email attachment and an instruction Email containing a link to the Round 3 questionnaire on Survey Monkey. Participants were asked to review their Round 2 responses and make any changes they deemed necessary based on the group response. All the 38 participants who responded to Round 2 completed the Round 3 questionnaire.

The coefficient of variation was used to determine that a consensus had been reached at the end of Round 3. Only items that had a mean score of strongly agree (4) or agree (3) and a coefficient of variation less than 0.5 were included in the final list of factors. Based on these statistical deductions participants rejected 34 (36%) items in Question 1, disagreeing that they were influential to their successful persistence. Thus, 61(64%) items were retained in the final list of factors. These items were summarized and placed in the following categories: positive personality traits, positive mental attitude, self-efficacy in STEM, positive self-esteem, and intrinsic motivation.

Furthermore, participants disagreed with 55 (89%) items in Question 2 based on means and coefficient of variation; so only 7 (11%) items were retained with a mean score of 3 or 4. These factors were categorized as affirmation and encouragement, availability of mentors and role models, and supportive/enabling environments.

Finally, on Question 3, participants agreed that 14 (16%) items were important to their success and persistence, and thus 72 (84%) were not. Here too factors were categorized as: supportive/enabling environment, affirmative/equity policies within institutions, networking and collaboration, institutional expectation of excellence, service opportunities, collegiality, and financial aid and research opportunities. These were the factors participants deemed important to their success and persistence as female STEM faculty members.

Conclusions

The purpose of this study was to discover factors that female faculty in STEM perceived as influential to their success and persistence. To achieve this purpose, a panel of 43 female faculty in STEM were invited to list, refine, and validate personal, social, and academic/institutional factors they believed to be influential to their success and persistence. A three round modified Delphi technique was used in this process, guided by the four research questions.

Research Question 1

Research Question 1 asked participants to provide personal factors that they felt were influential to their success and persistence as university STEM faculty members. The 43 participants' listed 189 narratives in Round 1, which were condensed into 95 items for Rounds 2 and 3. Of these participants agreed by consensus that 61 (64%) of

them were important to their success and persistence. These are the factors that had a mean score of 3 or higher and also had a coefficient of variation less than 0.5. The 61 items were further categorized with the assistance of two external experts. The sub-categories for Question 1 were: personality traits with a mean of 3.4 on a four-point scale, self-efficacy in STEM with a mean of 3.3, positive mental attitude with a mean of 3.3, intrinsic motivation with a mean of 3.4, and positive self-esteem with a mean of 3.4.

Self-awareness helps individuals to discover and maximize their strengths while working to compensate for their weaknesses. Identifying strengths can also lead to the discovery and development of a positive mental attitude. In Hill et al. (2010), the importance of a positive mental attitude was emphasized in several research findings demonstrating when female students were convinced learning is a skill that gets better with time and effort, their performance in all subjects, particularly math, increased significantly. Researchers concluded: "passion, dedication, and self-improvement – not simply innate talent – are the roads to genius and contribution" (p. 35). They further recommend a shift from "talented" or "gifted" labels to, "challenging" or "advanced" programs to convey the message to students that skills and abilities can be developed further and are not necessarily fixed in individuals.

By identifying they possessed specific personality traits such as optimism, hard work, and ambition, participants were admitting they had learned the secrets of a positive mental attitude that translated to these positive traits. A positive view of oneself and ones abilities is crucial in a person's actual performance and persistence in a chosen field or career. Table 10 shows the sub-category personality traits with the list of descriptive factors and corresponding coefficient of variation and means.

Table 10

Summary of Consensus List of Personal Factors – Personality Traits Category with Coefficients of Variation and Means

Question 1 – Personal Factors: Personality Traits Category		
Descriptors	**CV**	**M**
Stubbornness/contrariness	0.3	3.1
Ability to multi-task	0.2	3.3
Flexibility (ability to adapt to diverse situations)	0.2	3.6
Resource mobilization and improvisation skills (resourceful)	0.2	3.1
Good Interpersonal skills/ability to collaborate	0.2	3.4
Willingness to sacrifice self to get a job done	0.2	3.5
Curiosity	0.1	3.6
Hard worker	0.1	3.7
Risk taker	0.3	3.0
Strong willed	0.3	3.2
Problem-solver	0.1	3.4
Independent	0.2	3.6
Question-driven	0.2	3.4

Research findings also indicate positive self-esteem and self-efficacy in STEM are strong predictors of success and persistence in a STEM major or career. In research reported in Hill et al. (2010), it was discovered that "Controlling for actual ability, the higher students assessed their mathematical ability, the greater the odds were that they

would enroll in a high school calculus course and choose a college major in science, math, or engineering" (p. 44). This research also found that "boys were more likely than their equally accomplished female peers to enroll in calculus not because boys were better at math but because they believed that they were better at math" (p. 44). The coefficient of variation for self-efficacy in STEM and positive self-esteem categories ranged from 0.1-0.3. This indicated a strong consensus among participants on their agreement of the importance of these factors to their success and persistence. In Tables 11 and 12 the categories self-efficacy in STEM and positive self-esteem with their lists of factors and corresponding coefficients of variation and means are depicted.

Table 11

Summary of Consensus List of Personal Factors – Self-Efficacy in STEM Category with Coefficients of Variation and Means

Question 1 – Personal Factors: Self-Efficacy in STEM Category		
Descriptors	**CV**	**M**
Natural inclination for STEM	0.2	3.5
Self-efficacy (belief in self ability to accomplish any task)	0.3	3.2
Creativity within STEM	0.2	3.0
Mathematics-efficacy (believe that I am good at Math and can excel in it)	0.3	3.0
Science-efficacy (believe that I am good in science and can excel in it)	0.1	3.4
Technical grasp of broad issues	0.2	3.3
Critical thinking skills	0.1	3.6
Idea oriented	0.2	3.3

Table 12

Summary of Consensus List of Personal Factors – Positive Self-Esteem Category with Coefficients of Variation and Means

Question 1 – Personal Factors: Positive Self-Esteem Category		
Descriptors	**CV**	**M**
Self-confidence	0.2	3.2
High expectation of myself to succeed	0.1	3.6
Efficiency	0.2	3.3
High intelligence	0.2	3.2
Strong time-management skills	0.2	3.3
Good organizational skills	0.2	3.4
Good personal work ethic	0.2	3.4
Competence	0.2	3.4
Good communication skills (written and oral presentation)	0.2	3.4
Personal integrity	0.2	3.5
Ability to work with people on multiple levels	0.2	3.4
Logical thinker	0.1	3.4
Good writer	0.2	3.3

Another critical factor given by participants was a positive mental attitude. This factor had a group mean of 3.3. Participants also agreed that they were self-motivated individuals who were able to persevere in their STEM endeavors. They agreed that intrinsic motivation was an important factor for their success and persistence with a mean

score of 3.4. The participants showed strong consensus for these two items indicated by a coefficient of variation that ranged from 0.1-0.3. Table 13 gives the list of factors and their coefficient of variation and means for the category positive mental attitude while Table 14 shows the same information for intrinsic motivation.

