AN ENGINEERING JOURNEY: A TRANSCENDENTAL PHENOMENOLOGICAL STUDY OF AFRICAN-AMERICAN FEMALE ENGINEERS' PERSISTENCE

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A Dissertation Presented in Partial Fulfillment
Of the Requirements for the Degree
Doctor of Education

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ABSTRACT

This transcendental phenomenological research study examined the perspectives and lived experiences of African-American female engineers related to the factors that led to their persistence to enter, persist through, and remain in the field. The study was guided by four research questions: (a) How do K-12 experiences shape African-American female engineers' decisions to enter the STEM field? (b) What persistence factors motivated African-American female engineers to enter the engineering profession? (c) What are the factors that shape African-American female engineers' persistence to progress through postsecondary engineering programs? (d) How do professional experiences shape African-American female engineers' persistence in the field? Cognitive interviewing techniques were used to validate data collection instruments. Interviews, focus groups, and timelines were used to collect data aimed at capturing the essence of the phenomenon of African-American engineers' persistence. The data was analyzed using Moustakas' (1994) phenomenological data analysis methods. The findings indicated that early academic experiences and achievement shaped participants' decision to enter the engineering field. Environmental factors, intrinsic motivation, support systems motivated participants to persist through postsecondary programs and to enter the engineering field. Further research is needed to examine the early academic experiences that encourage African-American females to enter engineering. In addition, research is needed to examine the barriers that lead to attrition of African-American females in engineering.

Keywords: Science, Engineering, Technology, and Mathematics Engineering (STEM), Underrepresentation, Persistence

Dedication

This dissertation is lovingly dedicated to my mother, Teresa Somerville. Your unconditional love and support has encouraged me to strive to reach this goal. You have always believed in me even when I did not believe in myself. You have always challenged me to be better and do better. I am so thankful for this moment to make you proud.

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List of Abbreviations

National Action Committee on Minorities in Engineering	NACME
Bureau of Labor and Statistics	BLS
Science, Technology, Engineering and Mathematics	STEM

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CHAPTER ONE: INTRODUCTION

Overview

This chapter presents a foundation of the study. The purpose of this transcendental phenomenological study is to examine the academic and occupational experiences of African-American female engineers and the factors that led to their persistence (reasons for remaining) within the field in the United States. In this chapter, I discuss the background and provides a synopsis of current literature in science, technology, engineering, and mathematics (STEM), particularly engineering. In addition, I explain why this study has academic, collegiate, and professional implications. The problem (need for the research) and purpose are discussed. Research questions are provided to examine the African-American female engineers' persistence in the profession. This chapter concludes with an overview of the research plan and delimitations for the study.

Background

Science, technology, engineering, and mathematics (STEM) education is essential in today's technological age. It is projected that approximately 1.2 million more jobs in the United States will be available in STEM in the next seven to ten years (U.S. Department of Labor, Bureau of Labor Statistics, 2012). Over the last two decades, the state of STEM has been a topic of industry and academia. Students in the United States are earning degrees in STEM at staggeringly low rates. American college students are earning fewer degrees in engineering than the other areas of STEM, such as math, science, and technology. Approximately 14% of United States college students earn a degree in science or engineering, in comparison to 33% to 50% in China and Singapore (Soldner, Rowen-Kenyon, Inkelas, Garvey, & Robbins, 2012).

Males constitute approximately 86.6% of the 2.5 million employed engineers in the United States. This staggering statistic is coupled with the fact that of that 2.5 million, only 5% are African-American. Less than 2% of the 2.5 million engineers are African-American women (U.S. Department of Labor, Bureau of Labor Statistics, 2012). African-Americans in general represent 13.1% of the population in the United States (United States Census Bureau, 2012). In reviewing these statistics, questions arise concerning the barriers, real or perceived, that hinder women and African-Americans from pursuing careers in STEM, particularly engineering. The aforementioned statistics have encouraged researchers to study the causes of this underrepresentation in engineering. There is evidence to suggest that childhood experiences may have a major impact on African-American females' interest in engineering (Elam, Donham, & Solomon, 2012).

Childhood experiences may influence self-concept and perceived career competence (Lent, Brown, & Hackett, 1994). There is evidence to suggest that girls' perceptions of STEM are negative (Tyler-Wood, Ellison, Lim, & Periathiruvadi, 2012). There are belief systems and mindsets that hinder young women in their pursuit of STEM careers. The male gender-specific nature of STEM fields may pose a hindrance to female interest (Jones, 2010). "Girls and women with a growth mindset are also less likely to believe in the stereotypes that girls are not as good as boys in math and that men are better suited to scientific careers than are women" (Jones, 2010, p. 60). This perception or mindset at an early age may affect their self-concept (Jones, 2010). Unfortunately, it has been ingrained in young girls to believe that boys are better in math and science (Jones, 2010). These beliefs in childhood translate into self-concept at the collegiate level. African-American women, in comparison to their peers, earn fewer undergraduate degrees (Soldner et al., 2012). There may be systematic barriers that prevent African-American women

from pursuing or persisting in STEM (Espinosa, 2011). Programmatic changes at the undergraduate level may prove beneficial to African-American women in STEM (Reyes, 2011).

Current research regarding African-American women in engineering focuses on the quantitative nature and provides statistics regarding how many have persisted in the field. There is information regarding the number employed, degree attainment, and perceived factors that may have hindered these women from entering the field. There is research regarding the perceptions of high school (Cantrell & Ewing-Taylor, 2009) and college engineering majors (Espinosa, 2011). "Unfortunately, there is little research about the experiences of women of color in STEM…students, especially regarding factors that affect attrition rates and persistence in STEM programs" (Reyes, 2011, p. 3). There is no current research that examines African-American female engineers' perspectives specifically. The proposed research will contribute to the literature of educational and engineering fields. The examination of those persistence factors is beneficial to the literature of educational and engineering fields.

Situation to Self

As a division level secondary administrator and former special education teacher, my beliefs are rooted in the social constructivist paradigm with ontological philosophical assumptions. I believe that we as individuals construct our own knowledge and perceptions based on the information we learn. I share the characteristics of being a college-educated African-American female with the participants. Science, Technology, Engineering, and Math (STEM) education for young women, particularly African-Americans, is of great interest to me. During my K-12 academic years, I was heavily involved in STEM projects, competitions, and activities. This interest continued into my collegiate studies. However, I made a choice during my junior year of college to discontinue that path. There were several reasons for changing

majors. Although I chose a different route, I am particularly interested in others who continued and were successful on their journey into the STEM workforce, particularly in engineering, where the disproportionality exists. As an administrator, it is important for me to promote the inclusion and participation of underrepresented groups in STEM.

Problem Statement

In 2010, there were 135,846 engineering degrees awarded in the United States. Twenty percent of all engineering degrees went to women (Society of Women Engineers, 2012). Approximately 3.67% of engineering degrees were awarded to African-Americans (National Action Committee on Minorities in Engineering, 2010). African-American women represent roughly 13% of females in the United States. However, less than $1/8^{th}$ of this 13% are represented in engineering (Center for American Progress, 2013). African-American women represent only 1.44% of individuals who earned a degree in engineering (National Action Committee on Minorities in Engineering, 2010).

There are over 2.5 million engineers employed in the United States workforce (National Action Committee on Minorities in Engineering, 2010). There is a projected need for 178,000 engineers in the next decade (Byars-Winston, Estrada, & Howard, 2008). In order to meet the increasing labor needs, it is imperative that underrepresented groups, such as women and minorities, are encouraged to enter and remain in the field. Of the 2.5 million engineers employed in the United States today, women represent 13.4% (National Action Committee on Minorities in Engineering, 2010) of that workforce, while African-Americans represent 5% (National Action Committee on Minorities in Engineering, 2010). The percentage of African-American women engineers is even lower. African-American women comprise approximately 1.65% of the total number of engineers in the United States (National Action Committee on

Minorities in Engineering, 2012). In summation, the investigated problem represents the limited information regarding the perspectives of African-American female engineers and the factors that led to persistence in their engineering journey.

Purpose Statement

The purpose of this transcendental phenomenological study is to examine the academic and occupational experiences of African-American female engineers and the factors that led to their persistence (reasons for remaining) within the field in the United States. At this stage in the research, For this study, persistence was defined as 4.5 or more years of experience in the engineering field, with intention to remain in the profession (Reyes, 2011). The theories guiding this study were the Social Cognitive Career Theory and Tinto's Theory of Persistence.

Significance of the Study

This transcendental phenomenological study of African-American female engineers is significant because of its contributions to educational settings, the engineering profession, and the theoretical and empirical literature.

Academic and Collegiate Implications

The findings from this study may enable K-12 and collegiate institutions to understand the processes of the underrepresented group. There are "several statistics [that] illustrate gaps in the preparation of African-Americans for educational attainment in STEM fields [such as engineering, science, and technology]" (Perna et al., 2009, p. 3). The information will generate ideas and provoke interest in the successes and obstacles of the participants. Espinosa (2011) suggested that support and involvement in activities at the collegiate level relating to the STEM programs proved effective for the retention of African-American women in these majors. Furthermore, it provides an opportunity for educators to view women in STEM, particularly

African-American women interested in engineering, through another lens, which may ultimately affect practices for supporting the persistence of this group.

Professional Implications

The findings from this study will provide an opportunity for employers to see African-American female engineers through a new lens. Gender and race may play a role in the work environment for some. Unfortunately, "being a numerical minority in work settings can activate gender stereotypes" (Richman, vanDellen, & Wood, 2011, p. 493) which may influence the level of comfort for those affected. This lens will allow employers to explore the group's unique perspectives. In turn, employers will be able to review their diversity policies and procedures to ensure that they attain and maintain a diverse engineering workforce (Gill, Sharp, Mills, & Franzway, 2008).

Contribution to the Literature

The current research suggests that there is a disparity in African-American engineers in comparison to other groups (National Action Committee on Minorities in Engineering, 2010). There is information regarding the quantity of African-American females earning undergraduate and graduate engineering degrees and those who have entered the field (National Action Committee on Minorities in Engineering, 2010). It is difficult to find data that examines the perspectives of African-American female engineers regarding the factors that led to their persistence to enter and remain in the field. The lack of data regarding the persistence factors leaves an empirical gap in the literature. The examination of the unique perspectives of the persistence of this underrepresented group is significant in the future development of programs and opportunities.

Research Questions

The following research questions guided the study:

1. How do K-12 experiences shape African-American female engineers' decisions to enter the STEM field?

The exploration of K-12 and childhood experiences is imperative in exploring the factors that helped these women develop their interest in STEM, particularly engineering. "It is commonly believed that boys have higher academic achievement in STEM than girls, but some literature suggests that the gender gap is less of an ability gap than a gap in perceptions of science careers" (Tyler-Wood et al., 2012, p. 46). Boys traditionally have exhibited a higher interest in STEM than girls (Chang, Yeung, & Cheng, 2009). In addition, parent and teacher attitudes towards girls in STEM may affect their interest and/or perception of ability (Bhanot & Jovanovic 2009). Interview, focus group, and timeline data are gathered, coded, and analyzed to explore the K-12 and childhood experiences of African-American female engineers.

2. What persistence factors motivated African-American female engineers to enter the engineering profession?

Previous studies on African-American female engineers expressed that career intentions and confidence may be determining factors on persistence to enter the profession (Cech, Rubineau, Silbey, & Seron, 2011). African-American women represent less than 2% of engineers in the United States (National Action Committee on Minorities in Engineering, 2010). Therefore, it is imperative to examine the factors that motivated this unique group to persist and enter the engineering profession. The exploration of these factors will enable me to understand the final leg of the journey for the purposes of this study. Interview, focus group, and timeline data are

gathered, coded, and analyzed to explore the factors that motivated African-American females to enter the engineering profession.

3. What are the persistence factors that shape African-American female engineers' persistence to progress through postsecondary engineering programs?

The exploration of the collegiate experiences of African-American female engineers is imperative to understand the journey towards becoming an engineer. Opportunities to conduct research at the undergraduate level have been an indicator for success of minority students in STEM (Woodcock, Graziano, Branch, Ngambeki, & Evangelou, 2012). Evidence has suggested that women engineering [STEM] majors exhibited higher dissatisfaction than men (Morganson, Jones, & Major, 2010). Interview, focus group, and timeline data are gathered, coded, and analyzed to explore the factors that shaped African-American female engineers to persist through a postsecondary engineering program.

4. How do professional experiences shape African-American female engineers' persistence in the field?

Since African-American women comprise 1.65% (National Action Committee on Minorities in Engineering, 2012) of the engineering workforce, it is important to explore the daily journey within the field. African-American women are more likely to serve as engineering technicians as opposed to managers (National Action Committee on Minorities in Engineering, 2010). Attrition for African-American female engineering majors is disheartening (Perna et al., 2009). Therefore, focus on the factors that lead to persistence is important for advancing the field and the literature. The disparities of African-American women in higher-level engineering positions may have an impact on the participants and need to be explored. In this study, interview, focus

group, and timeline data are gathered, coded, and analyzed to explore the professional experiences that shaped African-American female engineers' decisions to persist in the field.

Research Plan

This study employed a transcendental phenomenological approach to examine the unique experiences of African-American female engineers' persistence through their own lens. The transcendental aspect of the research design allowed participants' conscious thoughts to evolve into their own perceptions, realities, and truths. The transcendental process allows for the "consciousness [and] the internal experience of being conscious of something" (Moustakas, 1994, p. 28). The transcendental process allowed me to remain disciplined in her efforts to examine the participants' realities. In addition,

> the researcher following a transcendental phenomenological approach engages in disciplined and systematic efforts to set aside prejudgments regarding the phenomenon being investigated . . . in order to launch the study as far as possible free of preconceptions, beliefs, and knowledge of the phenomenon from prior experience and professional studies to be completely open, receptive, and naive in listening to and hearing research participants describe their experience of the phenomenon being investigated. (Moustakas, 1994, p. 22)

The transcendental phenomenological approach allowed me to examine the perspectives of the participants' persistence through their engineering journeys.

Delimitations and Limitations

This transcendental phenomenological study is confined to the unique experiences of African-American women in engineering; there are a number of limitations and delimitations. Participants in this study will meet the following criteria: African-American females who are

currently employed as engineers for a minimum of 4.5 years. According to the Bureau of Labor and Statistics, the average career life is 4.5 years prior to switching careers for people currently entering the workforce (U.S. Department of Labor, Bureau of Labor Statistics, 2012). African-American is defined as an individual of African descent (Merriam-Webster's Collegiate Dictionary, 2003). It is indicated that it may include individuals of Caribbean descent. The cultural context for which individuals of color from African or Caribbean descent identify themselves within the United States (Nasir, 2012) is another way African-American is defined in this study. Females are identified as individuals not of the male gender.

CHAPTER TWO: LITERATURE REVIEW

The purpose of this transcendental phenomenological study is to examine the academic and occupational experiences of African-American female engineers and the factors that led to their persistence (reasons for remaining) within the field in the United States. For this study, persistence was generally defined as 4.5 or more years of experience in the engineering field, with the intention to remain in the profession (Reyes, 2011). This chapter begins with the theoretical framework that includes two relevant theories to the study: (a) Social Cognitive Career Theory, and (b) student persistence and retention theory that provide a foundation for the research. The theoretical framework guiding the study is derived from Lent, Brown, and Hackett's (1994) Social Cognitive Career Theory (SCCT), and Vincent Tinto's theories of college student persistence and retention (1997). These theories frame the lens from which the study of the African-American female engineers' journey will be told. In addition, the chapter encompasses reviews from significant bodies of literature: (a) engineering and the educational system, (b) engineering and gender, and (c) engineering and race. The first body of literature to be examined is the K-12 and postsecondary educational practices for implementation of STEM, particularly engineering. A review of current studies was conducted to gain insight into the successes and barriers to providing engineering principles. The second body of literature examined was the implications for race and gender in engineering. The chapter concludes with a summary of the literature review.

Theoretical Framework

The exploration of the phenomenon of African-American females in engineering is grounded in the foundation of two theories: Social Cognitive Career Theory (Lent et al., 1994) and Tinto's persistence and retention theory (Tinto, 1997). These theories lend themselves to the question of the African-American female engineers, their persistence in the field, and their shared experiences as they relate to their journeys of persistence.

Social Cognitive Career Theory

The social cognitive career theory (Lent et al., 1994) lends itself to the question of African-American females' decision to pursue a career in engineering. Social cognitive career theory "derived primarily from Bandura's 1986 general social cognitive theory, emphasizes the means by which individuals exercise personal agency in the career development process, as well as extra-personal factors" (Lent et al., 1994, p.79). The theory is based on three building blocks of career development: self-efficacy, outcome expectations, and personal goals. Although, "no comprehensive model of career development" involving only African-Americans is present in the literature, these three aspects are interrelating to race and gender (Hackett & Byars, 1996, p. 44). SCCT involves the examination of active traits and characteristics that enable individuals to choose and remain in a career.

Career development is multi-faceted and complex. The complexities lend themselves to the intricate nature of one's interests, skills, abilities and efforts and how they relate to career choice (Lent et al., 1994). Career and academic behaviors are at the heart of the SCCT. In one's early academic schooling, the framework is developed to guide future career aspirations. In addition to career and academic behaviors, there are distinguishing features that make this theory unique (Lent et al., 1994). First, interest and achievement are intertwined in the model. Self-

efficacy is an active attribute where individuals set goals and actively pursue them (Lent et al., 1994). Also, there are fixed attributes that, when coupled with self-efficacy, providing the desired results. Finally, one's personal beliefs and experiences are interlocked with the preceding characteristics that are the foundation of the SCCT (Lent et al., 1994).

Two major aspects of the participants' lives that are explored are the K-12 and postsecondary educational experiences that helped shape their engineering career choice (Lent et al., 1994). Research on early STEM education and practices indicates that one's interest is related to [early] exposure. Therefore, the "interest in [a] particular academic or career-relevant activity depends, in part, on the outcomes that are anticipated to result from participation in the activity . . ." (Lent et al., 1994, p. 91). Early experiences greatly affect one's self-efficacy, outcome expectations, and goals. Furthermore, there may be a correlation between an individual's participation in career and educational opportunities and potential outcomes (Lent et al., 1994).

Tinto's Theory of Persistence

A significant focus in higher education research has been on student retention and the factors that enable students to persist and graduate (Tinto, 1997). Although there has been focus on the persistence of college students, the results have been wavering over the last decades. Lack of academic ability and motivation were perceived as reasons why students did not persist in college (Tinto, 1997). There is a belief that if the student failed and did not remain in college, this setback cannot be attributed to the institutional framework. This belief minimizes the college or institution's responsibility for student failure or attrition. Tinto (1998) believes that when students are separated from familiar structures, such as home and community, and are unable to make adequate connections in college, they may be unable to remain and persist.

Persistence may be linked to the level of student involvement in the college community (Tinto, 1997). The level of student integration and involvement is critical to student retention as well (Tinto, 1997). There is a link among classroom effort, involvement, and college community connectedness that contribute to student persistence (Tinto, 1997). Tinto's theory of student retention and persistence directly correlate to African-American females' persistence in undergraduate and/or graduate studies in engineering.

Higher education student retention and persistence relate to the question regarding the factors that led African-American females to persist and attain engineering degrees. There have to be certain conditions in place for students to persist in higher education (Tinto, 1997). There are "five conditions [that] stand out as supportive of persistence, namely expectations of persistence, advice, support, involvement, and learning" (Tinto, 1997, p. 4). There must be an expectation of success. There must be a level of support in terms of financial, emotional, and/or academic. Students must feel as if they are valued and learning. Tinto (1997) encourages the use of institutional policies that will enable students to persist through college. Tinto's (1997) theory of persistence and college student retention are applicable because the present study examines the factors that led to African-American females remaining in college and persisting in order to graduate.

The Social Cognitive Career Theory, Persistence, and Retention Theories provide a meaningful foundation to the course of study and thus serve as the theoretical framework that guides the examination of the engineering journey for participants (Tinto, 1997). The social cognitive career theory provides a lens for examining the participants' early interests, achievements, and personal beliefs that guided their decisions to pursue engineering. The theory of persistence and retention will assist with the understanding of the factors that encouraged the

African-American females to remain in college, persist to graduation, and enter the field of engineering.

Related Literature

Engineering and the K-12 Educational Setting

The concern for increasing the workforce in STEM has not wavered since the 1980s when the A Nation at Risk report was published. Concerns regarding "our once unchallenged preeminence in commerce, industry, science, and technological innovation is being overtaken by competitors throughout the world" are now being challenged (A Nation At Risk, 1983). STEM education continued to remain a prevalent issue in the 1990s in the United States (Bybee, 2010). At its inception, many educators did not fully understand the STEM curriculum, design, and implementation.