Table 13

Summary of Consensus List of Personal Factors – Positive Mental Attitude Category with Coefficients of Variation and Means

Question 1 – Personal Factors: Positive Mental Attitude Sub-category		
Descriptors	**CV**	**M**
Enjoyment and/or enthusiasm for work (STEM) (I am never bored)	0.1	3.6
Acceptance of being different	0.3	3.3
Goal-oriented	0.2	3.4
Strong sense of purpose	0.2	3.3
Desire, commitment to, and passion to learn	0.2	3.6
Ability to tolerate frustration	0.2	3.1
Ability to shake off minor insults, resistance, biases, or problems and move on	0.2	3.3
Passion for passing on knowledge and skills	0.2	3.4
Dealing with stress/workload proactively	0.2	3.0
Optimistic	0.3	3.1
Ability to keep things in perspective	0.2	3.3
A sense of humor	0.2	3.2

Table 13 (Continued)

Question 1 – Personal Factors: Positive Mental Attitude Category		
Descriptors	**CV**	**M**
Enjoy making a difference in students' lives	0.2	3.3
Patience – recognition that it is a "long game"	0.2	3.2
Positive attitude – ability to see beyond current crisis	0.2	3.3
Willingness to take credit and responsibility for my actions	0.2	3.3
Willingness to take on new challenges	0.1	3.5
Emotional stability	0.2	3.2
Love to figure things out	0.1	3.6

Table 14

Summary of Consensus List of Personal Factors – Intrinsic Motivation Category with Coefficients of Variation and Means

Question 1 – Personal Factors: Intrinsic Motivation Category		
Descriptors	**CV**	**M**
Determination in the face of challenges/adversity	0.1	3.6
Ability to work independently	0.2	3.6
Intrinsic motivation (personal drive in the absence of external support)	0.1	3.7
Focused	0.2	3.4
Persistence (ability to stay focused and strategic over time)	0.1	3.7
Capacity for working long hours	0.2	3.3

Table 14 (Continued)

Question 1 – Personal Factors: Intrinsic Motivation Category		
Descriptors	**CV**	**M**
Recognized my STEM field as a great opportunity for a satisfying profession/job	0.2	3.1
Tenacity (moving forward despite "it can't be done" or "we're not interested in what you do" because I believe it is important)	0.2	3.6

Research question 1 asked participants to list personal factors that had been influential to their success and persistence as female STEM faculty members. Participants agreed by consensus that positive mental attitudes, self-efficacy in STEM, intrinsic motivation, positive personality traits, and positive self-esteem. The descriptors for these factors had means between 3.3 and 3.4 and they all had coefficients of variation less than 0.5.

Research Question 2

Research Question 2 asked participants to list social factors, i.e., factors within their socio-cultural environments that have been influential to their success and persistence. Collectively, the respondents listed 160 factors in Round 1, which were then condensed into 62 items for the Likert scale questionnaires in Rounds 2 and 3. By the end of Round 3, the consensus among participants was that seven (11%) factors were important to their success and persistence. Consensus was shown when a factor had a coefficient of variation less than 0.5 and a mean of 3 or higher. These were summarized with the help of a panel of experts under the sub-headings of affirmation and

encouragement, mentors and mentoring relationships, and supportive/enabling environment.

Because females are less likely than their male counterparts to consider themselves well informed in STEM, they need to be encouraged and affirmed and guided to understand that they can be equally good and successful in those fields. Hill et al. (2010) recommend that girls be guided to discover their relevant career related skills – for example, they need to be taught to understand that excellence in math is an indication that they have what it takes to study a broad range of subjects in college, not just scores on paper. Again, high school girls should be encouraged to enroll in STEM classes when available. This will help them build their self-esteem and open opportunities for them to pursue STEM courses in higher education.

Furthermore, research shows that an institutional environment that is supportive and includes an attitude of collegiality and opportunities for mentoring, both formally and informally, is conducive to success and persistence of female students and faculty. Consequently, Trower and Chait (2002) recommend that departments ensure mentoring opportunities are available for all faculty members. "Exposing students to role models who can help students see their struggles as a normal part of the learning process rather than as a signal of low ability" can boost the test scores of both minority students and girls (Hill et al., 2010, p. 41).

Hill et al. (2010) also concluded that:

> When institutions (including K–12 schools, universities, and workplaces) and individuals send the message that girls and boys are equally capable of achieving in math and science, girls are more likely to assess their abilities

more accurately. Since schools are responsible for educating, they have a unique opportunity to help students learn new ways to interact. (p. 67)

The affirmation and encouragement category had a mean score of 3.0. Closely associated with affirmation and encouragement is the role of mentoring in promoting success and persistence. Participants agreed that mentors both male and female were important to their success and persistence. The category mean for the mentoring and mentoring relationships was 3.4. Affirmation and encouragement within an institution creates a supportive/enabling environment where members thrive.

In addition, the participants of this study agreed that a supportive/enabling environment at home and work was important to their success and persistence. The mean for the supportive/enabling environment sub-category was 3.2 with a coefficient of variation ranging from 0.2-0.4. Similarly, the coefficient of variation for mentoring and mentoring relationships ranged from 0.2-0.4, while the range for affirmation and encouragement was 0.2-0.3. Table 15 is a summary of the category affirmation and encouragement.

Table 15

Summary of Consensus List of Social Factors – Affirmation & Encouragement Category with Coefficients of Variation and Means

Question 2 – Social Factors: Affirmation & Encouragement Category		
Descriptors	**CV**	**M**
Supportive spouse	0.3	3.5
Supportive family (parents, siblings, children, etc.)	0.2	3.4

Supportive faculty (male and female) at undergraduate and graduate level	0.3	3.1
Supportive [and/or] gender neutral/affirmative minded supervisors/bosses	0.3	3.0

Mentoring and mentoring relationship had one descriptive factor that was retained with a mean of 3.4. The descriptive factor was "Good and influential teacher(s) and professor(s)". In addition, the supportive/enabling environment factor also had two descriptive factors retained and they are "Stable marriage" with a mean of 3.1 and "Positive interaction with students" with a mean of 3.2.

In conclusion, participants agreed that affirmation and encouragement from the people in their sphere of influence, mentors and role models, and a supportive/enabling environment were important social factors that contributed to their success and persistence.

Research Question 3

Research Question 3 asked participants to list academic/institutional factors – ones pertinent to their educational institutions as well as work places. Participants were in agreement about the factors that were important to their success, which includes supportive/enabling environment, affirmative/equity policies, financial aid and research opportunities, networking and collaboration, institutional expectation of excellence, service opportunities, and collegiality. These categories were arranged with the help of a panel of experts from the list of descriptive factors for Question 3.

A supportive/enabling environment is welcoming to all and is a place nobody feels out of place. By sending an inclusive message about who makes a good scientist, mathematician, technologists, etc., minorities and women will be encouraged to feel

comfortable and persist in those fields. This involves changing the environment to make room for new members and not just expecting new members to become part of existing groups. It also includes sponsoring departmental social activities, seminars, lunches, and other events that can help to integrate students and new faculty into departments (Hill et al., 2010). Table 16 shows the summary of the supportive/enabling environment category, which had a mean of 3.2 and the coefficients of variation that ranged from 0.2-0.3.

Table 16

Summary of Consensus List of Academic/Institutional Factors – Supportive/Enabling Environment Category with Coefficients of Variation and Means

Question 3 – Academic/Institutional Factors: Supportive/Enabling Environment		
Descriptors	**CV**	**M**
Flexible schedule	0.2	3.3
Senior faculty/department head supportive of junior colleagues' needs	0.3	3.0
Freedom to determine individual research priorities and service roles	0.2	3.4
Support in graduate school encouraging my career path	0.3	3.1
Undergraduate faculty expected women to perform as well as men	0.3	3.2
As a student, willingness by faculty to accept (at least in part) female students	0.3	3.1

In addition to an enabling environment, participants indicated that clear affirmative/equity policies and the availability of financial aid and research opportunities

have been influential to their success and persistence. There was one item in the category of affirmative/equity policies with a mean of 3.1 and coefficient of variation of 0.2. This descriptive factor was "Encouraging and supportive teachers and faculty". Similarly, the service opportunities category had one descriptor retained by participants, which had a mean of 3.0 and a coefficient of variation of 0.3. The descriptor was "inclusion on institutional, local, regional, and or national agencies' review panels".

On the other hand, the financial aid and research opportunities category had two items with a means of 3.1 and coefficients of variation of 0.3 each. The descriptive factors were "Availability of financial support (grants, scholarships, assistantships, and fellowships)" and "Support in graduate school for my research.