Researchers suggested that many educators were unaware and not adequately prepared to implement advanced mathematical and scientific concepts into everyday learning. Educators and researchers have examined how to advance STEM and encourage students' interest in early grades (Bybee, 2010). There is a great need for the inclusion of engineering concepts into the K-12 curriculum. Currently, the implementation of engineering in public schools does not prepare students for future careers in the field. The occupational outlook exhibits continual growth for which we will not have the supply to meet the demand (Bybee, 2010). The lack of exposure to STEM in their early academic studies correlates to limited interest in later years (Rockland et al., 2010).There has been much discussion regarding the catalyst of the problem that creates a lack of exposure to engineering concepts.

Researchers suggest that the problem lies with how engineering concepts are being identified and taught. The concepts are being taught in isolation and not embedded in the 21st

century skills focus (Bybee, 2010). An "integrated curricular approach" is necessary to garner students' interests as early as in elementary school (Bybee, 2010, p. 31). Engineering concepts can be embedded in early math and science courses. In addition, experiential and hands-on activities help students to apply the learned concepts. Without the integrated approach, there is an overreliance and urgency to grow interest at the high school and collegiate level, which is often too late (Rockland et al., 2010). For those individuals who may enter the pipeline later than recommended, there are bridge programs that assist students to close the gaps between high school and college (Zhe, Doverspike, Zhao, Lam, & Menzemer, 2010). These bridge programs have been developed to meet the growing demand for engineers. Their aim is to expose students to research experiences and coursework necessary to enter and persist through a postsecondary education program (Zhe et al., 2010). In addition to bridge programs, engineering summer programs strive to encourage underrepresented students to pursue engineering (Elam et al., 2012). These summer programs are intensive and provide hands-on opportunities to that ensure women and minorities gain exposure to engineering (Elam et al., 2012). Ultimately, the vision of such programs is to encourage interest in pursuing careers in engineering, thus encouraging others within the greater community to gain interest (Jamison, 2008). As decades have passed, educational systems have become increasingly more aware of the demand for STEM programs that prepare students to compete in a technologically driven, global society.

Students in the United States are earning degrees in STEM fields at staggeringly low rates. Approximately 14% of United States students earn a degree in science or engineering in comparison to 33% to 50% in China and Singapore (Soldner et al., 2012). The lack of students in the United States in Engineering is alarming. "There are only 32.4 % of undergraduates in America leaving college with [a] bachelor's degree in science or engineering" (Jamison, 2008, p.

36). Although there continues to be a shortage of qualified individuals in STEM, one specific area is often overlooked, engineering. Engineering and other "technological fields… are in desperate need of more qualified workers" (Rockland et al., 2010, p.53). In order to train additional qualified workers in engineering, there is a need to examine the K-12 educational path and explore factors that encourage and deter students to enter the engineering pipeline. There is a growing shortage of engineers in the United States (Elam et al., 2012). By 2022, the United States will need approximately twenty to fifty thousand engineers (U.S. Department of Labor, Bureau of Labor Statistics, 2012). This shortage only exacerbates the need for increased engineering instruction in K-12 institutions (Elam et al., 2012). The aforementioned concern poses a challenge for K-12 educational institutions in the United States.

Several studies have examined the implementation of STEM and engineering principles in K-12 educational institutions. One study examined the implementation of a multi-disciplinary approach to implementing engineering concepts in the classroom (Zhe et al., 2010). The goal of a multi-disciplinary approach was utilized to solve the shortage issue by "[producing] a sufficient pool of qualified graduates in STEM areas to face the benefits and challenges of both globalization and a knowledge-based economy" (Zhe et al., 2010). The focus was to create a "bridge" between secondary and post-secondary education by providing opportunities and access.

Summer and afterschool programs. Researchers have examined summer and afterschool programs that aim to address the engineering need in K-12. The premise of such programs is for students to grow as critical and analytical thinkers with an interest in engineering (Bybee, 2011). The study of engineering requires students to use critical and computational thinking. They are expected to use these skills to solve complex problems (Bybee, 2011). For

instance, "if students develop the practices of science and engineering, they can ask better questions and improve how they define problems" to improve their ability to solve complex problems and develop skills (Bybee, 2011, p.6). These specially designed programs aim to enhance the preceding ideals.

The implementation of summer programs in engineering for students from underrepresented groups was examined (Zhe et al., 2010) This STEM summer program served as a bridge between academic year instruction and authentic learning opportunities. For the purposes of this study, underrepresented groups were defined as young females of color (i.e. African-American or Hispanic). During the summer intensive program, students are exposed to rigorous curriculum, experiential activities, and field studies. In addition, the students are connected with mentors in the field (Zhe et al., 2010). After participating in the summer program, participants were surveyed to measure their interest. The findings suggested that when underrepresented groups are exposed to engineering concepts, a greater level of interest is formed (Zhe et al., 2010). Tyler-Wood, Ellison, Lim, and Periathiruvadi (2012) examined the implementation of an afterschool program, "Bringing Up Girls in Science" (BUGS). The after school program was designed for girls in grades 4 and 5. Through mentoring, experiential, and authentic learning experiences, participants gained greater interest in environmental sciences (Tyler-Wood et al., 2012). The participants were assessed using the Iowa Basic Skills assessment in science. This study, designed to narrow the gender gap in STEM interest and careers, yielded favorable findings. It was noted that BUGS participants had higher levels of interest in STEM and science careers (Tyler-Wood et al., 2012).

Secondary STEM programs. At the secondary level, researchers explored the implementation of the K-12 Engineering Education Program (KEEP). KEEP leaders developed

a seminar series for high school juniors and seniors (Cantrell & Ewing-Taylor, 2009). The program that continued for five years focused on providing seminars with professionals currently in the field of engineering or science. This outreach program highlighted practicing engineers and scientists research interests (Cantrell & Ewing-Taylor, 2009). A weekly questionnaire was distributed to collect data over the course of an 8-week period. The results indicated that approximately 45% had no change in their engineering interest. The participants remained relatively unchanged in their future career choice (Cantrell & Ewing-Taylor, 2009). Researchers attested these findings to the maturity of participants. By the junior or senior year of high school, some students had career goals in sight (Cantrell & Ewing-Taylor, 2009).

Study after study has explored the implementation of programs to garner students' interest in STEM prior to college. Educational institutions are making an effort to provide access and opportunities to students not only during the academic year but also with after-school and summer programs as well. It is imperative that engineering remains an integral focus of K-12 education, focus that is coupled with the emphasis on 21st century skills. There is great importance for youth to understand engineering because "almost everything we use is a result of or highly influenced by it" (Feller, 2011, p.10). This understanding, coupled with engineering, focused instructional delivery, and a laser focus may increase our college retention and persistence in engineering.

Engineering and Postsecondary Education

Similar to K-12 education, higher education institutions are embracing the challenges of producing more engineering graduates (Woodcock et al., 2012). "A declining cadre of workers appropriately skilled in scientific research threatens U.S. global competitiveness, potentially reduces national security, and almost ensures continued exploration of highly technical jobs

outside of the United States" (Strayhorn, 2010, p. 86). The market for engineers is growing at an exponential rate and colleges and universities are attempting to meet the demands (Jones, Paretti, Hein, & Knott, 2010). Researchers continue to examine the factors that motivate students to persist in engineering programs (Jones et al., 2010). The postsecondary, collegiate level is critical for engineering students. This undergraduate level is where the dissention from engineering seems to occur. The engineering pipeline begins as early as middle school and often begins with the academic completion and success of Algebra I (Espinosa, 2011). In this section, I provide an overview of the studies that examined retention and persistence of undergraduate engineering students.

College retention and engineering. "The retention rates of freshmen engineering students must be examined to understand the engineering shortage (Veenstra, Dey, & Herrin, 2008). Veenstra et al., (2008) examined the retention rates of college freshmen majoring in engineering versus those who chose another field. The researchers explored the predictors such as GPA and ACT scores as predictors of academic success as a freshman engineering major (Veenstra et al., 2008). The results indicated that pre-college preparation predicted the retention of freshman engineering majors. Math and science abilities were the major predictors of retention and success during the freshman year (Veenstra et al., 2008). Alternatively, "limited research [has] focused on understanding the values and impact [that] faculty … [has] on the learning outcomes of students (Hong & Shull, 2010, p. 266). Hong and Shull (2010) examined the impact of faculty on the success of undergraduate engineering majors. A case study analysis of six engineering students was conducted to examine their perspectives (Hong & Shull, 2010). The results were mixed in terms of the engagement and quality of engineering faculty. Some participants believed that the faculty was qualified and accessible throughout their educational

program. Alternatively, other participants believed that their engineering faculty was ill prepared which caused a great deal of frustration throughout their academic programs (Hong & Shull, 2010).

Predictors for academic success. While some researchers are focused on the predictors for academic success and impact of faculty involvement, the financial aspects of retention were prevalent across studies. Kalevitch et al., (2012) examined the success of underrepresented groups in an engineering program at Robert Morris University. The National Science Foundation (NSF) grant provided opportunities for economically challenged participants (Kalevitch et al., 2012). The study examined the planning process for the cohort. The participants were tracked during their freshman year. At the conclusion of year one, four students decided not to return. Difficulty of coursework, lack of exposure to other STEM areas, and university transfer were the reasons for the four participants to leave the program. The researchers are continuing to track the remaining participants (Kalevitch et al., 2012). Student interest, faculty interest, finances, and retention are all factors that colleges face in engineering programs. Several studies have examined these challenges that students face as they persist through engineering programs. Further research in the area is encouraged.

Engineering and Gender

The National Science Foundation suggests that there are differences in career interests between males and females. Researchers have often questioned if the variance in career choice is due to differing interests or stereotype threats (Cherney & Campbell, 2011). Women represent 14% of the 2.5 million engineers currently employed in the United States (National Action Committee on Minorities in Engineering, 2010). Women earn 25% more college degrees than men (U.S. Department of Labor, Bureau of Labor Statistics, 2012). However, only 14% earn

degrees in engineering (National Action Committee on Minorities in Engineering, 2010). The aforementioned numbers represent an increase in the percentage of women earning degrees in engineering. Although there has been an increase in females in engineering, the increase has been gradual at best over the past decades. There have been persistent gaps among women and African-Americans in their interest and degree completion in engineering (Strayhorn, 2010). In addition, E-Poll market indicated that only 8% of girls demonstrate an interest in engineering (Lawrence & Mancuso, 2012). Social, cultural, and behavioral traits have been examined to determine factors for an engineering interest in girls (Lawrence & Mancuso, 2012). The slow, gradual trend or lack of female representation in engineering is believed to stem from self-perception, lack of opportunities, and parental perception during a girl's early years. "Researchers have speculated that stereotypes and in particular stereotype threat (ST) might turn women away from quantitative careers" (Cherney & Campbell, 2011, p. 712). Unfortunately, some girls succumb to stereotype threats. In terms of engineering, these threats present themselves as the perception that boys are stronger than girls in math and science (Jones, 2010). Due to these stereotypes, girls may question their abilities (Jones, 2010). "It is commonly believed that boys have higher academic achievement in STEM than girls, but some literature suggests that the gender gap is less of an ability gap than a gap in perceptions of science careers" (Tyler-Wood et al., 2012, p. 46). This is a common misconception in terms of the academic ability of girls in math and science. Fortunately, stereotypes are least likely to negatively affect females with a growth mindset (Jones, 2010). Girls with a growth mindset believe that they are equally as strong as men in math and science (Jones, 2010). Gender is not a reflection of science and mathematical ability. However, self-perception and parental perception may play a key role. Boys have consistently believed that they possess stronger science and mathematical abilities

than girls regardless of similar ability (Tyler-Wood et al., 2012). "Particular to math and science, studies have documented that when both mothers and fathers encourage their children to take such courses or consider these careers, children are more likely to express interest and value in science" (Bhanot & Jovanovic, 2009, p. 44). Parental perception and misconception about girls' scientific academic ability is believed to contribute to the underrepresentation of women in STEM and engineering fields. There is a preconceived notion that girls are naturally better at language arts and social studies while boys are better at science and math. Cherney and Campbell (2011) studied the perceptions of girls concerning their mathematical ability and determined that girls' misconceptions led to poorer scores on math assessments than their male peers. These poor scores on the assessments did not correlate with the mathematical academic ability of the girls. However, the experiential nature of engineering may be a factor.

Perception of engineering. Engineering is considered a hands-on, dirty field. It is the perception that "[girls] are naturally turned-off by the dirty heavy work that engineering entails, [and] that [girls] have insufficient experience in playing with machines in the early years, and so on…" (Gill et al., 2008, p. 393). In contrast, females have engaged in the study of life sciences because of the humanistic nature (Chang et al., 2009). Although a negative perception exists regarding girls and engineering, one study exhibits different findings. According to the Center for Institutional Data in Oklahoma, there have been substantial gains for women in engineering over the last fifty years although stagnancy has occurred since the 1970's (Laefer, 2009). Girls largely outnumber boys in high school upper level science and math courses (Laefer, 2009). Alternatively, the findings do not suggest factors that contribute to a disassociation between high school success and college engineering interest.

The laser focus on the completion of degrees in engineering may ensure competitiveness in the global marketplace (Perna et al., 2009). Women and minorities are among the United States' greatest untapped resources in engineering (Perna et al., 2009). Postsecondary institutions still have difficulty recruiting and retaining female engineering majors (Gill et al., 2008). Schools of education and society have regarded engineers as highly trained professionals thus contributing to higher salaries. This perception has placed the profession in high societal regard. In turn, this may make colleges of engineering highly competitive (Gill et al., 2008). Based on this competitive nature, research has been examined whether or not this factor hinders women and minorities from persisting with engineering programs in college (Gill et al., 2008). Alternatively, women and minorities have remained and persisted through engineering programs

Persistence in engineering. Some studies focused on persistence for women in engineering. Cech, Rubineau, Silbey, and Seron (2011) examined the persistence of women in engineering. Researchers examined participants' intentions for entering an engineering program as well as behaviors that helped them remain and persist. The study focused on the factors that lead to behavioral and intentional persistence. The factors were inconsistent. However, findings have indicated that the level of professional role confidence attributed to women persisting in engineering (Cech et al., 2011).

Alternatively, in a separate study, women who pursued industrial engineering persisted over those in other areas of engineering. In the field of engineering, industrial engineering is perceived as one of the easier areas. Researchers used a mixed methods design to examine the reasons why women choose industrial engineering over other areas of the field (Cech et al., 2011). Approximately twenty participants from three universities participated in this study to examine the factors that lead to persistence and their perspectives in the field of industrial

engineering (Cech et al., 2011). At the participating universities, results indicated that female industrial engineering majors far outnumbered their male counterparts. In addition, it was noted that this area is perceived as one of the more flexible areas of engineering thus providing greater job opportunities in industrial engineering (Cech et al., 2011).

Several studies have examined and compared the career interests of boys and girls while similarities may emerge. It is evident that males and females choose different paths when it comes to engineering (Gill et al., 2008). Whether it is because engineering can be construed as a hands-on, technical field that boys will prefer over girls (Gill et al., 2008), or that girls truly appreciate the life sciences more and have very little interest in STEM (Chang, Yeung, & Cheng, 2009). On the other hand, it could be that girls' perceptions of their mathematical and scientific ability are skewed, therefore discouraging their interest in engineering or STEM fields. Nevertheless, there is an apparent disparity in terms of gender representation in these fields.

African-Americans and Engineering

A review of the literature reveals limited findings relative to African-American females in engineering perspectives. There was very little delineation between African-American men and women in the current literature. The factors associated with academic experiences of African-American males enrolled in STEM programs have been explored in some current research. Williamson (2010) "examined how familial and institutional factors interact with the academic experiences of a diverse group of Black males enrolled as science, technology, engineering and mathematics (STEM) majors at one university" (p.45). The participants were chosen from a predominately white research institution. All of the participants were enrolled full time and were of African-American, biracial, or Caribbean decent. The participants were surveyed using the Academic and Social integration scale. Additional data was collected

through questionnaires and interviews. The results indicated that the campus and academic climate have a major impact on minority STEM majors. It was determined that, "black males are academically integrated and determined to succeed despite the limited amount of Black males on campus, poor teaching quality of professors, and professors who do not spend quality time with students" (Williamson, 2010, p. 66). Ethnic factors, however, played a larger role in the experiences of the black males.

Historically black colleges and universities. In addition, a great deal of the literature focused on graduates from Historically Black Colleges and Universities (HBCUs), which may yield skewed results that are not generalizable to all African-American female engineers. In addition, Historically Black Colleges and Universities (HBCUs) are thought to have a major role in producing diversity in engineering versus Predominately White Institutions (PWIs) (Lundy-Wagner, 2013). Although there have been higher numbers at HBCUs, there has been an over reliance on them to increase the quantity of African-American engineers (Lundy-Wagner, 2013). African-Americans represent 5% of the engineering workforce. The United States racial and ethnic landscape will change tremendously over the next 50 years (National Action Committee on Minorities in Engineering, 2012). Currently, African-Americans represent 13.1% of the United States population (United States Census Bureau, 2012). By the year 2050, it is projected that African-Americans will represent 15% of the United States population (U.S. Department of Labor, Bureau of Labor Statistics, 2012). The current college graduation rate for African-Americans is 42%. There are limited studies that examine the collegiate and professional experiences of African-Americans in engineering. Perna et al. (2009) examined Spelman College's preparation of African-American females in STEM fields. Researchers used a case study analysis to explore the barriers to academic achievement for African-American women in

STEM (Perna et al., 2009). Barriers may be construed as the institutions' practices and policies that may impede the academic achievement of African-American women in STEM (Perna et al., 2009). The results indicated that African-American women chose Spelman College because of its prestige and reputation of producing higher rates of STEM graduates for the underrepresented groups than the predominately-white institutions. Financial barriers were determined as a major barrier for African-American women interested in STEM (Perna et al., 2009).

African-American female academic achievement. Archer-Banks and Behar-Horenstein (2012) examined Ogbu's theories regarding African-American female achievement. Women, particularly African-Americans in engineering, are perceived as over-achievers. This belief and perception of over-achieving African-American women begins during their K-12 educational experience. The premise of this perception is based on academic gains for African-American females (Archer-Banks & Behar-Horenstein, 2012). African-American women still attain degrees at lower rates than white women regardless of academic gains (Archer-Banks & Behar-Horenstein, 2012). Class placement and discipline were noted as factors to encourage overachievement in African-American girls. Further study of African-American girls who are high achievers in hopes of discovering the determining factors is recommended (Archer-Banks & Behar-Horenstein, 2012).

Career experiences. The workplace experiences of African-American females in engineering were sparse in the literature. However, Rice (2011) conducted a qualitative study that examined the workplace experiences of African-American females in engineering. African-American women are underrepresented in engineering workplaces (Rice, 2011). The findings indicated that transitions and macrosystem challenges such as limited support were factors that impeded the workplace of some participants (Rice, 2011). "There is limited research which

includes challenges in the engineering workplace . . . [is] the intersection of … race and gender" (Rice, 2011, p. 560). However, it is noted that the findings were inconsistent among participants.

Challenges in engineering. Alternatively, researchers have examined those factors that have hindered students from participating in engineering. Perna, Gasman, Lundy-Wagner, and Drezner (2010) suggest that there are critical academic factors in K-12 education that influence or hinder one's academic achievement in STEM, particularly engineering. Poor instructional delivery and teachers' lack of content knowledge contribute to the hindrance (Perna et al., 2010). Some African-American children are impacted by these poor instructional decisions. African-American students who had difficulty with math and science in K-12 fail to enter or be successful in the engineering pipeline (Perna et. al, 2010). Remedial courses, tracking, and underrepresentation in honors classes are factors that may hinder African-American students' academic achievement. It is also noted that lack of qualified teaching professionals has a significant impact thus causing greater inequities in the engineering pipeline (Perna et al., 2010).

The academic experiences of African-Americans have been explored at the minimal level. The data is skewed in terms of retention rates at HBCUs versus predominately white institutions. As the percentage of African-Americans graduating from college increases, it is the goal for those participating in engineering programs to increase. Ultimately, reform has to take place at the K-12 level to ensure adequate instruction is provided to underrepresented groups. African-Americans in engineering are an area of recommended future research.