Another factor categorized in Question 3 was networking and collaboration, which had two listed factors. They were "respect for individual strengths among colleagues" with a mean of 3.0 and "networking and collaboration opportunities" with a mean of 3.7. Providing formal and informal networking and collaboration at institutions can be a crucial factor in ensuring that women, who are usually in a minority in STEM fields, do not feel so isolated in those fields. Participants agreed that such opportunities present in their own STEM academic careers contributed to their success and persistence. The mean for networking and collaboration category was 3.4 and the coefficient of variation was 0.2 for each descriptor.

Participants' view of the importance of a supportive/enabling environment, affirmation and encouragement, collegiality, and mentoring to faculty success and persistence is reiterated by Hill et al.'s 10 climate dimensions related to faculty satisfaction that are "actionable" by administrators. These were listed as:

1. Fairness of evaluation by immediate supervisor
2. Interest senior faculty take in your professional development
3. Your opportunities to collaborate with senior colleagues
4. Quality of professional interaction with senior colleagues
5. Quality of personal interaction with senior colleagues
6. Quality of professional interaction with junior colleagues
7. Quality of personal interaction with junior colleagues
8. How well you "fit" (i.e., your sense of belonging) in your department
9. Intellectual vitality of the senior colleagues in your department
10. Fairness of junior faculty treatment within your department (p. 69)

Thus, participants by consensus agreed that when institutions provide enabling and supportive environment that promotes collegiality, and when performance standards and expectations are clearly stated and defined, there is less reliance on stereotypes (Hill et al., 2010). Furthermore, opportunities for networking and collaboration, opportunities to serve, and the availability of financial aid and research opportunities also encouraged success and persistence among female faculty in STEM departments.

Research Question 4

Finally, Research Question 4 was intended to determine if participants could add any additional factor category that could be classified differently than those cited in the first three research questions. However, it became apparent during the analysis of Round 1 data that the factors listed in Research Question 4 could be integrated into the first three factors. This conclusion was arrived at in collaboration with the impartial panel of female

faculty who were asked to help in coding and categorization of the Round 1 open-ended questions data.

Recommendations

In view of the findings of this study, and knowledge gained through the review of literature, the following recommendations are offered for further studies:

1. Further studies should be conducted to develop a forecasting model based on the factors discovered in this study that can be used to pro-actively increase female access and retention in STEM. By implementing social and institutional policies using the factors that participants in this study have expressed as being important to their success and persistence, more females will be assisted to pursue and persist in STEM majors and professions.

2. This study should be replicated with female faculty in private DocSTEM institutions to ascertain if there are significant difference between their experiences and those of their counterparts in the public institutions to validate the finding of this study.

3. Another study posing these same questions to male STEM faculty should be conducted to determine how their experiences differ from those of their female counterparts.

Furthermore, the following recommendations for actions by institutions and individuals may be employed to encourage an increased female participation in STEM fields:

1. STEM outreach and awareness programs should consistently involve both males and females. This is because the successful female STEM faculty who participated in this study attributed their success and persistence in part to supportive spouses,

parents, and other male and female significant persons in their lives. These significant individuals must have understood the value of education, particularly in the STEM fields, to have positively influenced these female STEM faculty members.

2. Institutions should make fairness and equity in hiring, treatment of personnel, allocation of resources, etc., a priority. The study participants agreed that when their departments and institutions were aware and intentional about fairness and equity, it made their working environment safe and enjoyable so that females were more likely to stay.

3. Relevant work-study opportunities in the secondary, undergraduate, and graduate levels should be incorporated in all STEM curricula, since participants indicated that such opportunities aroused and helped them maintain their interest in STEM.

In conclusion, while there have been great achievements among women in many fields including STEM, their advancement and progression has not kept pace with the current talent pool or comparable to that of males in many key industry sectors. It is important that this research does not end in finding out how a few females have succeeded, but the work needs to proceed to discover how many more can be encouraged to enter and persist in STEM professions.

REFERENCES

Ainley, M. (1990). *Despite the odds: Essays on Canadian women and science*. Montreal, Canada: Vehicule Press.

Andrade, S.J., & Santiago, D.A. (2010) *Emerging Hispanic-serving institutions (HSIs): Serving Latino students*. Washington, D.C.: Excelencia in Education.

Bandura, A. (1977). Self-Efficacy: Towards a unifying theory of behavioral change. *Psychological Review, 84*(2), 191-215.

Bandura, A. (1989). Social cognitive theory. In R. Vasta (Ed.), *Annals of child development, Six theories of child development* (*6*, pp. 1-60). Greenwich, CT: JAI Press.

Bar-Tal, D., & Frieze, I.H. (1977). Achievement motivation for males and females as a determinant of attribution for success and failure. *Sex Roles, 3*, 301-313.

Bennett, C., & Okinaka, A.M. (1990). Factors related to persistence among Asian, Black, Hispanic, and White undergraduates at a predominantly White university: Comparison between first and fourth year cohorts. *Urban Review, 22*(1), 33-60.

Blickenstaff, J.C. (2005). Women and science careers: Leaky pipeline or gender filter? *Gender and Education, 17*(4), 369-386.

Bloch, R.H. (1978). Untangling the roots of modern sex roles: A survey of four centuries of change. *Journal of Women in Culture and Society, 4*(2), 237-254.

Boulter, L.T. (2002). Self-concept as a predictor of college freshman academic adjustment. *College Student Journal, 36*(2), 234-246.

Brill, J.M., Bishop, M.J., & Walker, A.E. (2006). The competencies and characteristics required of an effective project manager: A web based Delphi study. *E T R & D, 54*(2), 114-140.

Building Engineering, & Science Talent (BEST). (2005). *The talent imperative: Diversifying America's science and engineering workforce*. Building Engineering, & Science Talent Blue Ribbon Panel. Washington D.C.: BEST Blue Ribbon Panel.

Byrne, E.M. (1993). *Women and science: The snark syndrome*. London: Falmer Press.

Carnegie Foundation. (2010). Carnegie Classification Discription. Retrieved from http://classifications.carnegiefoundation.org/descriptions/grad_program.php

Campbell, P.S.J. (1997). Uniformed but interested: Findings of a national survey on gender equity in preservice teacher education. *Journal of Teacher Education, 48*(1), 69-75.

Charmaz, K. (2006). *Constructing grounded theory*. Los Angeles: Sage Publications.

Cheng, X. (2009). *NCES stats in brief: Students who study science, technology, engineering, and mathematics (STEM) in postsecondary education*. (NCES Report No. 2009-161). Retrieved from http://nces.ed.gov/pubs2009/2009161.pdf

Colwell, R.R. (2002, 08). Rethinking the rules to promote diversity. Proceedings from *Diversity*: Presidential Symposium conducted at the 75th Anniversary of the Women Chemists Committee of the American Chemical Society of the National Science Foundation, Boston Massachusetts.

Committee on Prospering in the Global Economy of the 21st Century (CPGE). (2005). *Rising above the gathering storm: Energizing and employing America for a*

brighter economic future. An Agenda for American Science and Technology. Retrieved from http://www.nap.edu/catalog/11463.html

Creswell, J. (1994). *Research design: Qualitative & quantitative approaches.* Thousand Oaks, CA: Sage Publications.

Creswell, J. (1998). *Qualitative inquiry and research design: Choosing among five traditions.* Thousand Oaks, CA: Sage Publications.

Cronin, C., & Roger, A. (1999). Theorizing progress: Women in science, engineering, and technology in higher education. *Journal of Research in Science Teaching, 36*(6), 637-661.

Fink, A., & Kosecoff, J. (1985). *How to conduct surveys: A step-by-step guide.* London, UK: Sage Publications.

Friedman, T.L. (2005). *The world is flat.* New York, NY: Farrar, Straus and Giroux.

Frome, P.M., Alfeld, C.J., Eccles, J.S., & Barber, B.L. (2006). Why don't they want a male-dominated job? An investigation of young women who changed their occupational aspirations. *Educational Research and Evaluation, 12*(4), 359-372.

Garland, R. (1991). The mid-point on a rating-scale: Is it desirable? *Marketing Bulletin, 2,* 66-70.

Given, L.M. (2008). *The SAGE encyclopedia of qualitative research methods* (Vol. 1). Thousand Oaks, CA: SAGE Publications.

Glaser, B., & Strauss, A. (1967). *The discovery of grounded theory.* Chicago: Aldine.

Gloria, A.M., & Kurpius, S.E. (1996). The validation of the cultural congruity scale and the university environment scale with Chicanoa students. *Hispanic Journal of Behavioral Sciences, 18*(4), 533-549.

Gloria, A.M., Kurpius, S.E., Robinson, H., Kimberly D., & Willson, M.S. (1999). African American students' persistence at a predominantly White university: Influences of social support, university comfort, and self-beliefs. *Journal of College Student Development, 40*(3), 257-268.

Guidmond, P.S. (2004). *Women with doctorates in science: Perceptions of facilitative factors and obstacles to thier success.* Unpublished Dissertation, Nothern Illinois University, Dekalb, Illinois.

Hackett, G., & Betz, N.E. (1981). A self-efficacy approach to the career development of women. *Journal of Vocational Behavior, 18*, 326-326.

Hill, C.H., Corbett, C., & St. Rose, A. (2010). Why so few? Women in science, technology, engineering, and mathematics. Washington, D.C.: American Association of University Women Research Report.

Johnson, S.D., & Thomas, R.G. (1994). Implication of congnitive science for industrial design in tecchnology education. *Journal of Technology Studies, 20*(1), 33-45.

Lent, R.C. (2008). Facing the issues: Challenges, censorship, and reflection through dialogue. *English Journal, 97*(3), 61-66.

Lent, R.W., & Brown, S.D. (2008). Social cognitive career theory and subjective well-being in the context of work. *Journal of Career Assessment, 16*(1), 6-21.

Lent, R.W., Brown, S.D., Sheu, H.B., Schmidt, J., Brenner, B.R., Gloster, C.S., et al. (2005). Social cognitive predictors of academic interests and goals in engineering: Utility for women and students at historically Black universities. *Journal of Counseling Psychology, 52*(1), 84-92.

Lent, R.W., Brown, S.D., & Larkin, K.C. (1986). Self-efficacy in the prediction of academic performance and perceived career options. *Journal of Counseling Psychology, 33*(3), 265-269.

Lent, R.W., Brown, S.D., & Larkin, K.C. (1989). Relation of self-efficacy to inventoried vocational interests. *Journal of Vocational Behavior, 34*(3), 279-288.

Lent, R.W., Lopez, A.M., Jr., Lopez, F.G., & Sheu, H.B. (2008). Social cognitive career theory and the prediction of interests and choice goals in the computing disciplines. *Journal of Vocational Behavior, 73*(1), 52-62.

Linstone, H.A., & Turoff, M. (Eds.). (2002). *The Delphi method: Techniques and applications*. Retrieved from http://www.is.njit.edu/pubs/delphibook/

Lukas, C. (2008, September 12). Excellence, not gender parity, should be priority for STEM faculty. [Online forum comment]. Retrieved from www.iwf.org

Mason, M.A., & Ekman, E.M. (2007). *Mothers on the fast track: How a new generation can balance family and careers.* New York: Oxford.

Mason, M.A., & Goulden, M. (2004). Marriage and baby blues: Redefining gender equity in the academy. *The ANNALS of the American Academy of Political and Social Science*, *596*, 252-253,

Mason, M.A., Angelica S., Goulden M., Hoffman C., & Frasch K. (2005). *Faculty family friendly edge: An initiative for tenure-track faculty at the University of California.* Retrieved from http://ucfamilyedge.berkeley.edu/ucfamilyedge.pdf

Massachusetts Institute of Technology. (1999). A study on the status of women faculty in science at MIT. *MIT Faculty Newsletter*, 11, 4.

Massachusetts Institute of Technology. (2011). *A report on the status of women faculty in the schools of science and engineering at MIT, 2011*. Retrieved from http://web.mit.edu/newsoffice/images/documents/women-report-2011.pdf

Matell, M.S., & Jacoby, J. (1972). Is there an optimal number of alternatives for Likert-scale items? Effects of testing time and scale properties. *Journal of Applied Psychology, 56*(6), 506-509.

Mau, W.C. (2003). Factors that influence persistence in science and engineering career aspirations. *Career Development Quarterly, 51*(3), 234-243.

McDonald, J.H. (2009). *Handbook of biological statistics*. Baltimore, MD: Sparky House Publishing.

Murphy, J., Vriesenga, M., & Storey, V. (2007). An analysis of types of work, methods of investigation, and influences. *Educational Administration Quarterly, 43*(5), 612-628.

Murphy, M.C., Steele, C.M., & Gross, J.J. (2007). Signaling threat: How situational cues affect women in math, science, and engineering settings. *Psychological Science, 18*(10), 879-885.

National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine. (2009). *I was wondering. A curious look at women's adventures in science*. Retreived from http://www.iwaswondering.org/

National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine. (2010). *Rising above the gathering storm, revisited: Rapidly approaching category 5*. Washinton, D.C.: National Acadamies Press.

National Academies Press, National Academy of Sciences, National Academy of Engineering, Institute of Medicine. (2007). *Beyond bias and barriers: Fulfilling the potential of women in academic science and engineering.* Washington, D.C.: National Academies Press.

National Center for Education Statistics. (2000). *Women in mathematics and science* (NCES Publication No. 97-982). Washington, D.C.: Government Printing Office.

National Center for Education Statistics. (2007). *The condition of education*. Washington, D.C.: Government Printing Office.

National Center for Education Statistics. (2008). *NAEP 2008 trends in academic progress*. Washington, D.C.: Government Printing Office.

National Research Council. (1991). *Women in science and engineering: Increasing their numbers in the 1990s: A statement on strategy and policy.* Washington, D.C.: Government Printing Office.

National Science Foundation. (2007). *A national action plan for addressing the critical needs of the U.S.A. STEM education system*. Arlington, VA: Government Printing Office

Nelson, D.J. (2005). *A national analysis of diversity in science and engineering faculties at research universities.* Retrieved from http://cheminfo.ou.edu/~djn/diversity/Faculty_Tables_FY07/07Report.pdf

Nelson, D.J. (2007). *A national analysis of minorities in science and engineering faculties at research universities*. Retrieved from Diversity In Science Association website: http://cheminfo.ou.edu/~djn/diversity/Faculty_Tables_FY07/07Report.pdf

Nettles, M.T., & Millett, C.M. (2006). *Three magic letters: Getting to Ph.D.* Baltimore, MD: Johns Hopkins University Press.

Pancer, S.M., Hunsberger, B., Pratt, M.W., & Alisat, S. (2000). Cognitive complexity of expectations and adjustment to university in the first year. *Journal of Adolescent Research, 15*(1), 38-57.

Patton, M.Q. (2002). *Qualitative research and evaluation methods*. Thousand Oaks, CA: Sage Publication.

Peter, K., & Horn, L. (2005). *Gender differences in participation and completion of undergraduate education and how they have changed over time* (NCES Publication No. 2005–169). Washington, D.C: U.S.A. Government Printing Office.

Pope, J. (2008, March 15). U.S.A. behind in doubling science grads. E-School News. Retrieved from http://www.eschoolnews.com/2008/07/18/report-u-s-behind-in-doubling-science-grads/

Quimby, J.L., & DeSantis, A.M. (2006). The influence of role models on women's career choices. *Career Development Quarterly, 54*(4), 297-306.

Rampey, B.D., Dion, G.S., and Donahue, P.L. (2009). *NAEP 2008 Trends in academic progress* (NCES Publication No. 2009-479). Washington, D.C.: National Center for Education Statistics.