Summary

This chapter presented the theoretical framework that lies at the foundation of the study. The theoretical framework encompassed the social cognitive career theory and Tinto's (1997) college persistence and retention theory. The theoretical framework guides the research

questions and plan of study. The social cognitive career theory focuses on the achievement, abilities, and interests that guide African-American females to pursue engineering. The persistence and retention theory focuses on the factors that lead to African-American females to remain and persist in engineering. The literature presented in this chapter examined engineering as it relates to K-12, post-secondary education, women, and African-Americans. The body of the literature examined the successes and challenges of engineering at the K-12 and collegiate level as well as for women and African-Americans. A significant gap in the literature exists in terms of African-American women and their persistence in to engineering. In terms of underrepresented groups in engineering, the majority of literature focused on women and African-American males. Future chapters will examine the factors that led to African-American women's persistence to remain and succeed in the engineering profession.

CHAPTER THREE: METHODS

This transcendental phenomenological study explored the lived experiences of African-American female engineers currently employed in the field. The purpose of this transcendental phenomenological study was to examine the academic and occupational experiences of African-American female engineers and the factors that led to their persistence (reasons for remaining) within the field in the United States. For this study, persistence was defined as 4.5 or more years of experience in the engineering field, with the intention to remain in the profession (Reyes, 2011). This methodology was selected to ensure that the perspectives, voices, and journeys of the participants are depicted in their own words. In this chapter, I discuss the design and rationale, sampling procedures, data collection, data analysis, trustworthiness, and ethical considerations for the study.

Design

Qualitative Research

Denzin and Lincoln (1994) expressed that "qualitative research [is] a set of interpretative practices" (p. 3). A qualitative design is imperative in studying the disproportionality, which exists within engineering. The interpretive process enabled me to explore the unique experiences of African-American female engineers. African-American women are underrepresented in the field. The qualitative research design enabled me to explore multiple meanings for African-American female engineers at different stages within their lives. These varied meanings allowed for the interpretation of the participants' truth.

Phenomenological Research

I chose this phenomenological approach because the African-American female's persistence in this field is an interesting and unique phenomenon. The participants' experiences

are related to their own perceptions and view of the world around them. These perspectives relate to the participants' consciousness of thought and this "knowledge of intentionality requires that we be present to ourselves and to the things in this world, that we recognize that self and world are inseparable components of meaning" (Moustakas, 1994, p. 28). Due to the nature of this unique group, African-American female engineers and their perspectives of the factors that led to their persistence throughout the engineering field is a phenomenon. A phenomenological approach will allowed me to gather data about descriptions of African-American female engineers' experiences relating to their persistence in K-12, postsecondary studies and the field of engineering (Creswell, 2007).

Transcendental Approach

To ensure the transcendental nature of the study, I bracketed out, my own experiences. This type of phenomenological approach allowed for rich descriptions of the participants' experiences (Creswell, 2007). The transcendental phenomenological approach is distinctive and places "emphasis on intuition, imagination, and universal structures in obtaining a picture of the dynamics that underlay the experience, account for, and provide an understanding of how it is that particular perceptions, feelings, thoughts, and sensual awareness are evoked in consciousness with reference to a specific experience" such as the persistence of African-American female engineers (Moustakas, 1994, p. 28).

The transcendental phenomenological approach guided me to answer the following:

Research Questions

This study was guided by the following four research questions:

1. How do K-12 experiences shape African-American female engineers' decisions to enter the STEM field?

2. What persistence factors motivated African-American female engineers to enter the engineering profession?
3. What are the persistence factors that shape African-American female engineers' persistence to progress through postsecondary engineering programs?
4. How do professional experiences shape African-American female engineers' persistence in the field?

Participants

In conducting a transcendental phenomenological study, it is imperative that the sample size remain relatively small in an effort to document rich, lived experiences by the participants (Creswell, 2007). The participants, through the process of the study, assisted me in the process of developing and interpreting meanings. They are an integral part of the research process. I aimed to use an initial sample size of a minimum of 10 participants (Polkinghorne, 1989). However, the final sample size of 6 participants was determined by thematic saturation (Creswell, 2007). Thematic saturation involves the "saturation" of common themes, meaning that once themes begin repeating themselves, the findings have been saturated. Once achieved, there is no need to continue adding to the sample (Creswell, 2007).

The sample for this study was derived using purposeful convenience sampling. Purposeful sampling allowed me to delineate the participants who meet the criteria necessary for this study (Creswell, 2007). Participants in this study met the following criteria: African-American females who are currently employed as engineers for a minimum of 4.5 years. The minimum year expectation does not require a consecutive 4.5 years, due to the nature of varying life events. Participants on average were employed 4.5 to 9 years. However, there were two participants who have been employed in the field for 9 years or more. African-American

females are defined as individuals with at least one parent of African-American or African descent. Participants were chosen from the membership of the National Society of Black Engineers, American Society for Engineering Education, The Structural Engineers Association of North Carolina, and the Virginia Society of Professional Engineers. The preceding are national organizations that have headquarters located in the eastern United States. These organizations are developed for individuals who are traditionally underrepresented in the engineering profession: African-Americans and women.

Snowball sampling techniques were throughout this process. As participants were chosen, they will be asked to refer other potential participants for participation in the study. Participants were asked to provide contact information to me. I contacted these potential participants to determine their interest in the study.

The study had participants from Oklahoma, Georgia, Tennessee, and Indiana. All participants identified themselves as Black/African-American. All participants hold bachelor's degrees in engineering, while two hold doctoral degrees. Four of the participants were employed in the field 4.5-9 years, while the other two were employed 9 or more years. One participant indicated that her age was between 41-55 years old and the other five participants indicated that their age was between 26-40. Chemical, mechanical, electrical, and petroleum engineering were represented.

Setting

The United States population is estimated to exceed over 316 million people (United States Census Bureau, 2012). African-American women represent 13.1 % of the United States population and 1.44% of individuals in the engineering profession (U.S. Department of Labor, Bureau of Labor Statistics, 2012). In addition, African-American women represent 9.7% of

college enrollment (Center for American Progress, 2013). The setting for the study was at various locations across the United States. This will allow for all forms of data collection, particularly the interviews and focus groups that may need to be conducted in face-to-face contact, by phone, or via internet-based means such as Skype, Face Time, or WebEx.

Procedures

I submitted an application for the use of human research subjects to obtain IRB approval. Data collection began once the Institutional Review Board (IRB) granted permission on May 21, 2014 (see Appendix J). Consent forms, email, mail, and phone scripts that were used to recruit participants are included in the IRB application (see Appendices A-D). This process ensured the protection of the participants throughout the research process. Preliminary contact was made with a number of organizations to gather information regarding their privacy policies and the process and procedures in recruiting the organization's members for the study (K. N. Somerville, personal communication, June 30, 2013). I sought and received permission from the following organizations: American Society for Engineering Education, The Structural Engineers Association of North Carolina, and the Virginia Society of Professional Engineers (K.N. Somerville, personal communication, June 30, 2013).

I used purposeful, convenience sampling to select the participants for the study (Creswell, 2007). Those who indicated interest was evaluated based on the participant criteria. The sample pool was based upon the size of those who met the criteria. The following provided an outline of how I secured participants for the study through the aforementioned organizations.

Based on preliminary communication with the organizations, I sought permission using each organization’s recommended procedures for accessing membership rolls and information. I sought permission from the American Society for Engineering Education to purchase their

membership roll (Appendix G) and place an advertisement in their newsletter publication (Appendix H). Mailing lists may be purchased for twenty cents per name for non-members from the American Society for Engineering Education (2014). There are currently 473 minority members in the organization. I purchased the entire membership list from the American Society for Engineering Education for a total cost of $94.60 (American Society for Engineering Education, 2014). In addition, the researcher sought permission from the Structural Engineers Association of North Carolina to request the board's approval for information to be sent to its membership to solicit volunteers to participate in the study (K.N. Somerville, personal communication, June 28, 2013). I sought permission from the Virginia Society of Professional Engineers to request inclusion in their organizations' newsletter (K.N. Somerville, personal communication, June 30, 2013).

Thematic saturation was not achieved through the professional associations, I used snowball sampling. Snowball sampling and chain referrals allowed me to identify potential participants in studies where they may be difficult to locate. Essentially, the "snowball sampling [method] is described as a [process] of interviewing a person's immediate social environment by using socio-metric questions in the interview for sampling purposes" (Goodman, 2011, p. 347). Participants, who were recruited through the professional organizations, were asked via phone, email, or mail to refer other African-American female engineers for possible participation in the study. Recruited participants were asked to provide me with contact information for potential participants. The snowball sampling and chain referral methods were used until an adequate sample size of 6 participants was achieved. As participants were identified, they completed a screening questionnaire to proceed with the study (Appendix E). The screening questionnaire determined if the potential participant met the criteria for participation in the study such as

gender, race, and a minimum of 4.5 years in the engineering field (U.S. Department of Labor, Bureau of Labor Statistics, 2012). Participants accessed the screening questionnaire through the website, Survey Monkey. Survey Monkey is a confidential and secure site. It provided a secure transmission feature, a database, and server security. I setup an account on the Survey Monkey website and entered the information from the screening questionnaire located in Appendix E. An invitation to participate in the screening questionnaire is located in Appendix D.

When criteria were met, participants were provided along with the guidelines of the study and informed consent forms. Once signed consent was received, I began the process of collecting data.

I collected and analyzed data on an ongoing basis until thematic saturation is achieved. If, due to unforeseen reasons, an adequate sample size was not achieved, the process of recruiting through professional organizations and snowball sampling would have been used to include African-American males. I achieved an adequate sample size through the aforementioned procedures and did not have to recruit African-American males.

Individual interviews, focus groups, and timelines were used to collect data. The process of cognitive interviewing tested the validity of interview, focus group, and timeline structures. Cognitive interviewing is "a commonly used tool for the development of self-report survey items" (Boeije & Willis, 2013, p. 87). To ensure the validity and relevancy of interview questions, I requested a minimum of three engineers to review the relevant nature of the questions. This panel of engineers "evaluate[ed] the quality of the response or help determine whether the question is generating the information that its author intends" (Beatty & Willis, 2007, p. 287).

Individual interviews utilized open-ended questions and were more than 25 minutes in length. Interviews were conducted via WebEx. The interviews were electronically recorded via the internet to record the data for future analysis. I interviewed each participant only once, because there were not any themes that emerged to warrant additional interviews.

A focus group allowed for an opportunity for participants to share experiences and examine key statements pertaining to their journeys. In order to ensure the relevancy and validity of the focus group statements, a minimum of three engineers reviewed the statements to determine relevancy. Due to participants' schedules, I hosted one focus group session as opposed to two as previously planned to gather participant data. The focus groups occurred via WebEx. The focus group session was electronically recorded via the internet. Each participant was contacted via phone and/or email and asked to participate in the focus group. I explained that the focus group that is via electronic means may reveal their identity to other participants, thus disclosing their privacy. If a participant wished to maintain privacy, she had the right to participate in the focus group via conference call to avoid revealing her identify. More importantly, the participant had the right to refuse to participate in the focus group. Depending on the location of participants, the focus group session was held via WebEx.

In addition, participants created a timeline to have a pictorial representation of their journeys (Duhl, 1981). Each participant was provided an Excel spreadsheet that provides directions for completing the timeline. The participants were instructed to enter key moments in their individual lives on the timeline as directed in Appendix F. Key moments include early childhood, school, postsecondary education, workforce experiences, and any other factors that led to persistence in engineering.

The Researcher's Role

Phenomenological research encouraged me to guide the participants to relive the experience in an effort to obtain rich, thick descriptions of the phenomenon's essence (Moustakas, 1994). I served as the sole human instrument that will, through various data collection methods, guide participants to share their rich experiences of the engineering journey. As "the human scientist [the researcher] determines the underlying structures of an experience by interpreting the originally given descriptions of the situation in which the experience occurs" (Moustakas, 1994, p. 13). In this transcendental phenomenological study, I aimed to understand the structures that led to the participants' persistence to enter, persist through, and remain in the engineering profession.

In this study, I am an African-American female central office administrator in a public school division in Virginia. I am currently in my twelfth year of education and have served as a special education teacher, assistant principal, principal, and now division level director. I am responsible for working with secondary principals and career and technical education teachers while also handling division level disciplinary issues and transportation. In my professional career, I have worked closely with students interested in STEM through Robotics and Math/Science clubs.

I have always had a personal interest in African-Americans and STEM. Early in my college career, I was heavily involved in the sciences, competitions, and research opportunities. In addition, I was a part of a mentoring group for African-Americans interested in science. At the conclusion of my college career, I changed course and pursued special education and psychology as a career choice. I was a biology major who had taken dual enrollment biology in high school. During my freshman year, I was enrolled in a 400 senior level course. This course

was difficult, to say the least, because I lacked the prerequisite skills. At that time in my life, I did not understand how to advocate for myself and explain to my advisor that it was a difficult course. I struggled throughout the semester and completed the course with a "C". I felt discouraged and lacked the confidence to continue. After doing so, I continued with the mentoring cohort for an additional semester and by sophomore year, I changed my major. I observed several members of my mentoring cohort transfer or change majors. This interest and research has led to my desire to determine the factors that lead to persistence for African-American females in engineering.

I conducted interviews, focus group and participant timelines throughout the study, as well as gather data regarding the factors that lead to persistence. In an effort to remain objective and refrain from biases, I secured participants with whom I do not have personal or professional connections. In order to maintain integrity, I bracketed out my own experiences prior to, during, and after conducting the research process using a reflexive journal (Lincoln & Guba, 1985). The reflexive journal allowed me to think critically about the data collection and analysis process by bracketing personal opinions or biases at each step of the process. My rationale for choosing this design is to capture the lived experiences of the participants as a means to share rich descriptions of their journeys.

Data Collection

In transcendental phenomenological research, it is important to collect multiple forms of data to understand the perspectives of "the individuals who have experienced the phenomenon" (Creswell, 2007, p. 61). I collected data using interviews, focus group, and participant timelines to capture the rich experiences of African-American female engineers' persistence.

Individual Interviews

Each interview question has undergone analysis by a content expert. A panel of two engineers who have currently practiced in the field for over 4.5 years had an opportunity to review the questions to determine their appropriateness to determine the phenomenon of the journey of African-American female engineers. The engineering experts were provided with an overview and purpose of the study (K.N. Somerville, personal communication, April 3, 2014). The first content expert reviewer is a computer engineer for the state where expert reviewer one performs server work for all of the state agencies. Content expert reviewer one is African-American and has worked in the engineering field for 7 years (K.N. Somerville, personal communication, April 10, 2014). Content expert reviewer one examined the questions and answered a few to determine the feasibility and appropriateness to the study (K. N. Somerville, personal communication, April 9, 2014). After reviewing and answering a few of the questions, Content expert reviewer one deemed that the interview questions were appropriate for the study (K. N. Somerville, personal communication, April 10, 2014).

The second content reviewer is a computer engineer for the military. Content expert reviewer two performs several security and confidential tasks for the military (K.N. Somerville, personal communication, April 8, 2014). Content expert reviewer two is African-American and has worked in the engineering field for 5 years (K. N. Somerville, personal communication, April 8, 2014). Both provided insight into the structure of the questions. For example, content reviewer two felt that I used the term "please" inconsistently and wondered how using the term would lend itself to a conversational tone. Content reviewer two suggested that I change the order of a few questions to encourage a conversational flow. In addition, content reviewer two expressed that although STEM is explained throughout the dissertation, it is imperative to

explain it to participants prior to starting the interview process. All suggestions were noted and changes were made to the questions where appropriate.

Each interview was conducted individually and will be recorded for transcription purposes. The interview will consist of 39 open ended questions that focus on the journey of the participants. The complete list of 39 questions is listed in Table 1. These open ended and broad questions will allow for the rich descriptions of the experiences (Moustakas, 1994). Each participant will be asked all 39 questions. Follow-up questions may be asked as themes emerge.

Interview questions on pre-engineering experiences (childhood academic experiences). The purpose of the questions pertaining to the pre-engineering and childhood experiences was to gather information about the participants' academic, social, and home experiences. This subset of questions aimed to gather information regarding the factors that motivated participants' interest in Science, Technology, Engineering, and Math, particularly engineering. Questions 1 through 3 were developed to examine the home, school, and community structures and their interconnectedness. These questions were also included to explore the environmental factors and experiences that may lead to future careers (Lent et al., 1994). These questions aimed to gather information regarding the impact of parent relationships on their academic achievement. The social cognitive career theory research examines the influence of early childhood experiences on future career interests. These early experiences coupled with personal beliefs are believed to provide guidance for future career choices (Lent et al., 1994). Self-efficacy, aptitude, and early academic achievement may predict future career success. Thus, the examination of these early factors may be linked to their current achievements (Lent et al., 1994).

1. Please tell me about the community in which you grew up.

2. Please describe your structures at home, community, and school. Describe the level of connectedness of these structures.
3. Please describe your relationship with your parents and their involvement in your education.

Questions 4 through 12 were developed to examine the participants' early academic experiences and their relationship with STEM. These questions place an emphasis on the role of race, gender, conditions, and interests' impact on these early academic experiences. The following questions were included to examine the impact of early experiences on future career decisions (Lent et al., 1994).

4. Please describe your level of classroom effort.
5. What were your career aspirations during this period in your life? In what ways, if any, do they differ?
6. What early experiences did you have with STEM? Is there an experience that grew your interest in STEM?
9. Please describe your K-12 educational experiences.
12. Please describe when you first became interested in STEM, particularly engineering.

Questions 7, 8, 10, and 11 were developed to understand the influences of environmental conditions on early persistence factors (Tinto, 1997).

7. How has being an African-American female influenced your academic and social experiences?
8. Please describe your early academic achievements and interests.
10. What conditions contributed to your ability to persist through K-12 education.
11. How did these experiences shape your interest in the field?

Interview questions on pre-engineering experiences (postsecondary academic experiences). The purpose of the questions pertaining to the pre-engineering and postsecondary academic experiences was to gather information about the participants' postsecondary academic and social experiences. This subset of questions aimed to gather information regarding their motivation to persist through, and remain in college while majoring in engineering. Questions 13 through 17 were developed to examine the college environment and experiences with an exploration as to how these experiences shaped their interest in engineering. These questions were included to examine the environmental and experiential factors as expressed in the social cognitive career theory (Lent et al., 1994). Thus, making it imperative to examine the conditions present such as the institutional make-up to examine the participants' persistence (Tinto, 1997). Social cognitive career theory as it relates to this study involves development of new interests or expansion of earlier interests that led to engineering major (Lent et al., 1994).

13. Please describe your college environment.

14. Please describe your experiences during undergraduate and/or graduate study.

15. Did you participate in any internship experiences? If so, please describe this experience.

16. How did these experiences shape your interest to pursue engineering?

17. Please describe the process of choosing an engineering major.

Questions 18 through 26 were included to explore the experiences that motivated the participants to remain and persist through college. The connectedness to the college community may predict college retention and persistence (Tinto, 1997). Questions 18 and 19 were developed to examine the successes, challenges, and the motivation to persist through college.

18. What was your motivation to remain in college and persist to degree completion?

19. Please describe successes and challenges as it relates to your collegiate studies and experience.

Questions 20 through 26 were developed to examine the relationships between participants, peers, and advisors. The questions also focused on the connections between the home and college community. There was an emphasis on mentoring and support systems for participants as they persisted through college.

20. Please describe your relationship with your advisor.
21. Please describe your relationship with your engineering peers.
22. How were you able to make connections between home, community, and college?
23. Please describe your integration into the college community both socially and academically.
24. To whom (or what?) did you turn to for support?
25. Did you have a mentor during your undergraduate and/or graduate study? If so, explain his or her role.
26. How would you describe your sense of connectedness to the greater college community and the engineering department?

Interview questions about the engineering workforce. Questions 27-39 focused on the participants' experiences within the engineering workforce. The purpose of the questions pertaining to the engineering workforce was to gather information about the participants' experiences as an engineer. This subset of questions aimed to gather information regarding their persistence and motivation to remain in the field. Questions were included to explore how mentorship, relationship building, integration, and involvement in the work environment make conditions favorable for individuals to persist (Tinto, 1997). Conditions in the workforce that

motivates participants to persist and remain in the profession will be explored through questioning (Tinto, 1997). In addition, questions were aligned with the premise of the social cognitive career theory in an effort to connect early interests and experiences to present day outcome expectations, thus, providing an opportunity to examine how the career interests and goals transitioned to action (Lent, 1994). Race, gender, and socio-economic status are considered perceived barriers to positive outcome expectations. Therefore, the factors that led to persistence are examined for the participants although they fall into two of three categories within the perceived barriers (Tinto, 1997).

Question 27 was developed to examine the participants' community structures and the similarities and differences from the environment from which they grew up.

27. Please describe the community in which you currently live. How does the community differ or is similar to the environment from which you grew up?

Questions 28-31 were developed to examine the participants' processes for job acquisition and integration (Lent et al., 1994). There was a focus on the examination of successes and challenges in the engineering workforce.

28. Please describe the interview and job acquisition process.

29. Please describe your integration into the workforce.

30. Please describe the successes and challenges within the workforce.

31. What competencies are most critical to your survival and success as an engineer?

Questions 32-37 were developed to examine the relationships within the workforce, mentorship, and involvement in professional organizations (Tinto, 1997).

32. Is there a particular belief system that impacts and guides your life?

33. How has your personal beliefs and experiences influenced your choice of employment.

34. Please describe goals that you have set for yourself. What are your next steps?
35. Do you have a mentor in the workforce? If so, explain his or her role.
36. To whom do you turn for support?
37. Please describe your involvement with professional organizations.

Questions 38-39 were developed to examine the influence of cultural, racial, and gender on their experiences as African-American female engineers in the workforce (Tinto, 1997).

38. How have your cultural experiences shaped you as an engineer?
39. Please describe your experiences as it relates to being an African-American female in the engineering workforce. Please describe how these experiences influence you in the workforce.

Table 1

Standardized Open-Ended Interview Questions

Questions
Pre-Engineering Experiences (Childhood academic experiences)
1. Please tell me about the community in which you grew up.
2. Please describe your structures at home, community, and school. Describe the level of connectedness of these structures.
3. Please describe your relationship with your parents and their involvement in your education.
4. Please describe your level of classroom effort.

5. What were your career aspirations during this period in your life? In what ways, if any, do they differ?
6. What early experiences did you have with STEM? Is there an experience that grew your interest in STEM?
7. How has being an African-American female influenced your academic and social experiences?
8. Please describe your early academic achievements and interests.
9. Please describe your K-12 educational experiences.
10. What conditions contributed to your ability to persist through K-12 education.
11. How did these experiences shape your interest in the field?
12. Please describe when you first became interested in STEM, particularly engineering.

Pre-Engineering Experiences (Postsecondary academic experiences)

13. Please describe your college environment.
14. Please describe your experiences during undergraduate and/or graduate study.
15. Did you participate in any internship experiences? If so, please describe this experience.
16. How did these experiences shape your interest to pursue engineering?
17. Please describe the process of choosing an engineering major.
18. What was your motivation to remain in college and persist to degree completion?
19. Please describe successes and challenges as it relates to your collegiate studies and experience.
20. Please describe your relationship with your advisor.
21. Please describe your relationship with your engineering peers.
22. How were you able to make connections between home, community, and college?

23. Please describe your integration into the college community both socially and academically.
24. To whom (or what?) did you turn to for support?
25. Did you have a mentor during your undergraduate and/or graduate study? If so, explain his or her role.
26. How would you describe your sense of connectedness to the greater college community and the engineering department?

The Engineering Workforce

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27. Please describe the community in which you currently live. How does the community differ or is similar to the environment from which you grew up?
28. Please describe the interview and job acquisition process.
29. Please describe your integration into the workforce.
30. Please describe the successes and challenges within the workforce.
31. What competencies are most critical to your survival and success as an engineer?
32. Is there a particular belief system that impacts and guides your life?
33. How has your personal beliefs and experiences influenced your choice of employment.
34. Please describe goals that you have set for yourself. What are your next steps?
35. Do you have a mentor in the workforce? If so, explain his or her role.
36. To whom do you turn for support?
37. Please describe your involvement with professional organizations.
38. How have your cultural experiences shaped you as an engineer?

39. Please describe your experiences as it relates to being an African-American female in the engineering workforce. Please describe how these experiences influence you in the workforce.

Focus Group

At the conclusion of the individual interviews, a focus group was conducted to allow participants to share their experiences. The focus group questions were different from the interview questions. However, there was an alignment among common themes. Focus groups provided an opportunity for the participants to participate in a group interview session. This data collection method elicited group communication and interaction (Kitzinger, 1995). Focus groups encourage the exploration of issues and their commonalities and differences. My role was that of a facilitator and observer. The researcher was responsible for facilitating the conversation by providing the topics. However, through listening and observation, I allowed the conversation between participants to develop. Through these conversations, I had a view into the participants' collective perspectives and essence of the phenomenon (Kitzinger, 1995). Please refer to Table 2 for focus group topics.

Table 2

Engineering Focus _____

1. What can the K-12 profession do to encourage more African-American girls to enter the profession?
2. What can universities do to foster persistence and decrease attrition?
3. How can employers attract and retain more African-American women in engineering?

Timeline

Each participant was asked to complete a timeline of significant events and factors that led to persistence throughout their journey from elementary school to the engineering workforce. A timeline allowed for a visual and written description of the experiences (Duhl, 1981). A colleague of I assisted with the development of the Excel timeline spreadsheet. Participants were emailed the Engineering Journey Timeline in an Excel spreadsheet. At each milestone, participants were instructed to enter a significant event or persistence factor at that time period in their journey. Detailed directions for completing the timeline are included in Appendix F. The participants were encouraged to save the Excel spreadsheet and return the document via email within 7 days of receipt. In the event that the participant wished to handwrite the timeline, I agreed to mail a copy to the participant. The participants were encouraged return the document via regular mail within 7 days of receipt in a stamped, addressed envelope provided by me. All participants decided to complete the form and return to me via email.

Figure 1: Engineering Journey Timeline

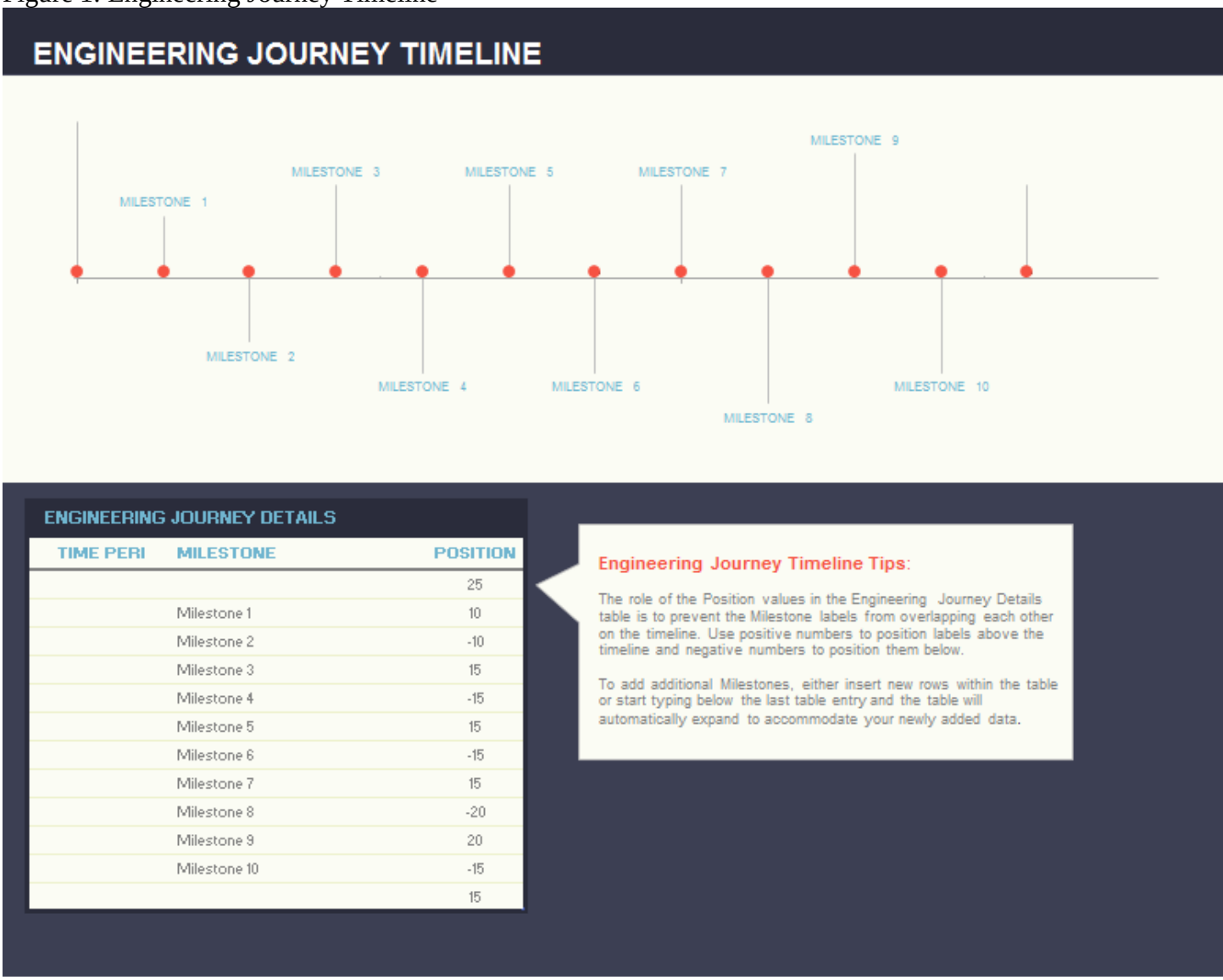

Figure 1. This figure shows the timeline that participants completed to provide a visual representation of their engineering journey. The benefits of using timelines in qualitative research were derived from Duhl's 1981 article on marital and family therapy (Duhl, 1981). Based on the research and benefits of using a timeline in qualitative research, I created this timeline to depict their engineering journey.

Data Analysis

Once the data collection process was complete, I began the process of theming the data (Saldana, 2013). Theming the data is a process for coding and categorizing data in phenomenological studies. It involves the review of the data and then capturing themes that

exemplify the essence of the participants' experience (Saldana, 2013). This strategic and reflective method permitted me to "allow categories to emerge from the data" (Saldana, 2013, p.177) and to construct meaning. The preceding processes for analysis were used individually then collectively to examine interview, focus group, and timeline data. The researcher personally transcribed the interview responses.

The researcher organized and coded the interview, focus group, and timeline responses into a qualitative data organizational and coding software program named Atlas.ti, version 7.17. Saldana (2013) suggests that researchers code and organize data into a form that will naturally delineate the patterns or themes pertinent to the study. The use of this program allows me to code the data for common themes (Saldana, 2013). Due to the volume of the data collected during the interviews, focus group session, and timelines, the software assisted with accurate data organization and coding (Atlas.ti, 2013). I transcribed the interviews and focus groups and uploaded them into Atlas.ti. The participants' timelines were uploaded into Atlas.ti as well. Using the quotations and codes feature in Atlas.ti, I was able to identify common words and themes throughout the interviews, timelines, and focus groups.

The researcher used Moustakas' (1994) phenomenological data analysis procedures to analyze the interview, focus group, and timeline data. The analysis of data took place in three parts: phenomenological reduction, imaginative variation, and essence of the phenomenon. Epoche is the process of phenomenological reduction that involves the bracketing out my experiences to maintain the focus by removing personal experiences as an African-American female with STEM experiences in an effort to remove or reduce biases (Moustakas, 1994). The next step in the phenomenological reduction process is horizonalization. During this process, "every statement initially is treated as having equal value" (Moustakas, 1994, p. 97). Those that

are not relevant were eliminated in order to reveal the textural description. The aim of phenomenological reduction is to get to the essence of what the participants experienced in their engineering journey. During this process, I highlighted individual meanings in the data without including repetitive meanings. The individual meanings were clustered into emergent themes. As they related to the research questions, textural descriptions were clustered together. Textural descriptions described what happened in the participants experiences. Textural descriptions were constructed from the descriptive components of the participant's experience (Moustakas, 1994). Individual textural descriptions were clustered into whole group and composite textural descriptions (Moustakas, 1994). Components and themes within the individual participant's descriptive experience were examined. These composite textural descriptions were analyzed to identify the core themes of participants' engineering perspectives and journeys. Furthermore, during this process, the individual themes and components were examined to determine themes regarding the group textural descriptions (Moustakas, 1994). After the phenomenological reduction process was complete, the imaginative variation process begins. "The task of imaginative variation is to seek possible meanings through the utilization of imagination, varying the frames of reference, employing polarities and reversals, and approaching the phenomenon from divergent perspectives, different positions, roles, or functions" (Moustakas, 1994, pp. 97-98). This process aimed to get to the essence of *how* the participants experienced their engineering journey; that is, their *structural descriptions* of the experience. The researcher analyzed the individual structural descriptions to determine composite structural descriptions. Common themes emerged from the clustering of structural descriptions (Moustakas, 1994). The grouping of the individual structural descriptions emerged into composite structural descriptions that will examine how African-American female engineers experienced their experiences. The

final process in the data analysis is to examine the textural and structural descriptions that evolved from the research. The researcher analyzed the composite textural and composite structural descriptions as a whole. During this examination, the descriptions were combined to develop the essence of the phenomenon of African-American female engineers' journey.

Trustworthiness

Trustworthiness was achieved through the establishment of four major techniques: credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985). Credibility was achieved through the triangulation of the three sources of data (interviews, focus groups, and timelines) to compare the participants' perspectives at different points in time. Transferability was achieved through acquiring the thick descriptions and quotes from the participants; I was able to determine if the conclusions can be transferred to others. Dependability was achieved using an inquiry audit; an inquiry audit reviewer will review the methods and findings. It is notable that the inquiry audit reviewer was not familiar with the research (Lincoln & Guba, 1985). However, the reviewer has an earned doctorate degree from an accredited university in Virginia. The inquiry audit reviewer has also served a committee member on numerous dissertation committees with a focus mainly on research methods. Confirmability was achieved using reflexivity; I used a reflexive journal to reflect on biases, methodological decisions, and values that may interfere with the interpretation of data (Lincoln & Guba, 1985).

Ethical Considerations

The consideration of ethical implications was imperative to this study. The comfort and protection of the participants are the main priority in the study. This study dealt with an issue that involves sensitivity, in both gender and ethnicity. Anonymity and confidentiality were the

major ethical implications for this study. All documents, phone conversations, email scripts, and recruitment forms had IRB approval prior to being used in the study. All procedures were approved by the IRB as well. In order to ensure anonymity, pseudonyms will be used for the participants and places of employment. Confidentiality was preserved by securing all hardcopy data in locked file cabinets. Electronic data will remain password protected. Shredding and media sanitizing will be used to destroy the data once a three-year period for maintaining data is up. All hard copies will be shredded with a crosscut shredder to prevent identification. Media sanitizing will be used to permanently erase data.

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CHAPTER FOUR: FINDINGS

Overview

The purpose of this study was to examine the perspectives of African American female engineers and the factors that motivated them to enter, remain, and persist in the engineering field. The study intended to provide an opportunity for this underrepresented group to share the unique perspectives of their engineering journey. The perspectives of the participants were provided through interviews, focus groups, and journey timelines. Participants' quotes are provided as an opportunity to examine the participants' individual textural descriptions through their lens.

Each descriptive summary was organized to exhibit the individual textural descriptions detailing what they experienced during their engineering journey. In addition, the descriptive summary details how participants experienced their engineering journey. This chapter contains individual textural and structural descriptions that are organized in the order of data collection. Pseudonyms are used to ensure anonymity and confidentiality of participants' names as outlined in the IRB application. The descriptive summaries encompass all data collected regarding the perspectives of African-American female engineers and their journey.

Participants' Individual Textural Descriptions

Individual textural descriptions were gathered to capture what each participant's engineering experienced. The researcher conducted a total of six lengthy interviews and collected timeline data to exhibit what the participants experienced during their engineering journey through their own lens. Each interview was transcribed verbatim to ensure an accurate representation of what each participant experienced.

Participant 1, Chemical Engineer

Participant 1, chemical engineer, grew up in the suburbs on the east coast in a predominately-white setting. She was reared in a traditional home with a mother and father. There was a great deal of time spent with family throughout childhood and on holidays. Community involvement was limited, other than a few volunteer opportunities as a young adult. Participant 1's parents were actively involved in her education and served as a support system. Participant 1's parents encouraged her to do her best. Her academic interests pertain mostly to math and science. She excelled in math and science while exerting a reasonable amount of effort. At an early age, she enjoyed the "practical side of things" and "figur[ing] out a problem." She found joy in taking things apart and putting them back together. Participant 1 became interested in STEM in her 10th or 11th grade chemistry course. She enjoyed her chemistry teacher and decided to try chemical engineering. During her K-12 studies, she noticed that in her advanced placement courses, she was always one of the few African Americans in her classes. It did not bother her; it was just noticeable. Participant 1 went to a large university out of state, which enrolled over 40,000 undergraduate students at that one location. Participant 1 was able to persist through degree completion because she "started looking towards the future." She was adamant about being a productive member of society. She feels that with it would be difficult to pay back her student loans if she did not graduate. She made a substantial financial and time investment, and completing her degree was the only option. Participant 1 did not have an active role with a college advisor; however, she developed lifelong relationships with her engineering peers. While she was in college, her parents served as a source of support and constant in her life. She participated in a woman in engineering program where mentors would sporadically check on students. In addition, she participated in a co-ed mentoring program, where one of the mentors

has been a lifelong friend. Participant 1 felt more connected to the greater college community than the school of engineering

Currently, Participant 1 resides in the Mid-West in a predominately-white area with traditional home and family values. The area is very similar to the upbringing in her home state. Participant 1 works for an oil services company that provides equipment to several independent oil suppliers. She went through a rather extensive interview and job acquisition process, which involved a phone interview, extensive travel, and field experiences that mimicked an actual day in the life of a field engineer. This process was to ensure that Participant 1 understood the company culture and was prepared to meet the demands of the position. During her first three years, she served as a field engineer that worked extensively with the process of protecting the water and rig while oil well drilling took place. Companies would contact her company, and they were on location within a few hours to execute a job. After the completion of a job, Participant 1 felt a great deal of success for a job well done. In addition, she felt a great deal of success and pride when clients would request her for their jobs and she made the company money. Participant 1 believes that one needs to be organized, not necessarily technical, to be successful as an engineer. Professionalism, knowledgeable, and being well-informed are all characteristics of a successful engineer. Participant 1's ethical and moral beliefs are characteristic of her success as an engineer. These ethical and moral beliefs translate to the company for which she works. She strives to work in the most ethnical ways possible to ensure client satisfaction and company success. Participant 1 has reached several of her goals through the company. She has completed her 3-year field-engineering program and currently works in sales within the company. In terms of her next steps, she is thinking about what to do professionally within the company. She has worked in the field, management, and sales but is unsure of her next steps.

Although she has not had a formal mentor with the company, Participant 1 has had several people over the last nine years that she has been able to talk to for advice. At this point in her life, her mother and father are her greatest source of support. Her involvement in professional organizations is limited. She is a member of the Society for Control Engineers. As she reflects on being an African-American female engineer, she was initially apprehensive about moving to her current state in a male dominated field. She had concerns about how clients would react when she showed up at various sites to supervise jobs. Participant 1 is an individual with a hard work ethic and enjoys proving her work. She believes that being a female or an African-American female has not negatively affected her career nearly as much as her initial concerns. She has earned the respect of her colleagues and subordinates and believes that if there were an issue at the job site with her race or gender, she would have a great deal of support.

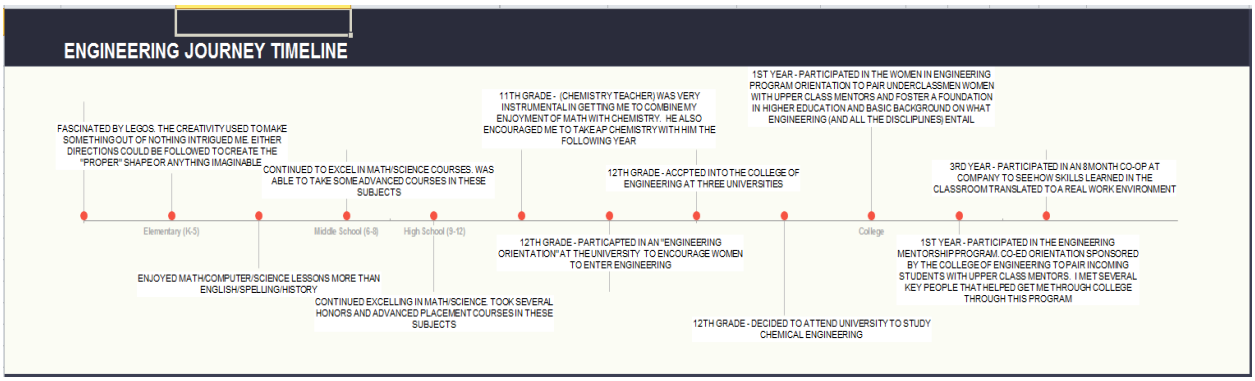


Figure 2. This figure shows the timeline that Participant 1 completed as a visual representation of her engineering journey.