Redden, E. (2007, October 18). Female faculty and the sciences. *Inside HigherEd.* Retrieved from http://www.insidehighered.com/news/2007/10/18/womensci

Rosser, S.V. (1985). The feminist perspective on science: Is reconceptualization possible? *Journal of the National Association of Women Deans, Administrators, and Counselors, 49*(1), 29-35.

Rotundi, A., & Gustafson, D. (1996). Theoretical, methodological, and practical issues arising out of the Delphi method. In M. Adler & E. Ziglio (Eds.), *Gazing into the Oracle: The Delphi method and its application to social policy and public health* (pp. 34-55). London, England: Jessica Kingsley Publishers Ltd.

Rowe, G., & Wright, G. (1999). The Delphi technique as a forecasting tool: Issues and analysis. *International Journal of Forcasting 15,* 353-375.

Seymour, E. (1995). The loss of women from science, mathematics, and engineering undergraduate majors: An explanatory account. *Science Education, 79*(4), 437-473.

Seymour, E. (2002). *Tracking the process of change in US undergraduate education in science, mathematics, engineering and technology*. Boulder, CO: John Wiley & Sons.

Seymour, E., & Hewitt, N.M. (1997). *Talking about leaving: Why undergraduates leave the sciences*. Boulder, CO: Westview Press.

Siaya, L., & Hayward, F.M. (2003). *Mapping internationalization in U.S.A. campuses.* Washington, D.C.. Retrieved from American Council on Education website: http://www.acenet.edu/bookstore/pdf/2003_mapping_summary.pdf.

Skulmoski, G.J., Hartman, F.C., & Krahn, J. (2007). The Delphi method for graduate research. *Journal of Information Technology Education, 6,* 1-21.

Steeh, J. (2001). $3.7 Million grant aids women in science and engineering. *The University Record.* Retrieved from the University of Michigan website: http://michigantoday.umich.edu/01/Fal01/mt12bf01.html

Stohl, M. (2007). We have met the enemy and he is us: The role of the faculty in the internationalization of higher education in the coming decade. *Journal of Studies in International Education, 11*(3-4), 359-372.

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory.* Thousand Oaks, CA: Sage Publication.

Strenta, A.C. (1994). Choosing and leaving science in highly selective institutions. *Research in Higher Education, 35*(5), 513-547.

Travis, C.B. (1982). Sex comparisons on causal attributions: Another look at the null hypothesis. *Sex Roles, 8*(4), 375-380.

Tinto, V. (1993). *Leaving college: Rethinking the causes and cures of student attrition.* Chicago, IL: University of Chicago Press.

Trower, C.A., & Chait, R.P. (2002). Faculty diversity: Too little for too long. *Harvard Magazine.* Retrieved from http://harvardmagazine.com/2002/03/faculty-diversity.html

United States Census Bureau. (2008). *The national data book.* Washington, D.C.: United States Census Bureau.

United States Government Office of Accountability. (2005). *Higher education: science, technology, engineering, mathematics trends and the role of federal programs*. (Publication No. GAO-06-702T). Retrieved from http://www.gao.gov/new. items/d06702t.pdf

United States Government Office of Science and Technology Policy, Executive Office of the President. (2006). *American competitiveness initiative.* Retrieved from http://georgewbush-whitehouse.archives.gov/stateoftheunion/2006/aci/aci06-booklet.pdf

Wilhelm, W.J. (2001). Alchemy of the Oracle: The Delphi technique. *Delta Pi Epsilon Journal, 43*(1), 6-26.

Witt, S.D. (1997). Parental influence on children's socialization to gender roles. *Adolescence, 32*(126), 253.

Wright, T. (1993). Tom Wright's response to Petrina's reaction. *Journal of Technology Education, 4*(2), 77-79.

Yang, Y.N. (2003). *Testing the stability of experts' opinion between successive rounds of Delphi studies*. Chicago, IL: American Educational Research Association.

Zubritsky, E. (2000). Women in analytical chemistry speak out. *Analytical Chemistry, 72*(7), 272 A–281.

APPENDIX A

E-MAIL REQUESTING PARTICIPATION ON THE STUDY PANEL

To: Female Faculty for inclusion in a modified Delphi study on female success and persistence in STEM.
Subject: Participation in a Research Study
Date: December 06, 2011

Dear Madam,

I am a doctoral candidate at Old Dominion University conducting research on factors that female faculty in select STEM fields perceive as being influential to their academic and professional success and persistence. This study constitutes my dissertation in partial fulfillment of my degree in Technology Education.

A modified Delphi technique has been selected to seek expert opinion of female faculty members in select STEM departments in institutions labeled as DocSTEM by the Carnegie classification of institutions. While researching such institutions I identified your name in your institutional database as a female faculty in a STEM field. I will be very grateful if you will consent to be one of the experts on the panel for this study.

The study will comprise three rounds of questionnaires, sent via Email, over approximately 10 weeks. In Round 1 you will be asked to list the factors that you perceive have been influential to your success and persistence as a female university faculty member in a STEM discipline. In Rounds 2 and 3 you will receive a list of the factors given by all participants and you will be asked to indicate your agreement or disagreement about the importance of factors you collectively identified.

If you are willing to participate, please reply to this Email. You will then receive another e-mail, which will contain further directions for the study and the initial questionnaire as an attachment.

Your participation is voluntary and the names of individual participants will be kept confidential in all written records. With your participation, it is anticipated that crucial factors, which might be important in increasing female participation in various STEM fields, particularly in academia, will be determined.

Thank you very much for your time and assistance in this research. The results of the study will be available to all panelists upon request. If you have any questions, you may respond to this e-mail or call me at 814-779-0163 (cell).

Sincerely,

Phyllis B. Opare
Ph.D. Candidate, Old Dominion University

Cindy Tomovic, Ph.D.
Professor - Training Specialist
STEM Education and Professional Studies, Old Dominion University

APPENDIX B

DIRECTIONS E-MAIL FOR PARTICIPANTS IN DELPHI EXPERT PANEL

To: Female Faculty for inclusion in a modified Delphi study on female success and persistence in STEM.
Subject: Participation in a Research Study
Attachments: Questionnaire1.doc
Date: 12/13/2011

Dear Madam,

Thank you for your willingness to participate in this study. This e-mail and its attachments constitute Round 1 of a modified Delphi study to discover factors that female faculty in various STEM departments consider influential to their success and persistence as university faculty members.

I know that your time is precious and this survey will only take about 15 minutes of your time. Please respond by **12/27/2011**. The entire study is designed to be completed within a period of 10 weeks. A copy of the final consensus of factors as given by you and your counterparts will be made available to you if you so desire.

Please find attached to this Email the Round 1 questionnaire document. Answer the questions in the Microsoft Word document and return it to me as an Email attachment to popar001@odu.edu

I would like to reiterate that data gathered as part of this study will be treated with utmost confidentiality. Additionally, even though the results of this study may be used in reports, presentations, and publications, no one will be personally identified. Thank you very much for your time and assistance in this research.

Sincerely,

Phyllis B. Opare
Ph.D. Candidate, Old Dominion University

Cindy Tomovic, Ph.D.
Professor - Training Specialist
STEM Education and Professional Studies, Old Dominion University

APPENDIX C

ROUND 1 QUESTIONNAIRE

The purpose of this survey is to give you and the other participants an opportunity to generate a list of factors that you perceive as being influential to your success and persistence in your STEM career as a university faculty member.

Please consider all your educational and professional experiences as you answer these questions. Also, contrast your experiences with those of your female colleagues who at some point in their educational or professional career decided to leave the STEM field and the factors that made them leave.

For the first part of this round, please list various factors that you consider important to your success and persistence as a female academic STEM professional.

OPEN-ENDED DELPHI QUESTIONS

1. Please list up to five personal factors you believe have helped you to succeed and persist in your chosen career as a STEM faculty member. Personal factors are those that originate from within – a person's perception of themselves and their abilities to handle situation in their environment. Examples of personal factors include self-efficacy, tenacity of purpose, and intrinsic motivation.