Participant 2, Electrical Engineer

Participant 2 grew up on the west coast. She grew up in a traditional home with married parents and was the youngest of nine children. Her family was very close knit. Health issues plagued their family and they faced many tragedies. She is mechanically inclined and enjoyed working on trucks. Her parents were highly involved in academics since early childhood. She

was required to read often. Participant 2 was strong in math, science, English, and the arts. She was a lifelong learner at an early age. Participant 2 was always inquisitive and enjoyed exploring the various critters and creatures in the dessert. Her early interests in engineering were developed through time spent with her father. They always worked on cars or trucks. She found excitement in working on big engines and motors. Participant 2's focus was more on motors and motor controls because she enjoyed the processing side of electrical engineering. Participant 2's early academic achievements were A/B honor roll and citizenship awards. During her K-12 studies, Participant 2 was one of the few African-American students in her college prep classes. Participant 2 attended a Historically Black College and University (HBCU) for her undergraduate studies. She chose to attend a HBCU so that she did not have to worry about if she was the exception. She wanted to be judged solely on her academic ability, achievement, and character. Alternatively, her graduate school experience was quite different. Participant 2 felt that she was a trailblazer. She recounts an experience of meeting her graduate advisor in her first class and being told that he no longer wanted to be her advisor. Participant 2 believes that his apprehension to advising was due to her involvement in the military and electrical engineering and the possibility that he assumed she was an Asian male. Participant 2 did not let this hinder her progress. She moved forward and found another advisor. As she progressed through her graduate studies, she faced challenges, such as relationships with engineering peers, loss of family members, and project interference. For instance, an engineering peer sabotaged her graduate project on the day of the thesis presentation. Through the support of her parents, she maintained focus, corrected the issue, and presented her project successfully.

Although she faced these hardships, Participant 2 was determined and motivated to remain independent and take care of herself. She wanted a career with longevity that she would enjoy.

These factors led to her persistence to degree completion. Graduate school was strictly business for Participant 2. She worked closely with a cohort of African-American graduate students, not necessarily engineering students throughout her graduate studies.

Participant 2 currently lives in a suburban area in the south. The neighbors are friendly; however, they do not participate in activities together, making it quite different from the environment from which she was raised. Participant 2 worked as an electrical engineer in the military and industry prior to transitioning to her current position. Currently she serves as a professor at an engineering technical college. The process of attaining this position was relatively seamless. Her transition into academia was fairly seamless as well, although adjustments were made to accommodate the fiscal differences of that which she was previously accustomed to in corporate America. Despite the fiscal challenges, Participant 2 has had several successes in the workforce. At the time of hiring, she and another African-American female engineer were the only two like them in the department of technical education for the entire state. Over the years, Participant 2 expressed that she has learned that her most critical skills for survival in the engineering workforce are learning, not taking it personally, and understanding that it is business. She expressed that it is important to avoid taking things personally and try to see things from another person's perspective.

At this time in her life, Participant 2 finds her support and guidance from God. She is of the Baptist faith and follows her church covenant. She relies on particular Bible verses, such as 23 Psalms, for comfort. Participant 2 expresses that having that foundation helps in knowing that troubles soon will pass. In terms of next steps, Participant 2 has some goals of completing her PhD by 2016. Although she faced another tragedy by losing her niece, she is still determined to complete this milestone.

Participant 2 has always served as a mentor for other engineers; however, she has never been the mentee. Participant 2 is heavily involved in engineering organizations such as the American Society for Engineering Education and the International Society of Automation. She provides a great deal of community outreach within and outside of these organizations. As Participant 2 reflects on her experiences as an African-American female engineer and her influence on the workforce, she expresses that it is important for her to dispel the myth. She wants others to understand that when a group is underrepresented in the workforce, those present are there because of their ability, not to fill a quota. She strongly believes that people should be given opportunities to demonstrate their knowledge, skills, and abilities, and it is up to them whether they succeed or fail.

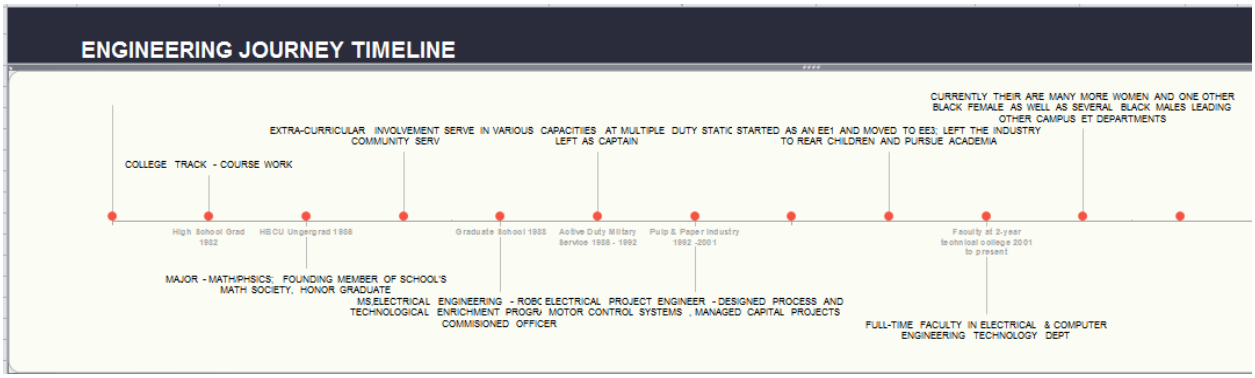


Figure 3. This figure shows the timeline that Participant 2 completed as a visual representation of her engineering journey.

Participant 3, Petroleum Engineer

Two former educators raised Participant 3 in a small town in the southwest. She was extremely involved in community and extra-curricular activities such as athletics, community service, and the boys and girls club. Initially, Participant 3 was interested in studying law because she enjoyed analyzing things. However, she always had a love for math and science.

Participant 3 excelled in academics and received many accolades in terms of the junior national honor society, national honor society, student council, and participation in honors courses during K-12. During Participant 3's sophomore and junior years in high school, she began to see differences in her classes. She began to notice that she was the only black female in her high school honors classes. That was the first time that Participant 3 realized that she was different. She did not allow that to faze her; she knew more than ever how important it was to earn her education and stay ahead of the game. Participant 3 attended a large university within her home state. She had a positive college experience. She entered the college of natural sciences with the intention of becoming a biochemist upon graduation. Through participation in an internship experience at a reservoir, Participant 3 realized that natural sciences are not a long term interest of hers, and she changed her major to engineering due to a love for science and mathematics. In particular, Participant 3 decided to pursue petroleum engineering. She was extremely active and involved in college life through participation in a sorority, and several events on campus. The African-American community on campus was relatively small which encouraged them to be a close-knit group. She relied heavily on her relationship with God and her father. They both served as a constant source of support in her life. She did not have a formal mentor. She started in the field as an engineer at a company from which she interned earlier. Through her internship, she became familiar with the lifestyle and culture of the company.

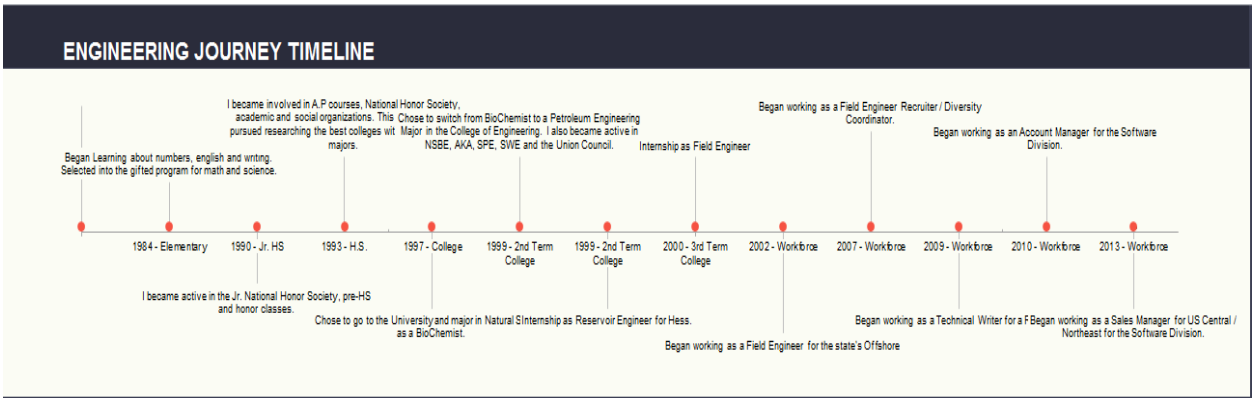


Figure 4. This figure shows the timeline that Participant 3 completed as a visual representation of her engineering journey.

Participant 4, Chemical Engineer

Participant 4 grew up in a major city in the south. She was raised by a single mother, a schoolteacher, and is one of three children. Participant 4 was very involved in her community through tutoring and church. Her mother modeled active community involvement through her participation in church activities. Participant 4 attended a specialty college prep high school, which she found to be academically rigorous, rewarding, and challenging. She expressed how she pulled all-nighters and wrote 25-50 page papers. Participant 4's exposure to STEM during K-12 was minimal, other than her participation in science and math classes. Participant 4 expressed that she first wanted to be an engineer in 10th grade. Participant 4 participated in the band and took piano lessons during K-12. Other than that and academics, she did not have many interests. Participant 4 attended four colleges. She received a bachelor's degree in mathematics at a historically black college and university. Participant 4 enjoyed a wonderful, small family environment at the HBCU. During her junior year, she transferred to a larger, predominately white institution. She earned a degree in mathematics and electrical engineering. She attended a large, predominately-white institution as well. She experienced discrimination and isolation at the hands of faculty members and peers. Through this experience, Participant 4 decided that she was going to become an engineering professor one day. She thought that there had to be a better way to teach diverse students. Participant 4 often wondered, "these are people that I don't like, why would I ever want to be a part of their profession?" Participant 4 wanted to be a professor to show others that there is a better way to teach and encourage future engineers. Participant 4 interned at a major manufacturer in the south. Participant 4 persisted to degree completion

because it was the expectation. Her mother made her expectations clear for her to attend college and earn a degree.

The environment in which Participant 4 currently resides in is completely different from the environment from which she came. Her first engineering interview took place over the phone. Fortunately, she had interned with the company and developed a reputation. She had to go through a series of four interviews for the position. The interviewer during her first interview gave advice as to how she needed to answer questions in the last three interviews. She got the position.

Participant 4 has accomplished many of her professional goals, such as earning her PhD. Now, she is focusing on her family. She wants the freedom of just being a mom, bringing snacks to school, and attending field trips with her daughter. Participant 4 finds her support through God. She believes that all things are possible to God and believes in listening to God. Participant 4 stated, "You know when those opportunities come, you step out on faith and take it." She also finds a great deal of support from her husbands and girlfriends. Participant 4 has a group of girlfriends who have PhDs in engineering as well. They serve as personal girlfriends and professional colleagues. Participant 4 is also involved in two engineering professional organizations, American Society for Engineering Education and the Institute of Electrical and Electronics Engineer. She attends conferences and publishes a paper at least once a year. She has served on several committees within these organizations. Participant 4 feels that being an African-American female engineer can be rough at times. She has experienced isolation and marginalization in the workforce. Participant 4 and other African-American female engineers present at conferences about the isolation and marginalization in the profession. Although there have been challenges, Participant 4 views it as part of her journey. She feels that her "purpose

for being in their life is to influence [others] in such a positive way that the next black person, the shock and awe is over."

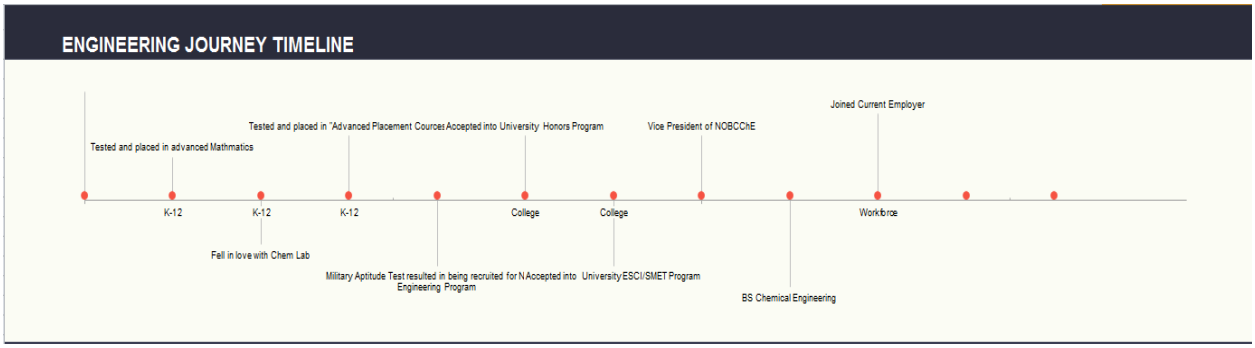


Figure 6. This figure shows the timeline that Participant 4 completed as a visual representation of her engineering journey.

Participant 5, Electrical Engineer

Participant 5 grew up in a middle class, predominately black community in the south. She grew up in a two-parent home and was heavily involved in the community through participation in American Red Cross, volleyball, basketball, and drill team. She had a good relationship with her parents. She started out in private school and transitioned to the public school setting around 10th grade. She participated in Advanced Placement class in high school. Participant 5 became interested in a career in science around 11th or 12th grade, when she took an Advanced Placement biology class because of her interest in becoming a physician. She earned several academic achievements, such as a mention in a national publication, skipping a grade in math and English, and graduating high school with honors. Participant 5 attended a small, predominately African-American university. Participant 5 participated in internships on campus and with a major financial company, which gave her work experience, although it did not influence her interest in engineering. Participant 5 persisted through degree completion because quitting was not an option for her. She had a good relationship with her academic advisor. She

had a descent relationship with her engineering peers, although they were not as close as some departments. Participant 5 indicated that engineering is an "on your own" type of academic program. She indicated that there was a lack of female presence in the engineering department. She had a self-sought out mentor that assisted her with what classes to take and from which professors. Participant 5's current living environment is different from the community from which she came. She still resides in the southwest, approximately one state away from where she grew up. The people are not very friendly and are considered racist. Participant 5 had a few experiences where the people in the current community were not tolerant of other races. Despite her experiences with intolerance, Participant 5's integration into the workforce was seamless. She considers her colleagues a second family. She did face challenges in the workforce to gain a level of respect. She worked hard in the technical school and as a field engineer, which resulted in excellent performance reviews and a promotion. She was selected as a women's engineering mentor. Carmen was encouraged to participate in an executive leadership conference representing her company. Participant 5's Christian belief system influences her choices of employment. Her belief system encouraged her to week employment that did not violate her moral and ethical standards. Participant 5 has personal goals set for her, such as to move back home and begin working on the family, life, and career balance. Participant 5 still has three important mentors in her life. She holds their opinions dear because they have her best interest at heart. They do not focus on just what is best for the company but her as an individual. Participant 5's major support system in her life is her Christian faith, parents, and friends. Participant 5 is involved in the Society of Petroleum Engineers and Young Professional Engineers. Previously, she was involved in the National Society of Black Engineers. Participant 5 is unsure if being an African-American female has affected her engineering journey in

particular. Although, she does feel that as a double minority, she has to always put her best foot forward because she is the representative for African-Americans and females in engineering. She is concerned about the severe underrepresentation of African-American females in the engineering workforce. Participant 5 is pleased to work for a company that encourages diversity.

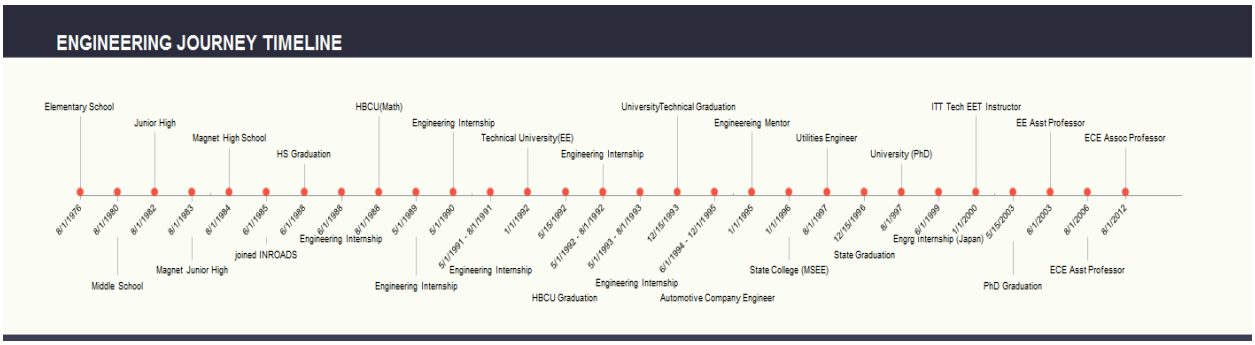


Figure 5. This figure shows the timeline that Participant 5 completed as a visual representation of her engineering journey.

Participant 6, Mechanical Engineer

Participant 6 grew up in a major city in the south. It was a predominately African-American neighborhood. She grew up in a two-parent home in a close-knit community. She had a very close relationship with her parents and they were very involved in her life. One parent was a retired science teacher that encouraged her interest in engineering. Participant 6 worked very hard during school and always put forth a great deal of effort. She became interested in engineering probably around junior high school. During her junior high years, there was a push to encourage African-Americans and minorities who were strong in math and science to pursue engineering. Participant 6 candidly remembers one experience that was the defining factor for her to pursue mechanical engineering. The summer between her 8th and 9th grade year, she participated in a summer camp that solely focused on students' exposure to engineering concepts. She participated in experiments throughout several engineering disciplines, but found

that mechanical engineering was her favorite. Participant 6 excelled academically and was on the honor roll. She participated and placed in a Science Olympiad competition. Participant 6 describes her K-12 experiences as supporting and nurturing. She truly feels appreciative and fortunate for the foundation she had to be successful in life. Participant 6 went to a HBCU for undergraduate. She enjoyed her undergraduate experience both socially and academically. The college was academically challenging. She feels that she received an excellent undergraduate education in engineering.

She was inducted in several honor societies during her collegiate studies. She graduated magna cum laude from college. Participant 6 did face challenges throughout her collegiate studies. She found that one major challenge she experienced was the engineering examples provided by professors. During childhood, boys and girls may not be inclined to play with the same types of toys. In doing so, boys may present a more mechanical inclination than girls may. Participant 6 found that examples provided in class were more focused towards males than females. In addition, in general, Participant 6 felt that the rigor of engineering study was challenging. During undergraduate studies, she had two advisors from which she had a good relationship. Her advisors were supportive and informative. Participant 6 had a good relationship with her engineering peers. The rigor of the engineering program encouraged students to work collaboratively on assignments and projects. Participant 6's aunt was a civil engineer and served as her mentor. She remembers many times having conversations with her aunt regarding engineering. The community where Participant 6 currently lives is where she attended undergraduate school. The city is more diverse than the community from which she came. Participant 6's first job in engineering was the result of a previous internship during undergraduate studies. The temporary summer position turned into a permanent one. Participant

6 currently works for a company that encourages the advancement of science and engineering. The job acquisition process for the current position was typical in that she applied online and went through a series of interviews. She felt that her internship experiences were particularly helpful with her transition into the engineering workforce because she had an opportunity to understand the company's culture and norms. Participant 6 believes the employment opportunities she has had are a result of God's divine intervention. She feels that she has been blessed and wants to do God's will. Participant 6's goals and plans for the next steps in her life are more of a personal nature. She has achieved higher levels of education and transitioned into engineering education. Participant 6 is interested in starting a family and eventually becoming a working mother. She may return to school and study something very different. Participant 6 is allowing God to lead her in the direction that he sees fit. Through prayer, her goals and next steps will be revealed. Participant 6's support system consists of God and family. Participant 6 is not as involved in professional organization as she was in the past. Participant 6 worked in what she called an unrealistic work setting because it was predominately African-American. She truly feels fortunate that she was not in an environment where she felt out of place. Participant 6 expressed that there are stereotypes of African-American females that consider them bossy with bad attitudes. She fought hard to dispel the myths regarding African-American females and prove others wrong.