I.
II.
III.
IV.
V.

2. Please list up to five social factors you believe have helped you to succeed and persist in your chosen career as a STEM faculty member. Social factors are those that are situated outside an individual's internal control, but exist in their environment or the larger society. Social factors include limitations and or expectations placed on a person as a result of expected social norms and cultural practices. The assignment of gender roles by society and role models or mentors are examples of social factors.

I.
II.
III.
IV.
V.

3. Please list up to five academic/institutional factors you think helped you to succeed in and persist in your chosen career as a STEM faculty member. Institutional factors are

events, practices, and procedures within institutions and the people involved in those institutions that influences a person's choices made at the institution. Examples include presence or absence of career counselors, gender cues and biases in instruction, active and intentional equity approach to teaching, learning, and institutional life.

I.
II.
III.
IV.
V.

4. Please list any other factors you think have helped you to succeed in and persist in your chosen STEM faculty career that does not fall under any of the above categories.

I.
II.
III.
IV.
V.
VI.
VII.

I would also appreciate it if you would answer the following demographic and professional questions. Although the answers to these questions will not form part of the modified Delphi technique, I will share results of the analysis with you and your colleagues so that you know how similar or different you are from the other participants in this study. Please feel free to answer as many questions as you are comfortable.

Demographic/Professional Data

What area of STEM and in what country did you obtain the following degrees?

Bachelor Degree: ______________________________

Country: ______________________________

Master's Degree: ______________________________

Country: ______________________________

Ph.D./Doctoral Degree: ______________________________

Country: ______________________________

Post-Doctoral Degree: ______________________________

Country: ______________________________

Did you ever change your educational major?

- ☐ Yes
- ☐ No

If yes, what was your original major? ______________________________

And what was your final major? ______________________________

How long have you been at your present position?

- ☐ Less than one year or

________ number of years.

Have you changed institutions in your professional career?

- ☐ Yes
- ☐ No

How many institutions have you worked for? ______________________________

Have you changed fields in your professional career?

- ☐ Yes
- ☐ No

If yes what other fields have you worked in?

- ☐ STEM
- ☐ Non-STEM
- ☐ Other field(s), list

How long did it take for you get tenured? _____ number of years

Did you ever meet with your high school guidance counselor to discuss career plans?

- ☐ Yes
- ☐ No

Did you meet with your college major academic advisor to discuss career plans?

- ☐ Yes, How often?
- ☐ No

Have you ever had a mentor in your professional career?

- ☐ Yes, How many?
- ☐ No

Have you ever mentored another STEM student or professional?

- ☐ Yes, How many?
- ☐ No

What was your mother's profession? ______________________________

What was your father's profession? ______________________________

Do you have brothers?

- ☐ Yes, How many?
- ☐ No

Do you have any sisters?

- ☐ Yes, How many?
- ☐ No

Are any of your siblings STEM professionals?

- ☐ Yes
- ☐ No

If yes, are the STEM professionals:

- ☐ brother(s)
- ☐ sister(s)
- ☐ both

Marital Status:

- ☐ Married
- ☐ Single
- ☐ Divorced
- ☐ Separated

Do you have any children?

- ☐ Yes
- ☐ No

If yes, how many are Girls? ____________________ Boys? ____________________

Race/Ethnicity:

- ☐ White
- ☐ Black or African American
- ☐ Hispanic or Latino
- ☐ American Indian or Alaskan Native
- ☐ Asian
- ☐ Native Hawaiian or Pacific Islander
- ☐ Multiracial
- ☐ Other:

Religious denomination: ____

Date of Birth: ____________________________________

Phone number (if I may call you with questions, answers, or further clarifications about your answers): ____

APPENDIX D

ROUND 1 FOLLOW-UP E-MAIL

To: Female Faculty for inclusion in a modified Delphi study on female success and persistence in STEM.
Subject: Participation in a Research Study
Attachments: Questionnaire1.doc
Date: 12-20-2011

Dear Madam,

On Monday **12-12-2011** I sent you an e-mail requesting your participation in a research project seeking to discover factors that female faculty is various STEM departments consider influential to their success and persistence as university faculty members in those departments.

I am excited that you consented to participate in this study. I anticipate that your input will greatly enhance the quality of the results of this study. I have therefore re-attached a copy of the questionnaire for your convenience. Kindly fill in your answers on the Questionnaire1 document and return it to me as an e-mail attachment.

I need your response by **Monday 12-26-2011**.

Thank you very much for your time and assistance. If you have any questions or problems, feel free to e-mail me or call me at 814-779-0163.

Sincerely,

Phyllis Opare
Ph.D. Candidate, Old Dominion University

Cindy Tomovic, Ph.D.
Professor - Training Specialist
STEM Education and Professional Studies, Old Dominion University

APPENDIX E

ROUND 2 DIRECTIONS EMAIL

To: Female Faculty for inclusion in a modified Delphi study on female success and persistence in STEM.
Subject: Round 2: Consensus Building
Attachments: Demographic distribution figures
Date: 01-11-2012

Dear Madam,

I appreciate your continued help with my research study. I understand how valuable your time is. This round will take much less time than the previous one, and is to be completed online.

This e-mail contains the link for Round 2 of the modified Delphi study. In Round 1 you were asked to list personal, social, academic/institutional, and other factors that have been influential to your success and persistence. All responses were grouped and redundancies reduced by an impartial panel of three education experts. These responses were used to produce questionnaire 2.

Attached you will find data and figures showing some of the demographic information of the participants in this study. A Delphi technique is designed to gain consensus among a group of experts, and the data shows that you qualify as an expert for this study. In Round 2 you are required to indicate your agreement or disagreement with the factors given by all the participants. Please go the site https://www.surveymonkey.com/s/STEMfemalefacultysuccessfactors and answer the questions. I need your responses to be submitted by **Wednesday 01-18-2012.**

Thank you for your continued support in this research study. Your individual role is really invaluable. If you have any questions, you may respond to this e-mail or call me at 814-779-0163.

Sincerely,

Phyllis Opare
Ph.D. Candidate, Old Dominion University

Cindy Tomovic, Ph.D.
Professor - Training Specialist
STEM Education and Professional Studies, Old Dominion University

APPENDIX F

ROUND 2 FOLLOW-UP E-MAIL

To: Female Faculty for inclusion in a modified Delphi study on female success and persistence in STEM.
Subject: Round 2 Follow-up
Date: 01-15-2012

Dear Madam,

A few days ago I sent you an e-mail asking you for your continued assistance with my research study. I referred you to the study website: https://www.surveymonkey.com/s/STEMfemalefacultysuccessfactors where the questions could be answered. As at 6:00 pm today Sunday, January 15, 2012, I have received 26 responses out of 43.

I would like to express my sincere thanks to those who have already answered the survey; you do not need to do anything else at this time. However, if you have not yet done so please go the link above and answer the questions by Wednesday January, 18, 2012. If you need a day or two to complete it please Email me. If I do not hear back from you the survey will be closed on the morning of Thursday January 19.

Please allow me to use this Email to address one particular concern that a few of you had expressed. Some of you are not happy with the forced response nature of the questionnaire. However, since we are seeking to build a consensus list of factors, we could not allow the "not applicable" or "not sure" options.

Once again, thank you very much for your time and assistance. If you have any questions or problems, feel free to e-mail me or call me at 814-779-0163.