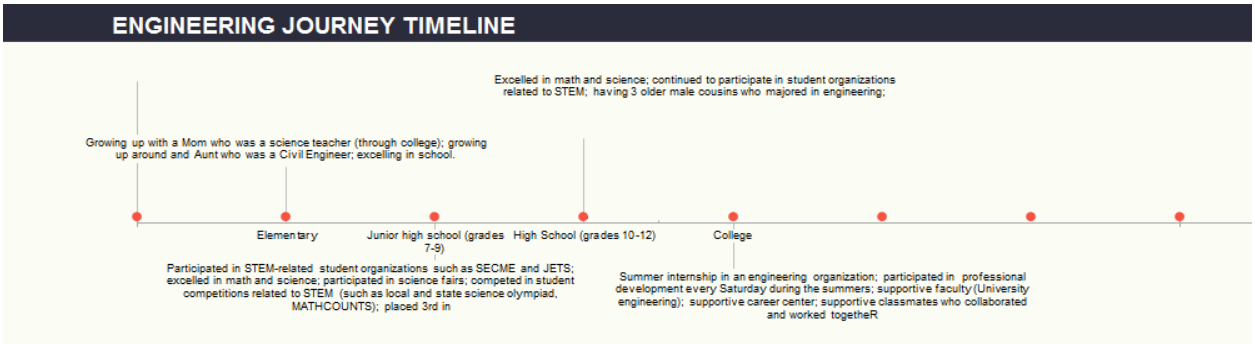


Figure 7. This figure shows the timeline that Participant 6 completed as a visual representation of her engineering journey.

Participants' Individual Structural Descriptions

The individual structural descriptions describe how the participants experienced their engineering journey. Six participants participated in lengthy interviews, focus groups, and timelines. Through reflection and analysis, I explored the essence of their experiences. Participants' structural descriptions were derived from their experiences and feelings emoted through the retelling of key elements from their journey (Moustakas, 1994).

Participant 1, Chemical Engineer

The structures and early foundation supported Participant 1's progression and success in engineering. Participant 1, in relation to her childhood, had a sense of connectedness to her immediate and extended family. She was at ease academically and felt a sense of comfort through her engagement in mathematics and science. In relation to her collegiate studies, Participant 1 felt connected to the larger college community; however, there was a disconnect between her and the department of engineering. Regardless of the disconnect, Participant 1 persisted. Participant 1, in relation to persistence, had thoughts of quitting or even possibly changing majors, but feared the financial repercussions of quitting. She moved forward. Quitting was never an option for Participant 1. She was intrinsically motivated to succeed and become a productive citizen that contributes to the world.

Participant 1, in relation to the fear of entering the workforce in a predominately white and conservative state, had misconceptions about how she would be perceived and treated as an African-American female engineer. She feared that clients and colleagues might not have accepted her because she was an African-American female engineer. A supportive and accepting

work environment quickly abolished these misconceptions. Currently, uncertainty surrounds Participant 1's next steps. As she contemplates her next steps and goals for the future, Participant 1 elicits support and guidance from her parents.

Participant 2, Electrical Engineer

Participant 2, in relation to her upbringing, faced several tragedies. Health issues plagued her family, which resulted in several illnesses or deaths. Participant 2 is a survivor that has experienced periods of life in survival mode. She felt a sense of responsibility and leadership as she assisted with raising younger family members. Grief and loss continued to surround Participant 2. Throughout the years, she lost several family members. In her later years, she lost her husband and became a single mother. In addition, during the time of the study, she had recently lost her niece who was like a sister to her.

Participant 2, a natural leader, experienced her graduate engineering collegiate journey through the lens of a trailblazer, burdened by always being the first to accomplish tasks in the field of engineering. She often felt alone but charged with leading and opening the door to opportunities for African-American females in engineering. She faced several challenges in which others rejected her within the field. For instance, Participant 2's first encounter with her graduate advisor was riddled with rejection. Despite her military and academic accolades, Participant 2's first graduate advisor immediately refused to advise her upon their first meeting. Unfortunately, biases that he held apparently led him to believe that Participant 2 was an Asian male. Participant 2 quickly rebounded from the rejection, found a new advisor, and moved forward. During this period, Participant 2 also dealt with feelings of sabotage and betrayal. There were times when she felt betrayed. During her preparation to defend her graduate thesis, Participant 2 experienced a classmate's sabotage of her engineering project. Initially, Participant

2 was devastated and felt defeated. After a conversation with her father to examine potential issues with the project, she immediately rebounded to examine her project, correct issues, and defend her thesis. Participant 2's natural leadership abilities prevailed.

Participant 3, Petroleum Engineer

Through the lens of God's love, support, and the love of her father, Participant 3 persisted. Participant 3 felt the strength to persist when the idea of quitting arose. Participant 3's father encouraged her to always give 110% and strive for the best. In addition, she feels that God would not give her more than she can bear. "His vision is so much bigger than ours" (Participant 3, personal communication, July 29, 2014). As Participant 3 faced challenges and wanted to quit, she reminded herself of her dad's guidance and belief system in God in order to persist.

Through a lens of hard work and dedication, Participant 3 has dealt with the challenges of being an African-American engineer. Her initiative and drive encouraged her to succeed. Participant 3 believes, "As an African American female in the engineering workforce, it is very challenging but doable. I used to always tell college students, that if I can do it, you can do it. Nothing that I have that you don't have. I think as long as you work hard and you are dedicated and you have initiative and drive, you can succeed at anything" (2014).

Participant 3 feels a sense of responsibility through her participation in organizations to recruit for diversity and participate in those events. There were times where Participant 3 felt that being African-American and a female were at a disadvantage and felt like the underdog. Participant 3 expressed,

> "the fact that you are African-American and female in a male world is a challenge within itself. In the field, I worked offshore and I was like the only female and the only black

> person on a rig of 50 to 100 people and I will be out there anywhere from 2 days to 2 weeks. I'm also short and petite. So, add that to the list. You come on location and it's a huge handicap. It's like I'm disabled. So, I continuously go into environments where I'm like the underdog, they already feel like you are not going to be able to do it. They already feel like that you are going to fail. They already feel like you aren't going to be better than the other person that they would have received. So, sometimes that's been a hindrance for me because sometimes I go into situations kind of with that…I guess I face before the situation event starts because I'm already prepared for the world. You know that I'm on attack mode kind of. It's weird because that's actually helped me to succeed and keep me going and motivated because it feels good whenever you are able to prove people wrong. You were the best manager, or the best mentor, coach and one of the things I do is I try to mentor other people that have less experience than me, that I didn't receive. You realize that as an African-American female, people aren't going to just tell you things. You have to figure out a lot by yourself. So, you tend to always work harder because people don't just tell you things" (July 2014).

Participant 3 persists and carries her sense of responsibility as she moves forward. Although she has had feelings of being the underdog in the past, she had work and dedication is present. Through this drive and determination, Participant 3 fights and moves past the barriers.

Participant 4, Chemical Engineer

Being a female engineer versus an African-American female engineer has influenced Participant 4's engineering experiences. She not only feels the responsibility for being an African-American, but a female in engineering as well. Participant 4 sees herself as someone who will open the door for other African-American female engineers. Participant 4 expressed, "

It influences me to stay and put my best foot forward as far as being an African-American female but not only am I a female representative but I'm an African-American representative as well. I want to see my actions make a way for future African-American females" (July 2014).

Through supportive family, friends, and professors, Participant 4 valued her academic and professional engineering journey. Participant 4 excelled academically as math and science were not challenges for her. However, this academic achievement did not correlate with the relationships with her engineering peers. She felt a lack of camaraderie within the engineering department, as it appeared cutthroat at times. There was a level of individualism and isolation, as a female presence was almost non-existent within the department.

Through the lens of a fighter, Participant 4 has persisted through two experiences of racism where she currently resides. There is an element of concern regarding her current surroundings. Participant 4 expressed, "The environment that I'm currently in…it's a little different due to the fact that it's not as home town friendly. People can tell I'm not from here. The [area] is … known to be racist … Back home can be pretty rough as well. At least back home, you know where not to go and where to go. You just know certain areas you don't go to if you don't want to be subject to that" (July 2014).

Participant 5, Electrical Engineer

At a large university, Participant 5 felt like she was just a number in an engineering machine. She felt that no one cared or acknowledged her existence. She never felt important to them. Participant 5 indicated that the professors were there for research and not teaching. Teaching duties were generally assigned to graduate assistants. She had a miserable experience at the larger university.

Participant 5 sometimes "[felt] like a lone voice in the wilderness" during her engineering journey (2014). Participant 5 does not enjoy speaking for her gender or race but often feels like she needs to in order to dispel stereotypes. She is constantly being asked to answer questions as the representative for African-Americans. She does not think that it is fair for her to have to speak for the African-American face. Participant 5 has students who have said on evaluations, "I don't understand her because she uses that jargon" (2014). Participant 5 is unsure as to what jargon they are referring to in their evaluations. She expressed that students approach her with stereotypes of whom they believe African-Americans speak and act that they are unable to move forward. Participant 5 has several colleagues who have admitted that they have never interacted with an African-American before. She feels isolated and marginalized in her professors. She indicates that she has several colleagues at work but none are friends. There is a level of cordiality but they do not socialize beyond work.

Participant 6, Mechanical Engineer

Dispelling the myths regarding African-American female engineers was a burden that Participant 6 had to bear. She often believed that African-American women were perceived as being bossy with an attitude. She was very aware of these stereotypes and strived to project the opposite. Participant 6 wanted to prove others wrong. She has always worked hard and gone above and beyond to disprove the stereotypes of African-American women. Participant 6 expressed, "as a result of experiences that I've had where I'm trying to be the poster child and go against stereotypes of what people have about African-American women" (Participant 6, personal communication, July 20, 2014).

Through a lens of appreciation and persistence, Participant 6 felt fortunate for the early academic, collegiate, and workplace opportunities. Participant 6 felt supported in all of those

environments. She had continued opportunities for growth and development over the years. Participant 6 persisted because she did not look at college as a choice. She felt that it was necessary. She was intrinsically motivated to do well. She believes that innate ability helped her to persist. Participant 6 had many successes while in school; she always did well in school, even when it was challenging.

Themes

Four themes emerged as ones that participants addressed most often. The four themes were academic achievement, motivating factors that led to persistence, support system, and the African-American female engineer. Based on prior research and structure of the study, the interview questions were divided into three categories: early childhood experiences, pre-engineering collegiate experiences, and the engineering workforce, in an effort to examine participants' experiences throughout their engineering journey. Participants were asked about their initial interest in STEM, early and collegiate academic achievement, support system, and collegiate and job acquisition experiences.

The participants were passionate about their experiences during the engineering journey. As the participants responded to interview questions, it appeared that they were more passionate about these emergent themes. Appendix I outlines the four themes that emerged during the study. The statements capture the essence of the prevalent perceptions of African-American female engineers who participated in this study.

Academic Achievement

Participants indicated that they each had early academic success during K-12 studies. Some participants indicated that they attended specialty college preparatory schools, which were academically challenging and rigorous. The responses varied when participants were asked to

explain their level of classroom effort. Although the level of classroom effort varied, a consistent statement among participants was the strength in math and science.

> "School was easy for us. Both of us were in AP courses throughout, as soon as you can get into them. We took college courses when we could in high school. We took the advanced science and advanced math. So, school was relatively easy. I graduated cum laude and my brother graduated with honors." (Participant 3, personal communication, July 29, 2014)
>
> "I've always been a math and science person. I'm not going to say that they came easy to me in the sense that I didn't need to study or it was necessarily effortless. I definitely excelled towards the math and science part of my curriculum versus the English, the histories, the regurgitation type of subject." (Participant 1, personal communication, July 3, 2014)
>
> "I thought it was typical to be on the a/b honor roll" (Participant 2, personal communication, July 11, 2014).
>
> "I decided to take an AP biology class my junior year" (Participant 4, personal communication, July 28, 2014).

Participants also indicated that they often were on honor roll and enrolled in honors or advanced placement classes. In addition, participants experienced success by graduating with honors or at the top of their classes in high school.

> "I made straight A's all the way through. So, my first "B" didn't come until like 7th grade" (Participant 6, personal communication, July 20, 2014).
>
> "I mean your standard honor roll, k-12, I was in the national honor society, I was a junior marshal, my junior year. I believe the junior marshals were the top 15 people; I want to

> say by GPA in the class. I graduated number 16 or 21, I can't remember if it was just outside of the top 15 or top 20 in my high school class of 500 something kids" (Participant 1, personal communication, July 3, 2014).

Each participant experienced a level of early academic achievement. Participants discussed participation in upper level classes and their natural inclination towards mathematics and science. Whether academic success was achieved through honor roll or honors courses, these aspects were critical to the foundation of their engineering journey. These experiences with early academic achievement contributed to later academic achievement and success.

Factors that Led to Persistence

The factors that motivated participants to persist were an integral element of this study. Through the structured interview process, participants answered questions to determine these factors. As a result, similarities and consistent themes emerged. Throughout this section, there will be discussion and supporting participant quotes about the common theme of factors that led to persistence. Participants indicated that they each had a strong family structure where high expectations were prevalent. These high expectations motivated the participants to persist. Several participants expressed the personal goals and expectations they set for themselves served as a source of motivation to persist. Intrinsic motivation, drive, and determination motivated the participants' to persist on their engineering journey.

> Well the fact of growing up and my dad told me that quitting wasn't an option. One of those things that you felt like there was no option to quit but you wanted to quit though. No one was entertaining that. So, we pretty much, it was understood. (Participant 3, personal communication, July 29, 2014)

"It's important, so even though I faced many roadblocks in undergrad, quitting just wasn't an option" (Participant 5, July 2014).

"I could have quit. In fact, I did quit and talked about quitting" (Participant 5, July 2014).

I think it's an expectation thing. My mom always made it clear; you are going to college and getting a degree. I don't think that she necessarily cared so much about what you got the degree in but that's just what you do. Like my mom got her master's and she's in her 70s and she probably got her master's in her late 50s, in her mind education, like her mom was a piano teacher for several years but in her mind education is just what you do. (Participant 5, July 2014)

"I just focused on the expectations that I had for myself" (Participant 2, 2014).

I think because I approached college as, I didn't look at it as a choice. I really looked at it as a must. You know like something I had to do. And I just think that it's something in me, it was innate, as you would intrinsic motivation that I wanted to do well and I think that was something in me k-12 as well. So, I think that's what helped me to persist. I wanted to do well. I just had the drive in me and I looked at college as not being an option but it was something that I had to do, it was no choice but to do well and something else that motivated me too I must say, I did earn a scholarship, a full scholarship and that was always something always in my mind too, oh, I got to maintain a 3.0 cumulative grade point average. So, I think that was something else that ke.pt me motivated to do well. (Participant 6, personal communication, July 20, 2014)

The participants persisted due to their drive, motivation, and support system. Quitting was never an option for them. Quitting was not a choice. Completing their engineering program and progressing to degree completion was the only option.

Strong Support System

The examination of the participants' support system throughout their engineering journey was a key element of the study. Through the interview process, participants expressed common themes regarding their support system. Participants indicated that their belief system, family, and friends served as a source of support for them throughout their engineering journey. All participants discussed parents and/or family as a strong element of their support system. The participants' statements evidenced this level of support.

> So there is definitely support of my parents. They definitely encouraged me to do my best and made sure that I was doing my homework and putting in all the work I needed. When I was studying in school, I had some great teachers along the way who encouraged me and make sure I was living up to my potential and doing the best that I could do. (Participant 1, personal communication, July 3, 2014)
>
> "I really lean on the lessons learned and the lessons taught by my parents" (Participant 2, personal communication, July 11, 2014).

Participants also indicated that their belief in God was a major source of support during their engineering journey. Through God's guidance, participants were able to make decisions about the direction of their lives. In addition, God's guidance provided a life path for participants to follow. The relationships developed through church involvement and worship provided support as well.

> Throughout my years, I grew up with a very strong faith based family and I always sought out my religion. I always sought out a church of my faith wherever I went and sought out a kinship, an external village of some sort. (Participant 2, personal communication, July 11, 2014)
>
> **"**There is no such thing as luck. I think sometimes, God is blessing me when I didn't even know what was going on with me" (Participant 5, July 2014).

The support of family, and the belief in God assisted participants during their engineering journey. The support from family encouraged participants to strive for the best and achieve their highest potential. In addition, participants' belief in God brought a level of support in their lives. God's divine will served as guidance throughout their engineering journey.

African American Female Engineer

One of the most important aspects of this study was to capture their experiences as African-American female engineers. Through interviews, focus groups, and timelines, these experiences were explored. More specifically, one interview question directly examined how being an African-American female has affected the engineering world. As a result, common themes regarding perceptions and stereotypes emerged. Stereotypes have the ability to harm both the holder and receiver of misplaced perceptions. Through the misplaced stereotypes and perceptions, participants felt a sense of responsibility to dispel myths.

> As an African American female in the engineering workforce, it is very challenging but doable. I used to always tell college students, that if I can do it, you can do it. Nothing that I have that you don't have. I think as long as you work hard and you are dedicated and you have initiative and drive, you can succeed at anything. (Participant 3, personal communication, July 29, 2014)

> I'm here to dispel the myth that African-Americans are given a position because they are underrepresented just because but they actually know what they are doing, or the expectation was to offer them the opportunity to demonstrate their knowledge, skills and abilities and afford them an opportunity whether they succeed or fail. I always remember that. (Kisha, July 2014)
>
> You know versus African American vs being a female in general. I think that's there …it influences me to stay and put my best foot forward as far as being an African American female but not only am I a female representative but I'm an African American representative as well. I want to see my actions make a way for future African American females. (Participant 4, personal communication, July 28, 2014)

For some participants being an African-American female in engineering was a challenge because of the stereotypes surrounding African-American females' attitudes. Participants used these challenges as an opportunity to dispel myths and misconceptions about African-American women in general. Through hard work and dedication, participants believe that they have had a positive impact on others' perceptions. Participants expressed that they have taken responsibility to overcome stereotypes that so that other African-American female engineers will have future opportunities.

Composite Textural Descriptions

The participants' individual textural descriptions were combined to form a composite textural description. This combination of individual descriptions aims to capture one universal description. This universal description provides insight into what the participants collectively experienced (Moustakas, 1994). The composite textural descriptions capture the essence of what the participants experienced during their engineering journey.

Participants grew up in close-knit communities. They felt connected to their families, school, and greater community. The participants' early childhood K-12 experiences were a time of achievement, structure, exploration, and support. Participants were reared in loving and supportive family structures. Participants were immersed in education and experienced early academic achievement. This is evidenced by their participation and success in honors and advanced placement classes as well as the ability to graduate with honors. In general, it was revealed that participants were academically strong in math and science. Each participant experienced their own process for discovering their interest in STEM.

The majority of participants attended Historically Black Colleges and Universities (HBCUs) for their undergraduate studies. This setting made the undergraduate collegiate environment comfortable for participants. They had connections with faculty, staff, and peers. In addition, they believed they were viewed based on their academic performance and not due to race. Participants were able to persist through college and to degree completion. Regardless of enrollment at a Predominately White Institution (PWI) or Historically Black College and University (HBCU), the majority participants indicated that they enjoyed their undergraduate collegiate experience and were connected to the college community. The majority of participants entered college as an engineering major. Some participated in internships, which led to later employment opportunities. Participants were able to remain connect to home during collegiate studies.

Currently, the majority of participants reside in communities different from the environment from which they grew up. Participants' experiences varied during the interview and job acquisition process. Although the participants' experiences varied with their interview and job acquisition process, they each have been successful in their integration into the workforce.

Participants expressed that critical thinking and organization are critical to one's survival and success as an engineer.

Participants expressed that their belief in God impacts and guides their lives. For the majority of participants, this belief system influenced their choice of employment.

Composite Structural Descriptions

Individual structural descriptions were constructed to examine how they each experienced their engineering journey. Once the analysis of the individual structural and composite textural descriptions was complete, the research used a process of imaginative variation to construct the composite structural description. Imaginative variation is used in this process to gather a group presentation of the journey. The composite structural description examines how the participants collectively experienced their engineering journey.

Because of a sense of responsibility, participants were leaders and trailblazers for African-American female in engineering. Plagued by the fear of stereotypes, participants felt an obligation to remedy the issue. African-American females are in this position to fill a quota and not because of their ability and achievement. African-American women are bossy and have bad attitudes. The two preceding statements resonated and burden participants whether it was conscious or unconsciously embedded in their psyches, participants felt compelled to act. Some made it their mission to dispel the myths of negative stereotypes of African-American women. They expressed that they worked hard and remained positive it would shift those negative perceptions.

Motivation, determination, and support guided the participants to persist. Challenges were a part of most participants' journeys. Through these challenges, thoughts of retreat and quitting entered their minds. Participants heard the voices of parents and family members

regarding their high expectations. God's presence, will, and place in their lives served as a guide. God was guiding them to persist and not quit. In addition, hearing those internal voices of intrinsic motivation, participants persisted.

Textural and Structural Synthesis

The early academic experiences of African-American female engineering participants were times of academic achievement and STEM exploration. Participants were reared in loving, supportive homes in close-knit communities. These supportive homes had structures that encouraged academic achievement and for some community involvement. These structures and support led into their collegiate experiences. Participants faced normal adjustment challenges during their undergraduate studies, but as a whole, enjoyed their experiences. There were challenges for at least one participant at the graduate level in terms of thesis project sabotage and discrimination by an advisor. The majority of participants participated in internship opportunities, which led to later career opportunities.

Participants were able to persist through college and to degree completion due to their support system, drive, determination, and intrinsic motivation. Family and friends always encouraged participants to strive for the best and to live up to their full potential. These high expectations encouraged participants' persistence. In addition, their own intrinsic motivations and drive served as an integral factor in their persistence. They did not understand the notion of quitting. There was no option other than success.

The experience of being an African-American female engineer is similar to being a trailblazer, leader, and representative of a unique group. The participants represent a small sample of a small population of African-American females in engineering. Serving as a representative for this unique group, participants were charged with the responsibility of

dispelling the myths associated with being an African-American female. African-American women have been perceived as having negative attitudes and bossy. Participants in this study had to work hard and sometimes harder to demonstrate their worth and to diminish those stereotypes.

Results

The purpose of this transcendental phenomenological study was to examine the academic and occupational experiences of African-American female engineers and the factors that led to their persistence (reasons for remaining) within the field in the United States. This study was guided by the following questions:

1. How do K-12 experiences shape African-American female engineers' decisions to enter the STEM field?
2. What persistence factors motivated African-American female engineers to enter the engineering profession?
3. What are the persistence factors that shape African-American female engineers' persistence to progress through postsecondary engineering programs?
4. How do professional experiences shape African-American female engineers' persistence in the field?

The questions were designed to examine the phenomenon of the unique experiences and perspectives of African-American female engineers. I triangulated the interview, timeline, and focus group data. Using Moustakas' (1994) transcendental phenomenological methods to collect, transcribe and analyze the data, each research question was answered.

How do K-12 experiences shape African-American female engineers' decisions to enter the STEM field?

Each of the participants had K-12 experiences that shaped their decisions to enter the STEM field. Research on K-12 interest in STEM lends value to the need for rigorous course work and exposure to engineering concepts at an early age (Zhe et al., 2010).Participants shared that they experienced academic achievement and success during their K-12 studies. Several were on the honor roll, took honors, and advanced placement courses. Three of the participants indicated that they graduated from high school in the top percentage of their class. Each participant indicated that she had a propensity towards math and science, which fed their STEM interest. Two of the participants were enrolled in an engineering club or program during their K-12 studies, which garnered their interest. One participant was involved in a science Olympiad competition. In addition, summer and afterschool programs have contributed greatly to engaging interest in engineering (Bybee, 2011). One participant was fascinated with Legos and her ability to construct and design structures, while two participants believed that they always had a mechanical inclination with a desire to see how things work. This scientific and mechanical inclination may be attributed to one participant's father, a mechanic, and another's science teacher mother. Parents played a major role in the participants' journey. Particularly during the K-12 years, parents had high expectations for them. The parents always encouraged the participants to strive for the best and never quit. The parents always expected them to attend college and be successful. All of the aforementioned examples may be attributed to the participants' experiences that shaped their decisions to enter the STEM field. Although the research did not specifically focus on African-American females, there was an emphasis on females in general for which the findings may be transferable.

What persistence factors motivated African-American female engineers to enter the engineering profession?

The study results reflect the participants' ability to persist and enter the engineering profession. Tinto (1997) indicated that students have the ability to persist if the conditions are right. Each participant was reared in an environment where expectations were high and persistence was the expectation. Participants had strong familial structures, which encourage academic achievement, college attendance, and completion. Participants possessed personal attributes such as motivation, determination, hard work, and technical skills that led to their ability to persist. The SCCT focuses on the attributes that one has and the belief of her individual outcome expectations (Lent et al., 1994). Participants experienced a great deal of academic achievement, which motivated them to continue and persist to enter the profession.

What are the persistence factors that shape African-American female engineers' persistence to progress through postsecondary engineering programs?

Each participant entered their postsecondary engineering program and persisted to degree completion. Quitting or not completing their engineering studies was not an option for the participants. There were strong connections between their home, school, and college community, which provided conditions to support the participants' retention, and persistence (Tinto, 1997). Participants indicated that strong family and friend support helped them to persist through degree completion. During the collegiate years, parents were a major source of support for the participants. Parents not only provided financial support if necessary but most importantly provided emotional support. For instance, one participant had her graduate thesis sabotaged and leaned on the support of her father to get through the challenging time. Each participant indicated that their relationship with God was a factor in their persistence. One

participant believes that God has predetermined her journey and that it was through his Will that she persisted. In addition, participants were exposed to engineering concepts and rigorous math and science courses during high school, which equipped them to face the challenges of an engineering degree. Early exposure to engineering concepts and the entrance into the STEM pipeline are some of the greatest indicators for engineering degree completion and success (Perna et al., 2010).

How do professional experiences shape African-American female engineers' persistence in the field?

Participants' professional experiences shaped their persistence in the field. Research on the experiences of African-American female engineers in the field is limited. However, there is research that examined the underrepresentation of African-American female engineers in the workforce (Rice, 2011). This underrepresentation has to lead to minimal support within the workplace, which hindered progress in the field (Rice, 2011). Each participant, while maintaining the classification of an engineer, practices outside of field engineering. Moreover, they use their engineering talents in other aspects of the field. Three of the participants are employed in engineering, sales, and management. Two participants serve as engineering professors. One participant serves as an educational consultant for an organization, which promotes engineering as well as other areas of STEM to K-12 school divisions.

The participants' professional experiences have shaped their persistence to explore other avenues to improve the engineering workforce. One participant faced some traumatic events that led to her feeling marginalized and isolated in the engineering workforce. These factors encouraged her to persist and become an engineering professor so that she could affect change with a new generation of engineers. Another participant identified the need for a greater level of

awareness and exposure of engineering concepts at an earlier age to encourage a more diverse interest in STEM. In addition, participants noted that skill, technical ability and organizational skills are attributes that engineers need to persist within the field.

Summary

The participants in this study were selected using purposeful convenience sampling. The selection of six African-American female engineers with 4.5 or more years in the engineering profession provided insight into the unique perspectives into this unique group's persistence. Through their sharing of experiences in this chapter, K-12 institutions, colleges, universities, and places of employment can gain a better understand of their unique perspectives and experiences that motivated them to persist to pursue, enter, and remain in the engineering profession. The interview summaries, and timelines presented in this chapter demonstrate the uniqueness of each of their experiences and the complex nature of motivating factors that encourage persistence.

CHAPTER FIVE: DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

The study is intended to evaluate the phenomenon of the experiences throughout the journey of African-American female engineers. Data was collected through the interviews, focus group, and timelines of six participants. This approach unveiled significant statements that were explored, and four themes were identified. This chapter will include a summary of findings, a review, an alignment of theoretical framework, implications of study, study limitations, and recommendations for further research.

The intent of this transcendental phenomenological study was to examine the phenomenon of the unique experiences of African American female engineers. This examination focused on their perspectives and the factors that led to persistence in their engineering journey. Interview, focus group, and timeline data was collected. The researcher used Moustakas' (1994) method of phenomenological analysis to analyze the data. Moustakas' (1994) method yielded four common themes with specific supporting participants' statements. This chapter includes a summary of findings, review of theoretical framework, and distinguishing findings from prior research, study limitations, and recommendations for future research.

Summary of the Findings

The purpose of this transcendental phenomenological study was to examine the academic and occupational experiences of African-American female engineers and the factors that led to their persistence (reasons for remaining) within the field in the United States. Through lengthy structured interviews, focus groups, and timelines, participants were presented questions aimed to answer the research questions.

This study was guided by the following questions:

1. How do K-12 experiences shape African-American female engineers' decisions to enter the STEM field?
2. What persistence factors motivated African-American female engineers to enter the engineering profession?
3. What are the persistence factors that shape African-American female engineers' persistence to progress through postsecondary engineering programs?
4. How do professional experiences shape African-American female engineers' persistence in the field?

Early academic experiences shaped the participants' decision to enter the STEM field. Participants experienced early academic achievement and success. In addition, through participation in science and mathematics competitions, and engineering clubs, participants garnered an early interest in STEM. There were several persistence factors that motivated participants to enter the engineering profession. Environmental factors such as upbringing and high expectations played role in their motivation to enter engineering. Intrinsic motivation, strong support systems, and academic achievement are persistence factors that shaped the participants' persistence through postsecondary engineering programs. The participants each had varying professional experiences that shaped their persistence in the field. Throughout their engineering journey, participants have transitioned from more technical field engineering to careers as professors, consultants, sales, and management within the profession.

Review of Theoretical Framework

The theories integrated in the theoretical framework are embedded throughout the study. The findings have implications in college retention, persistence and in the workplace. The social cognitive career theory was prevalent in the participants' responses to the interviews and timelines. Participants discussed how their early goals and future expectations had a critical impact on their career development. Several participants indicated that their interests and abilities greatly impacted their career choice of engineering. The timeline required participants' to explore milestones throughout their journey towards engineering. Milestones began as early as K-12 and focused on academic and environmental behaviors. Early academic behaviors contributed to future interest and success in engineering.

The theoretical framework was actively integrated throughout the study. The findings have implications in college retention, persistence and in the workplace. The Social Cognitive Career Theory aligned with the participants' decisions to pursue, enter, and remain in the engineering field. The Social Cognitive Career Theory involves the interrelation of three aspects of career development: self-efficacy, outcome expectations, and goals.

Social Cognitive Career Theory

The three aspects of career development were [expressed] throughout the participants' perspectives of their engineering journey. All perspectives were expressed through the participants' interviews, focus group, and timeline data. Self-efficacy relates to the participants' early beliefs about the ability to succeed with academic and parental support, which encourage outcome expectations and early goal setting; thus, creating the belief of successful future outcomes (Lent, Brown, & Hackett, 1994). Personal goals and goal setting was prevalent at all stages of the participants' journey (Lent, Brown, & Hackett, 1994).

Tinto's Theory of Persistence

Tinto's (1997) Theory of Persistence aligned with the factors that motivated the participants' persistence to pursue, enter, and remain in the engineering field. The participants' level of persistence and motivation had a direct impact on the decision to pursue and persist through undergraduate and graduate engineering studies. Each participant not only had a strong academic ability but a strong support system. Tinto's (1997) theory of persistence insists that students persist in college when they have strong support. In addition, participants remained closely connected to family and/or friends for encouragement, which assisted with their ability to remain and persist through collegiate studies. Tinto (1997) also expressed that college integration and involvement encourages students to persist in settings where their institutional make-up may not promote persistence. Participants expressed that they were integrated in the college community through student groups, internships, and mentorship from professors at varying levels. Tinto (1997) also expressed a correlation between classroom effort and persistence. Each participant excelled academically. The participants expressed that they exerted a great deal of classroom effort throughout their engineering studies due to the rigorous nature of the program. The interrelation between classroom effort, student integration, and support system were strong indicators of the participants' success and persistence in college.

Distinguishing Findings from Prior Research

It is important for the researcher to "distinguish his or her findings from prior research" (Moustakas, 1994, p.155). The current literature and prior research is scarce and limited in terms of perspectives of African American female engineers and the factors that motivated them to enter, persist, and remain in the field. Although prior research is scarce and limited, there were significant themes that appeared to correlate with the literature review. The interview questions,

focus group questions, and timeline purpose and structure were grounded in the literature to connect the findings to the research as a means of comparison. This section will discuss the comparison of the four emergent themes with the current research. The following themes are discussed: academic achievement, support system, factors that led to persistence, and African-American females in engineering.

Academic achievement, and in many cases perceived over-achievement, has been a characteristic of African-American female engineers in the current literature (Archer-Banks & Behar-Horenstein, 2012). Academic achievement in the early years has been an indicator of future progression in engineering. The participants in this study experienced early academic achievement. This is evidenced by the participants' enrollment in advanced placement and honors classes. Participants also earned achievements such as honor roll and graduating with honors at the top of their class.

Current research is scarce in terms of African-American female's persistence in engineering. However, research is available regarding the factors that can lead to one's persistence. Institutional framework, not necessarily academic ability, and motivation may be attributed to a student's persistence (Tinto, 1997). Connectedness with familiar structures and maintaining a link between home and school are factors that may lead to one's persistence (Tinto, 1997). Classroom effort and college community involvement have been linked to student persistence as well (Tinto, 1997). The study findings are connected with the research on persistence and college retention. Participants attribute their ability to persist to degree completion to their family support, high expectations, and intrinsic motivation.

A lack of support can lead to the attrition of African-American females during engineering collegiate studies (Tinto, 1997). Current research indicates that individuals who are

able to persist have a connection between the college community and home. These home, familial structures provide support as individual's progress through degree completion (Tinto, 1997). The participants in this study not only persisted but also did so to degree completion. This ability to persist was due largely in part to the strong support system. Participants expressed that they received support from family, friends, spouses, and strength from God.

African-American females represent 1.65% of the engineering workforce (National Action Committee on Minorities in Engineering, 2012). Research is limited regarding the factors that lead to persistence. Alternatively, there is research on the barriers to persistence for African-American women in engineering. Current research indicates institutional structures and practices may act as a barrier for some (Perna et al., 2009). Although all participants involved in the study persisted, some faced challenges due to the collegiate institutional structure and practices. One participant, Participant 2, had difficulty with her graduate advisor due to institutional structures and practices. For instance, her graduate school was a large research institution with a focus on writing and research, but absent of focus on student development.

Implications

These findings pose major implications for the literature and the field. Currently, the literature pertaining to African-American female engineers' persistence is scarce. There is great disparity in comparison to other gender or ethnic groups (National Action Committee on Minorities in Engineering, 2010). These findings contribute to the literature the participants' unique experiences through their own perspectives and lens. This perspective has been absent from the literature. This absence not only affects academia but K-12, collegiate, and places of employment as well.

Early academic behaviors, skills, and attributes contribute to the future career interests (Lent et al., 1994). Participants indicated that their participation in pre-engineering academies increased their knowledge and interest in the field. K-12 educational organizations may focus on providing opportunities for early exposure to STEM. K-12 educational organizations can utilize the pre-engineering perceptions of the participants to provide guidance and possible changes to STEM opportunities and curriculum. Curricula changes need to encompass an integrated approach to ensure skills are not taught in isolation (Bybee, 2010). In addition, some participants indicated that their interest began in the middle to late high school years. The inclusion of engineering concepts at an early age during K-12 is critical in garnering interest (Bybee, 2010). A potential implication is that K-12 needs to provide engineering exposure and opportunities to students earlier than in high school. Early exposure is critical to motivate and encourage persistence to this field by African-American females. Limited exposure hinders their future interest (Rockland et al., 2010).

Participants expressed how they at times felt isolated in their collegiate engineering programs. Although many shared their experiences of connectedness to their home and college community, there was a disconnect in the school of engineering. Some participants shared stories of their extremely competitive nature between engineering students, which contributed to the feelings of isolation. In addition, other participants indicated that they were often the only African-American females in their engineering programs. Familiar structures and connectedness contribute to persistence in college (Tinto, 1997). These findings pose procedure and policy implications for colleges and universities. Based on the findings, collegiate institutions are encouraged to examine their structures and supports for African-American females in their engineering programs. The institutional framework is critical in student retention and persistence

(Tinto, 1997). By reviewing policies that are designed to support and encourage diversity, colleges and university may is affect change in these areas.

The implications of the findings on the engineering workforce are similar to those in collegiate settings. Procedures and policies in the workplace need to be evaluated to ensure diversity is being addressed (Gill et al., 2008). Some participants expressed that isolation and marginalization in the workforce was so pervasive that they have transition to different facets within engineering where they felt secure and supported. The exploration of these procedures and policies may enhance the comfort of African-American female engineers in the workplace (Richman, vanDellen, & Wood, 2011). The findings indicate a need for places of employment to review their diversity policies. In addition, there is a great need for mentorship and programs that support diverse populations.

Delimitations

This study has two major delimitations the data collection instruments and participant demographics. I chose to triangulate the interview, focus group, and timeline data. The interview and focus group data provides vivid depictions of their engineering journey. It may have been helpful to provide a better description for the timeline data collection to ensure more vivid and rich responses. This change may have provided an opportunity to delve deeper into their unique experiences. The sample was a delimitation as well. The study was delimited to African-American females with 4.5 or more years of experience in the engineering field. It may have been beneficial to open the study to a larger range that would encompass participants with varying years of experience.

Study Limitations

The participant demographics cause the transferability of these findings to be limited. The demographics of the participants are African-American females who have worked in engineering for 4.5 or more years. In addition, the study was open to all types (e.g., chemical, mechanical, electrical, petroleum) of engineers. This diversity makes it difficult to transfer findings to populations other than African-American females. I investigated these demographics to examine the experiences of this unique group.

In addition to the demographics, another limitation of this study was the sample size. Currently, African-American females occupy 1.65% of the engineering workforce. The overall population of this group is small, therefore contributing to a small sample size. The small sample size may contribute to the lack of transferability as well.

Another limitation was issues in self-reporting, since I asked the participants directly. Anytime that a researcher asks participants questions through interview methods, there is an opportunity to receive misinformation. Participants may not be completely honest with the possibility of deceiving themselves or the researcher (Patton, 1990).

I requested access to the membership rolls of various engineering organization. I planned to recruit from the membership of the National Black Society of Engineers, American Society for Engineering Education, The Structural Engineers Association of North Carolina, and the Virginia Society of Professional Engineers. Membership roll access was another major limitation of this study. Access to membership rolls from organizations was limited due to constraints within organizations. The racial, gender, and work experience criteria was not be readily available when I accessed the membership rolls of the organization. Based on the depth

of each membership roll, I maintained a careful and unbiased eye to ensure that all potential participants were screened to determine if they met the criteria for the study.

Another limitation of this study was participation attrition. Nine participants expressed interest in participating in the study. Each potential participant, completed the screening questionnaire, signed the informed consent, and scheduled the initial interview. Prior to the initial interview, two participants declined to continue participation. Another participant completed the interview and timeline, but declined to participate in the focus group session and continue with the study.

Recommendations for Future Research

Further research is needed to investigate the early academic experiences that encourage African-American females to enter engineering. The study findings suggest that early academic achievement and participation in engineering programs motivated African-American females to enter the profession. However, it is imperative to examine the instructional and institutional factors that encourage early engineering interest.

Additional research is needed with larger samples of African-American female engineers to encourage greater transferability. In addition, research is needed to investigate different demographics, such as African-American males and/or females in engineering, and the factors that motivate their persistence to enter, remain, and persist in the engineering field. This research may lead to a greater understanding of the factors that motivate minority groups to persist. In addition, it may prove beneficial to examine the factors that led to attrition of African-American females' interest in engineering. Research to examine the barriers and causes for attrition is helpful for K-12 institutions, colleges, schools of engineering, and places of

employment is integral to the future development of supports and structures to retain these diverse groups.

Summary

The primary goal and purpose of this transcendental phenomenological study was to examine the academic and occupational experiences of African-American female engineers and the factors that led to their persistence (reasons for remaining) within the field in the United States. This study was pertinent and relevant to the current literature because of the inadequate amount of data regarding the factors that led to their persistence. Current literature regarding the experiences of African-American females in engineering is scarce. The data that is mostly available is quantitative in nature and provides statistics regarding the attrition and retention rates of African-American female engineers. Thus, this scarcity provides a need for their perspectives and unique experiences. Through lengthy structured interviews, focus groups, and timelines, participants were presented questions aimed to answer the research questions. Six African-American female engineers who have worked in the field for 4.5 or more years participated in this study. The data analysis process involved the transcription and coding of all data. All data was entered into Atlas.ti to assist with identifying themes and pulling pertinent quotes through the coding process. I employed Moustakas' methods for data analysis and ensured that the study was grounded in the theoretical framework. The theoretical framework consisted of Tinto's (1997) Theory of Persistence and the Social Cognitive Career Theory. I reflected upon each participant's horizon statement and analyzed the data to determine the emergent themes. The four themes that emerged were academic achievement, motivating factors that led to persistence, support system and the African-American female engineer.