Thank you,

Phyllis Opare
Ph.D. Candidate, Old Dominion University

Cindy Tomovic, Ph.D.
Professor - Training Specialist
STEM Education and Professional Studies, Old Dominion University

APPENDIX G

ROUND 2 QUESTIONNAIRE

Round 2 questionnaire and participant responses

Question 1: *Please indicate whether you strongly agree (SA), agree (A), strongly disagree (SA), or disagree (D) that the following personal factors (statements) are influential to your success and persistence as a female faculty member in a STEM field.*

Answer Options	SA	A	D	SA
Stubbornness/contrariness				
Natural Inclination for STEM				
Tom-boy – have better relations with males and enjoyed hobbies and pastimes traditionally considered masculine				
Enjoyment and or enthusiasm for work (STEM) (I am never bored)				
Determination in the face of challenges/adversity				
[Self-confidence]				
Ability to work independently				
Acceptance of being different				
High expectation of myself to succeed				
Willingness to sacrifice self to get a job done				
Intrinsic motivation (personal drive in the absence of external support)				
Curiosity				
Efficiency				
Ability to multi-task				
High intelligence				
Flexibility (ability to adapt to diverse situations)				
Kindness				
Exercise – physical and as well mental exercises to get work done and keep my mind alert				
Ability to keep things in perspective				
Goal-oriented				
[Strong sense of purpose]				
Strong time-management skills				
Focused				
Recognized my STEM field as a great opportunity for a satisfying profession/job				
Wanted to do and be something other than be a mom				
Self-efficacy (belief in self ability to accomplish any task)				
Desire, commitment to, and passion to learn				
Persistence (ability to stay focused and strategic over time)				
Positive attitude - ability to see beyond current crisis				
Resource mobilization and improvisation skills				

Answer Options	SA	A	D	SA
Ambition				
Competence				
Good Organizational skills				
Competitiveness				
[Good interpersonal skills/ability to collaborate]				
Hard worker				
Tenacity (moving forward despite "it can't be done" or "we're not interested in what you do" because I believe it is important)				
Risk taker				
The thrill of being pioneer or trailblazer in my STEM field				
Optimistic				
Belief that I could make a difference for other female scientists like myself				
Good personal work ethic				
Rebellious nature				
A sense of humor				
Skeptical about everything				
Great intuition (sense of right or production choice in a given situation)				
Type A personality				
Maintain distance from students - they tend to make female faculty into surrogate mothers or girl friends				
Ability to tolerate frustration				
Creativity within STEM				
Emotional stability				
[Mathematics-efficacy (believe that I am good at Mathematics and can excel in it)]				
[Science-efficacy (believe that I am good in science and can excel in it)]				
Pride and gratification in knowing that my accomplishments in STEM is making a difference				
Appreciate the prestige associated with my profession				
Good communication skills (written and oral presentation)				
Don't mind being alone in the middle of a group				
High personal self-esteem				
Capacity for working long hours				
Willingness to take on new challenges				
Willingness to take credit and responsibility for my actions				
Ability to shake off minor insults, resistance, biases, or problems and move on.				
Personal integrity				
Technical grasp of broad issues				
Ability to work with people on multiple levels				

Answer Options	**SA**	**A**	**D**	**SA**
Love to figure things out				
Logical thinker				
Good writer				
Strong willed				
Patience- recognition that it is a "long game"				
At peace with decisions				
Persistent feeling of inadequacy (sure, I accomplished this, but it was too easy because I am a big fish in a small pond)				
Enjoy making a difference in students' lives				
Passion for passing on knowledge and skills				
Need to have a steady paycheck				
Talent				
Refusal to allow myself to fail				
I don't think other fields have as much value to society				
Need to keep up in my STEM field				
Problem-solver				
Independent				
Question-driven				
Critical thinking skills				
Idea-oriented				
Kind of a loner and liked to read a lot				
Naiveté – not being aware initially of the dearth of females in my STEM field				
Dealing with stress/workload proactively				
Seeing other women in field give up on their dreams made me more determined to persist				
Seeing other women in my field change who they are to suit the dominant male culture made me determined to succeed and be myself				
Do not want the expense and time needed to retrain in other fields				
Academic position gives me opportunity to reach out to the larger community and impact them				
Wanted to contribute to my country's socio-economic development and advancement through STEM				
Wanted to help fill job shortage in STEM				
Grew up with five brothers which made me able to navigate a male-dominated field				
Significant work experience from industry				

Question 2: *Please indicate whether you agree or disagree that the following social factors (statements) are influential to your success and persistence as a female faculty member in a STEM field.*

Family members as role-models

Answer Options	SA	A	D	SA
Stable marriage				
Supportive spouse				
[Supportive family (parents, siblings, children, etc.)]				
Supportive faculty (male and female)at undergraduate and graduate level				
Good and influential teacher(s) and professor(s)				
Supportive female mentor(s)				
Supportive male mentor(s)				
Need to support my family				
Timing of child bearing				
Need to provide a stable environment for my children				
Opening of education opportunities for females to enroll in engineering schools in early 1970's				
Defying social norms, particularly the ones in academia				
Positive female role models (in STEM and other fields)				
Positive male role models				
Positive effect of gender roles: Being a woman in a male dominated field – more opportunities for women				
Negative effect of gender roles: difficulty in interacting with male faculty members at times				
Networking with other female science-oriented friends				
Ignoring societal expectations				
Mutual respect of department members and or support from colleagues				
Positive interaction with students				
Low incidence of gender-based discrimination				
Supportive friends who encouraged me				
Legal movement towards equality for women in business				
Availability of excellent schools				
[Supportive and/or ender neutral/affirmative minded supervisors/bosses]				
Work in a professional organization that is highly diverse				
[Family position (first born)]				
Age at beginning of degree program				
Job Experience at beginning of degree program				
Poverty				
Societal respect for higher learning				
Desire to provide alternative role model for my daughters				
Desire to "prove" that women are as good as men				
Good support group				
Success encourages more success				
Good daycare options (but none on campus back when I needed it)				

Answer Options	SA	A	D	SA
High earning/pay in my STEM field				
Luck				
Industrial applicability of my research area				
Need for improvement in the quality of lives of people and families was perceived by me at an early age				
Career opportunities and job market abound in STEM				
Knowledgeable friends				
Society's expectation of a contribution from its members				
Supportive professional organization(s)				
Recognition that "being smart" is "good" by most people				
Age of child/children when I entered academia				
Non-tenure track position was a good fit				
Academically competitive brothers and sisters				
Financial aid through government programs allowed me to attend college				
Opportunities for empowerment - High school sports for girls, Girl Scouts				
[Women's' Rights Movement]				
[I was raised without much TV/influence from popular culture]				
Determination to go against the tide and prove that minority can succeed				
My background (immigrant, first generation to complete graduate education, in me)				
Enabling work environment				
Desire to be a role model to my kids and others				
I have been lucky not to encounter the kind of in-your-face discrimination that many women have to put up with.				
Availability of excellent equipment for research				
Culture for research integrated into undergraduate years				
Acceptance and support by male colleagues in my department				
Exposure to unconventional learning experiences (inside and outside the USA)				

Question 3: *Please indicate whether you agree or disagree that the following academic/institutional factors (statements) are influential to your success and persistence as a female faculty member in a STEM field.*

Answer Options	SA	A	D	SD
I felt no gender bias from my academic institution at any level				
Opportunity to serve on boards and committee				
Being a minority representation on committees and boards				
Pressure on institutions to increase gender equity in STEM				
Grants and funds geared towards gender equity in my field				

Answer Options	SA	A	D	SA
Unrestricted curriculum that allowed coursework in women's studies as undergrad and grad student				
Small class sizes				
Extensive lab experiences in undergraduate and graduate research opportunities increased my desire to go further in STEM				
Relevant work-study opportunities as undergraduate				
Equity in teaching and research responsibilities on campus				
Equal opportunities for teaching assistant assignment to faculty members				
Equity during the promotion and tenure process				
Equal opportunities for research funding from the institution				
Equal opportunities for departmental or institutional training (including sexual harassment training which was required by all employees)				
Institution that was intentional about gender equity (Equity by-laws written down)				
Awareness of institutional policies sexual harassment training (this from industry, not academia).				
Flexible schedule				
Respect for individual strengths among colleagues				
Senior faculty/department head supportive of junior colleagues' needs				
Freedom to determine individual research priorities and service roles				
Networking and collaboration opportunities				
Encouraging and supportive teacher's and faculty				
Opportunity to be a role model				
Institutional expectations of success fit my expectations of performance				
High expectation of academic excellence in my department				
Institutional mentoring opportunities				
The institution had a neutral or laissez fair approach to faculty development.				
An ill-defined part-time position that allowed me considerable freedom				
A campus environment that was somewhat ready for change				
Small Ph.D. program				
[Availability of financial support (grants, scholarships, assistantships, and fellowships)]				
Flexible Ph.D. track				

Answer Options	SA	A	D	SA
Institution moved students who entered the undergraduate program through it as a cohort, which generated a sense of camaraderie and provided a supportive environment in my studies and outside of classroom				
Presence of female faculty in undergraduate/graduate [institution]				
Institution encouraged students to give talks and engage with the professional community early in our academic careers				
Undergraduate faculty expected women to perform as well as men				
Exposure to and interaction with women in STEM in various ways during undergraduate/graduate				
Graduate school participation in women Ph.D. and MD student group				
Faculty/advisor/supervisor was sexist and racist, which made me all the more determined to succeed				
UCSD allowed me to submit my first R01 without having an appointment anywhere				
Positive feedback from students				
Faculty/advisor/supervisor, gender sensitive and supportive				
Great collegiality in my department and institution				
Positive feedback from colleagues				
Presence of other female professionals in my department and institution				
Opportunity to do top-quality research (infrastructure present)				
Protection from excess service obligations as an untenured faculty				
Lowered teaching load as an untenured faculty				
Institutional commitment to increasing female faculty presence and success on campus				
Institutional commitment to assisting with dual-career situations				
Institutional support for request for extension of tenure clock for child-birth				
My current university employer actively sought to retain me when I received a competing job offer.				
Programs/events that exposed me to STEM and STEM professionals in Elementary and or High school made a lasting impact				
ADVANCE program				
WISE group				
Departmental incentives for funded research				
Career advancement clearly documented and achievable				
Faculty voice held authority				
Clear System for rewards and achievements (e.g. toward tenure)				

Answer Options	**SA**	**A**	**D**	**SA**
Networking and open communication with administration				
Support in graduate school for my research				
Support in graduate school encouraging my career path				
Institutional meritocracy -- good work is what matters				
Willingness of academic institution to consider alternate career pathways				
Expectation of mutual respect on all levels in my department/institution				
Departmental coffee pot gathering every day				
Equal opportunities for continuing education and professional development				
Support for travel to meetings and conferences				
Well-respected colleagues who are collegial in attitude				
Tacit assumption that being a professor with a lab was the epitome of being a scientist				
Opportunity to negotiate terms of employment, work, and resource distribution				
Great advising office				
Faculty/supervisors (male/female) encouraged mentored both male and female students to succeed in STEM				
Male mentors/professors who did not have a gender bias (because they had successful wives or daughters)				
Department had a culture of teaching excellence				
As a student, willingness by faculty to accept (at least in part) female students				
Promotion tenure committee selected for each faculty member, and having another female on that committee				
Well developed new faculty development program				
Involvement with student organization				
Faculty position is flexible and promotes good work family balance				
Incorporation of workshops/round tables regarding best teaching practices				
Inclusion on institutional, local, regional, and or national agencies' review panels				
Student-organized discussion groups/seminar series				
International opportunities (courses, workshops, post-doc)				
Equal opportunities for funding projects				
Working on high profile events in my field (e.g., planning research conferences)				

APPENDIX H

ROUND 3 DIRECTIONS EMAIL

To: Female Faculty for inclusion in a modified Delphi study on female success and persistence in STEM.
Subject: Round 3: Refining the list of factors
Attachments: Round 2 Results
Date: 01-25-2012

Dear Madam,

Once again, I will like to express my sincere appreciation for your continued support for this study. This e-mail and its attachment are the third and final Round of the study, and it is intended to refine and validate the factors that participants collectively agree has been influential in their success and persistence.

In Round 1 you provided input for a base list of factors you perceive as being influential to your success and persistence as a female STEM faculty. Based on your input and that of your colleagues, a questionnaire was designed aimed at obtaining consensus among all participants, about factors that were mutually influential to your success and persistence.

In Round 2 you were asked to indicate your agreement or disagreement about each of the factors provided. In Round 3 you are being asked to compare your Round 2 responses with the answers of the other participants, and revise your answers if you chose to. This will help refine the list of factors so that a final list that applies to the majority of the participants will emerge.

This is the last round of the research, and I will be very grateful if you can go the website and submit your answers by Friday 02/04/2012. Here is the link to the survey; https://www.surveymonkey.com/s/R3STEMfemaleFacultystudy_Opare8895JW7 . Please know that your individual role is really invaluable. There are currently 38 participants in the study.

If you have any questions, you may respond to this e-mail or call me at 814-779-0163. Please return your questionnaire to me by Saturday, February, 4th 2012.

Sincerely,

Phyllis Opare
Ph.D. Candidate, Old Dominion University

Cindy Tomovic, Ph.D.
Professor - Training Specialist
STEM Education and Professional Studies, Old Dominion University

APPENDIX I

ROUND 3 FOLLOW-UP E-MAIL

To: Female Faculty for inclusion in a modified Delphi study on female success and persistence in STEM.
Subject: Round 3 Follow-up
Date: 02-04-2012

Dear Madam,

I would like to express my sincere thanks to you for your continued support in this study. We had 38 participants going into Round 3, and as at 6am today, Saturday February 2, 2012, 31 of you have completed the survey. Thank you very much if you have completed Round 3.

Since I send everyone the same link, I have no way of knowing who already completed the survey. Therefore, if you have not yet completed Round 3 please go the link https://www.surveymonkey.com/s/R3STEMfemaleFacultystudy_Opare8895JW7 and answer the questions today. If you need a day or two to complete it please Email me. If I do not hear back from you the survey will be closed on the evening of Monday February 6, 2012, new date as per one request.

As I promised in the invitation Email, I will make copies of the final list of factors available to you. Once this dissertation is published, I will also make the link available to you so you can look at the complete work. I appreciate the wonderful suggestions many of you gave for further studies, and others that I believe has improved the quality of the current study.

Once again, thank you very much for your time and assistance. If you have any questions or problems, feel free to e-mail me or call me at 814-779-0163.

Sincerely,

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Education

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- M.Ed., Science Education, Clarion University of PA, Clarion, PA, May 2006
- B.Ed., Technology, University of Education of Winneba, Kumasi, Ashanti, Ghana 1999

Experience:

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- Graduate Teaching Associate, Old Dominion University, Norfolk, VA, 2006 – 2008
- Headmistress, Kingsby Methodist Girls High School, Koforidua, ER, Ghana, 2003 – 2005
- Subject Tutor, Koforidua Secondary Technical School, Koforidua, ER, Ghana, 1999 - 2005

Memberships:

- International Technology and Engineering Educators Association
- Society of African Physicists and Mathematicians
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Presentations:

Opare, P. B. (2011). Factors that female higher education faculty in select science, technology, engineering, and mathematics (STEM) fields perceive as being influential to their success and persistence in their chosen professions. Presented at the International Technology and Engineering Educators Annual Conference, Minneapolis, MN.

Opare, P. B. (2009). Factors Influencing Female Persistence and Success in STEM fields and Majors. Presented at the International Technology Education Annual Conference, Louisville, KY.

Opare, P. B., & Skophammer, R. (2008). Theatrical set design – a design activity for elementary students. Presented at the Annual Virginia Children's Engineering Convention, Richmond, VA.

Reed. P. A., Ritz, J. M., Moye, J., Skophammer, R., Frazer, M., & Opare, P. B. (2008). Yes, there is research support for technology. Presented at the International Technology Education Annual Conference, Salt-Lake City, UT.

Opare, P. B. (2008). Factors that influence females' persistence in science, technology, engineering, and mathematics (STEM) majors at ODU. Presented at the Virginia Council of Graduate Schools' Graduate Student Research Forum, Richmond, VA.