I analyzed individual participant statements to discover the individual textural descriptions. The individual textural descriptions express what the participants experienced during their engineering journey. The individual textural descriptions that were discovered were that participants achieved at high academic levels at an early age and had strengths in mathematics and science. Participants were reared in close-knit communities and loving homes. I then took the individual textural descriptions and analyzed them further to discover the composite textural descriptions for the group. The composite textural descriptions were that participants have strong support systems and due to these structures were able to persist to degree completion.

I then took the individual participant statements to discover the individual structural descriptions. The individual structural descriptions discovered were the participants' drive, determination, and motivation to persist. Participants refused to look through the lens of quitting and believed it was not an option. Participants also felt a strong sense of responsibility to persist to degree completion and beyond as well. The individual structural descriptions express how the participants experienced their engineering journey. I then used the composite textural descriptions, imaginative variation, and the individual structural descriptions to express how the collective unit experienced their engineering journey. The sense of responsibility that encouraged participants to persist also encouraged them to be leaders and trailblazers in the field of engineering. This responsibility motivated participants to work hard to dispel the myths that African-American women were bossy with bad attitudes.

The following research questions guided this study:

a. How do K-12 experiences shape African-American female engineers' decisions to enter the STEM field?

The participants' shared their experiences that shaped their decisions to enter the STEM field. Participants achieved at a higher level academically as evidenced by their participation in advanced placement and honors classes. In addition, participants expressed their natural mechanical inclination, which garnered their STEM interest. Participants were strong academically in mathematics and science, which led into their STEM interest as well.

b. What persistence factors motivated African-American female engineers to enter the engineering profession?

   The participants expressed persistence factors that motivated them to enter the engineering profession. There was a great deal of familial support and structure, which encouraged the participants' academic achievement. These supports and high expectations encouraged participants to participate in pre-engineering clubs and take upper level science and mathematics courses to prepare for entering a collegiate engineering program.

c. What are the persistence factors that shape African-American female engineers' persistence to progress through postsecondary engineering programs?

   Participants experienced persistence factors that shaped their persistence to progress through a postsecondary engineering program. While participants may have faced challenges during their engineering studies, they used those challenges as an opportunity to persist. Much like their families, participants had high expectations of them and believed that they did not have the option of quitting. In addition, participants expressed their intrinsic motivation to succeed and their belief in God as factors that enabled them to persist to degree completion.

d. How do professional experiences shape African-American female engineers' persistence in the field?

   The participants had experiences professionally that shaped their persistence in the field. Participants currently use their talents within varying aspects of the engineering field. Each has developed throughout their journey from the technical, field engineer to sales, management, professorship, and consulting within engineering. These professional experiences have not only shaped their persistence in the field but motivated them to encourage others to persist as well.

The research design included the individual and composite textural and structural descriptions, the discovery of common themes, with a synthesis of the structural and textural analysis. The research design allows for participants' unique voices to be heard. The rich and unique perceptions of the participants serve as a meaningful reflection to affect change and increase diversity in the field.

The goal of this study was to assist K-12 institutions, colleges and universities, and places of employment to understand the factors that lead to persistence. The findings demonstrate implications in the literature and engineering field. The study's findings will contribute to the disparity in the literature. Their unique perspectives and experiences will not only contribute to the literature but to procedures and policies within the field.

In K-12 settings, the findings indicate the need for curricula changes to encourage earlier interest in engineering. Collegiate and places of employment may need to examine procedures and policies that support and encourage diversity and reduce attrition. In addition, this study demonstrates the need for collaboration between K-12 institutions, college and universities, and

places of employment. The collaboration may contribute to the structures, procedures, and policies to support African-American females interested in engineering.

REFERENCES

A Nation at Risk: The Imperative for Educational Reform. (1983). A report to the nation *and secretary of education.* Washington, DC: National Commission on Excellence in Education.

American Society for Engineering Education. (2014). *Mailing labels and list rentals*. Retrieved from http://www.asee.org/member-resources/resources/mailing-labels--list-rentals

Archer-Banks, D., & Behar-Horenstein, L. (2012). Ogbu revisited: Unpacking high achieving African American girls' high school experiences. *Urban Education, 47*(1), 198-223.

Atlas.ti. (2013). In *Atlas.ti Qualitative Data Analysis*. Retrieved from http://www.atlasti.com/index.html

Beatty, P., & Willis, G. (2007). Research synthesis: The practice of cognitive interviewing. *Public Opinion Quarterly, 71*(2), 287-311.

Bhanot, R. T., & Jovanovic, J. (2009). The links between parent behaviors and boys' and girls' science achievement beliefs. *Applied Developmental Science, 13*(1), 42-59.

Boeije, H., & Willis, G. (2013). The cognitive interviewing reporting framework. *Methodology, 9*(3), 87-95.

Byars-Winston, A., Estrada, Y., Howard, C. (2008). *Increasing STEM retention for underrepresented students: Factors that matter*. Madison, WI: University of Wisconsin-Madison, Center on Education and Work. Retrieved from http://www.cew.wisc.edu/docs/resource_collections/CEW_InSTEMRetention_UWMadison.pdf

Bybee, R. W. (2010). Advancing STEM education: A 2020 vision. *Technology & Engineering Teacher, 70*(1), 30-35.

Bybee, R.W. (2011). Scientific and engineering practices in K-12 classrooms. *Science Scope,35*(4), 6-13.

Cantrell, P., & Ewing-Taylor. (2009). Exploring STEM career options through collaborative high school seminars. *Journal of Engineering Education, 98*(3), 295-303.

Cech, E., Rubineau, B., Silbey, S., & Seron, C. (2011). Professional role confidence and gendered persistence in engineering. *American Sociological Review, 76*(5), 641-666.

Center for American Progress. (2013, November). *Fact sheet: The state of African American women in the United States*. Washington, DC: Maria Guerra.

Chang, S.,Yeung, Y., & Cheng, M. (2009). Ninth graders' learning interests, life experiences and attitudes towards science & technology. *Journal of Science Education & Technology, 18*(5), 447-457.

Cherney, I., & Campbell, K. (2011). A league of their own: Do single-sex schools increase girls' participation in the physical sciences? *Sex Roles, 65*(9/10), 712-724.

Creswell, J. (2007). *Qualitative inquiry & research design: Choosing among the five approaches*. Thousand Oaks, CA: Sage Publications.

Denzin, N. K. & Lincoln, Y. S. (1994). *Handbook of qualitative research*. Thousand Oaks, CA: Sage Publications.

Duhl, F.J. (1981). The use of the chronological chart in general systems family therapy. *Journal of Marital and Family Therapy, 7*, 361-373.

Elam, M. E., Donham, B. L., & Solomon, S. R. (2012). An engineering summer program for underrepresented students from rural school districts. *Journal of STEM Education: Innovations & Research, 13*(2), 35-44.

Espinosa, L. L. (2011). Pipelines and pathways: Women of color in undergraduate STEM majors and the college experiences that contribute to persistence. *Harvard Educational Review, 81*(2), 209-240.

Feller, R. (2011). Advancing the STEM workforce through STEM-centric career development. *Technology & Engineering Teacher, 71*(1), 6-12.

Hong, B.S., & Shull, P.J. (2010). A retrospective study of the impact faculty dispositions have on undergraduate engineering students. *College Student Journal, 44*(2), 266-278.

Gill, J., Sharp, R., Mills, J., & Franzway, S. (2008). I still wanna be an engineer! Women, education, and the engineering profession. *European Journal of Engineering Education, 33*(4), 391-402.

Goodman, L.A. (2011). Comment: On respondent-driven sampling and snowball sampling in hard-to-reach populations and snowball sampling not in hard-to-reach populations. *Sociological Methodology*, *41*(1), 347-353.

Hackett, G., & Byars, A. (1996). Social cognitive theory and the career development of African American women. *The Career Development Quarterly, 44*(4), 322-339.

Jamison, K. (2008). Growing a new crop of engineers. *Mechanical Engineering, 130*(12), 36-39.

Jones, B., Paretti, M., Hein, S., & Knott. (2010). An analysis of motivation constructs with first-year engineering students: Relationships among expectancies, values, achievement, and career plans. *Journal of Engineering Education, 99*(4), 319-336.

Jones, J. (2010). Closing the gender gap. *Civil Engineering , 80*(7), 60-63.

Kalevitch, M., Maurer, C., Badger, P., Holdan, G., Iannelli, J., Sirinterlikci, A., & Bernauer, J. (2012). Building a community of scholars: One university's story of students engaged in learning science, mathematics, and engineering through a NSF STEM grant. *Journal of STEM Education: Innovations & Research, 13*(4), 34-42.

Laefer, D. F. (2009). Gender disparity in engineering as a function of physics enrollment and its implications for civil engineering. *Journal of Professional Issues in Engineering Education & Practice, 135*(3), 95-101.

Lawrence, D.A., & Mancuso, T.A. (2012). Promoting girls' awareness and interest in engineering. *Technology & Engineering Teacher, 72*(1), 11-16.

Lent, R.W., Brown, S.D., & Hackett, G. (1994). Toward unifying social cognitive theory of career and academic interest, choice and performance. *Journal of Vocational Behavior, 45*, 79-122.

Lincoln, Y.S., & Guba, E.G. (1985). *Naturalistic inquiry.* Beverly Hills, CA: Sage Publications.

Lundy-Wagner, V. (2013). Is it really a man's world? Black men in science, technology, engineering, and mathematics at historically black colleges and universities. *The Journal of Negro Education, 82*(2), 157-168.

Merriam-Webster's Collegiate Dictionary (11th ed.).(2003). Springfield, MA: Merriam Webster.

Morganson, V. J., Jones, M. P., & Major, D. A. (2010). Understanding women's underrepresentation in science, technology, engineering, and mathematics: The role of social coping. *Career Development Quarterly, 59*(2), 169-179.

Moustakas, C. (1994). *Phenomenological research methods.* Thousand Oaks, CA: Sage.

National Action Council for Minorities in Engineering. (2010, November). *Fact sheet: U.S. engineering workforce* (Research & Policy Brief No. 3). White Plains, NY: Lisa M. Frehill

National Action Council for Minorities in Engineering. (2012, August). *African Americans in engineering.* (Research & Policy Brief No. 4). White Plains, NY: N.A.

National Society of Black Engineers. (2009). *Membership*. Retrieved from http://www.nsbe.org

Nasir, N. (2012). *Racialized identities: Race and achievement among African American youth.* Stanford, CA: Stanford University Press.

Patton, M.Q. (1990). *Qualitative evaluation and research methods*. Newbury Park, CA: Sage Publications.

Perna, L., Gasman, M., Gary, S., Lundy-Wagner, V., & Drezner, N. D. (2010). Identifying strategies for increasing degree attainment in STEM: Lessons from minority-serving institutions. *New Directions for Institutional Research, 2010*(148), 41-51.

Perna, L., Lundy-Wagner, V., Drezner, N. D., Gasman, M., Yoon, S., Bose, E., & Gary, S. (2009). The contribution of HBCUS to the preparation of African American women for stem careers: A case study. *Research in Higher Education, 50*(1), 1-23.

Polkinghorne, D. E. (1989), Phenomenological research methods. New York, NY: Plenum.

Reyes, M. (2011). Unique challenges for women of color in STEM transferring from community colleges to universities. *Harvard Educational Review, 81*(2), 241-262.

Rice, D.N. (2011). *The career experiences of African American female engineers.* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses. (Accession Order No. 3486133)

Richman, L., vanDellen, M., & Wood, W. (2011). How women cope: Being a numerical minority in a male-dominated profession. *Journal of social issues, 67*(3), 492-509.

Rockland, R., Bloom, D. S., Carpinelli, J., Burr-Alexander, L., Hirsch, L. S., & Kimmel, H. (2010). Advancing the "E" in k-12 STEM education. *Journal of Technology Studies, 36*(1), 53-64.

Saldana, J. (2013). *The coding manual for qualitative researchers.* Thousand Oaks, CA: Sage Publications

Society of Women Engineers. (2012). *Membership*. Retrieved from http://societyofwomenengineers.swe.org/

Soldner, M., Rowan-Kenyon, H., Inkelas, K., Garvey, J., & Robbins, C. (2012). Supporting students' intentions to persist in STEM disciplines: The role of living-learning programs among other social-cognitive factors. *Journal of Higher Education, 83*(3), 311-336.

Strayhorn, T. L. (2010). Undergraduate research participation and STEM graduate degree aspirations among students of color. *New Directions for Institutional Research, 2010*(148), 85-93

Tinto, V. (1997). Classroom as communities. *Journal of Higher Education, 68*(6), 659-623.

Tinto, V. (1998). Colleges as communities: Taking research on student persistence seriously. *Review of Higher Education, 21*(2), 167-178.

Tyler-Wood, T., Ellison, A., Lim, O., & Periathiruvadi, S. (2012). Bringing up girls in science (BUGS): The effectiveness of an afterschool environmental science program for increasing female students' interest in science careers. *Journal of Science Education & Technology, 21*(1), 46-55.

United States Census Bureau. (2012). *Data.* Retrieved from http://www.census.gov

U.S. Department of Labor, Bureau of Labor Statistics. (2012). *Occupational outlook handbook.* Retrieved from http://bls.gov

Veenstra, C., Dey, E., & Herrin, G. (2008). Is modeling of freshman engineering success different from modeling of non-engineering success? *Journal of Engineering Education, 97*(4), 467-479.

Williamson, S. Y. (2010). Within-group ethnic differences of black male STEM majors and factors affecting their persistence in college. *Journal of International & Global Studies, 1*(2), 45-73.

Woodcock, A., Graziano, W. G., Branch, S. E., Ngambeki, I., & Evangelou, D. (2012). Engineering students' beliefs about research: Sex differences, personality, and career plans. *Journal of Engineering Education, 101*(3), 495-511.

Zhe, J., Doverspike, D., Zhao, J., Lam, P., & Menzemer, C. (2010). High school bridge program: A multidisciplinary STEM research program. *Journal of STEM Education: Innovations & Research, 11*(1), 61-68.

APPENDIX A

Consent Form

AN ENGINEERING JOURNEY: A TRANSCENDENTAL PHENOMENOLOGICAL STUDY OF AFRICAN-AMERICAN FEMALE ENGINEERS' PERSISTENCE

Kristy N. Somerville
Liberty University

You are invited to be in a research study of the perspectives of African-American female engineers. You were selected as a possible participant because you are an African-American female engineer that has been employed for a minimum of 4.5 years. I ask that you read this form and ask any questions you may have before agreeing to be in the study.

This study is being conducted by Kristy N. Somerville, a graduate student in the Liberty University School of Education.

Background Information:

The purpose of this study is to learn about the factors that led to persistence and retention in engineering. In my qualitative research process, I want to interview African-American females in engineering.

Procedures:

If you agree to be in this study, I would ask you to do the following:
Participate in an interview that may last more than 25 minutes in length. Interviews will be audio, video or electronically (internet-based) recorded through WebEx or Skype. Participate in a focus group, which may last more than 30 minutes in length. Participate in collecting timeline data of your engineering journey. The timeline may take more than 25 minutes to complete.

Risks and Benefits of being in the Study:

The risks associated with this study are minimal. Participants may find discussing events in their lives uncomfortable at times. The risks are no more than the participant would encounter in everyday life.

There are no direct benefits for participants in this study. However, educational institutions and the field of engineering may benefit from the results of the study.

Compensation:

Participants will not be compensated for their participation in the study.

Confidentiality:

The records of this study will be kept private. In any sort of report I might publish, I will not include any information that will make it possible to identify a subject. Research records will be stored securely and only the researcher will have access to the records.

Voluntary Nature of the Study:

Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with Liberty University. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

Contacts and Questions:

The researcher conducting this study is Kristy N. Somerville. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact her at ksomerville2@liberty.edu or (434) 738-3637. You may also contact the Dissertation Chair, Dr. L. Daniele Bradshaw, (434) 592-6296, ldbradshaw3@liberty.edu.

If you have any questions or concerns regarding this study and would like to talk with someone other than the researcher, **you are encouraged** to contact the Institutional Review Board, 1971 University Blvd, Suite 1837, Lynchburg, VA 24502, or email the Board at irb@liberty.edu.

You will be given a copy of this information to keep for your records.

Statement of Consent:

I have read and understood the above information. I have asked questions and have received answers. I consent to participate in the study.

☐ By checking the box, I authorize and give consent for the researcher to audio-record, video-record or electronically record the participant.

Signature: _____Date: _____

Signature of Investigator: _____Date:_____

IRB Code Numbers: 1871.052114 **IRB Expiration Date:** 05/21/2015

APPENDIX B

Phone Recruitment Script
(Chain Referrals)

Hello, Excuse me, sir/ madam **OR**
Hello, Excuse me, Mr. or Mrs. (Participant name inserted here)

Do you have a minute? My name is Kristy Somerville, a graduate student at Liberty University. _____ (referrer's name) referred you as a potential participant in my dissertation research regarding African-American females in engineering. In my qualitative research process, I want to interview African-American females in engineering. The purpose is to learn about factors in their engineering persistence and retention.

At this time, I would like to send you the link to a screening questionnaire and study consent form. Is it okay for me to continue? If yes, continue and say the following:

Thank you, please provide your email address and I will forward the link to you. Also, I will schedule a convenient time to begin collecting data.

If the individual says, "no, not interested in participating," continue and say the following:

Thank you for your time.

APPENDIX C

Email Script

My name is Kristy Somerville and I am a graduate student at Liberty University. I am working on my dissertation research. In my qualitative research process, I want to interview African-American females in engineering. The purpose is to learn about factors in their engineering persistence and retention.

I am requesting your participation in the study. If you are interested, please click on the link below to answer a brief questionnaire, review, and sign the informed consent. If you have any questions, please contact me at ksomerville2@liberty.edu or (434) 738-3637.

Sincerely,

Kristy N. Somerville
Graduate Student

IRB Approval #
Dissertation Chair: L. Daniele Bradshaw, Ph.D.

APPENDIX D

Date: [Insert Date]
[Recipient]
[Address 1]
[Address 2]
[Address 3]

Dear [Recipient]:

As a graduate student in the Education Department at Liberty University, I am conducting research as part of the requirements for a Doctorate in Education degree and I am writing to invite you to participate in my study.

If you choose to participate, you will be asked to take part in an interview and a focus group and also complete a timeline. It should take approximately 3 hours for you to complete the procedures listed. Your participation will be completely anonymous, and no personal, identifying information will be required.

To participate, go to www.surveymonkey.com and click on the link provided to answer a brief questionnaire and schedule your interview. Survey monkey is a confidential and secure site. It provides secure transmission features, database and server security.

An informed consent document is provided in the questionnaire link and will be given to you at the time of the interview. Please click on the questionnaire link at the end of the informed consent document to indicate that you have read it and would like to take part in the study.

The researcher conducting this study is Kristy N. Somerville. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact her at ksomerville2@liberty.edu or (434) 738-3637. Dissertation Chair, Dr. L. Daniele Bradshaw, (434) 592-6296, ldbradshaw3@liberty.edu.

Thank you for your time and consideration.

Sincerely,
Kristy N. Somerville
Graduate Student

APPENDIX E

Potential Study Participant Screening Questionnaire

1. What is your gender?
    a. Male
    b. Female
2. What is your age?
    a. 25 or under
    b. 26-40
    c. 41-55
    d. 56 or older
3. Do you identify yourself as Black/African-American?
    a. Yes
    b. No
4. What is the highest level of education you have you completed?
    a. High school or equivalent
    b. Vocational/technical school
    c. Some college
    d. Bachelor's degree
    e. Master's degree
    f. Doctoral degree
5. How long have you worked as an engineer?
    a. 0-4.5 years
    b. 4.5- 9 years
    c. 9 years or more

APPENDIX F

Timeline Directions (Electronic Version)

Step 1: Begin by entering the time period on the Excel spreadsheet. For example, you may enter elementary, middle, high, postsecondary and/or workforce.

Step 2: By each time period, type the exact milestone, event and/or persistence factor in the "milestone" column.

Step 3: Complete steps 1 and 2 until the timeline is completed. Please save the document and email to ksomerville2@liberty.edu

or

Time Directions (Regular Mail Version)

Step 1: Begin by entering the time period on the Excel spreadsheet. For example, you may enter elementary, middle, high, postsecondary and/or workforce.

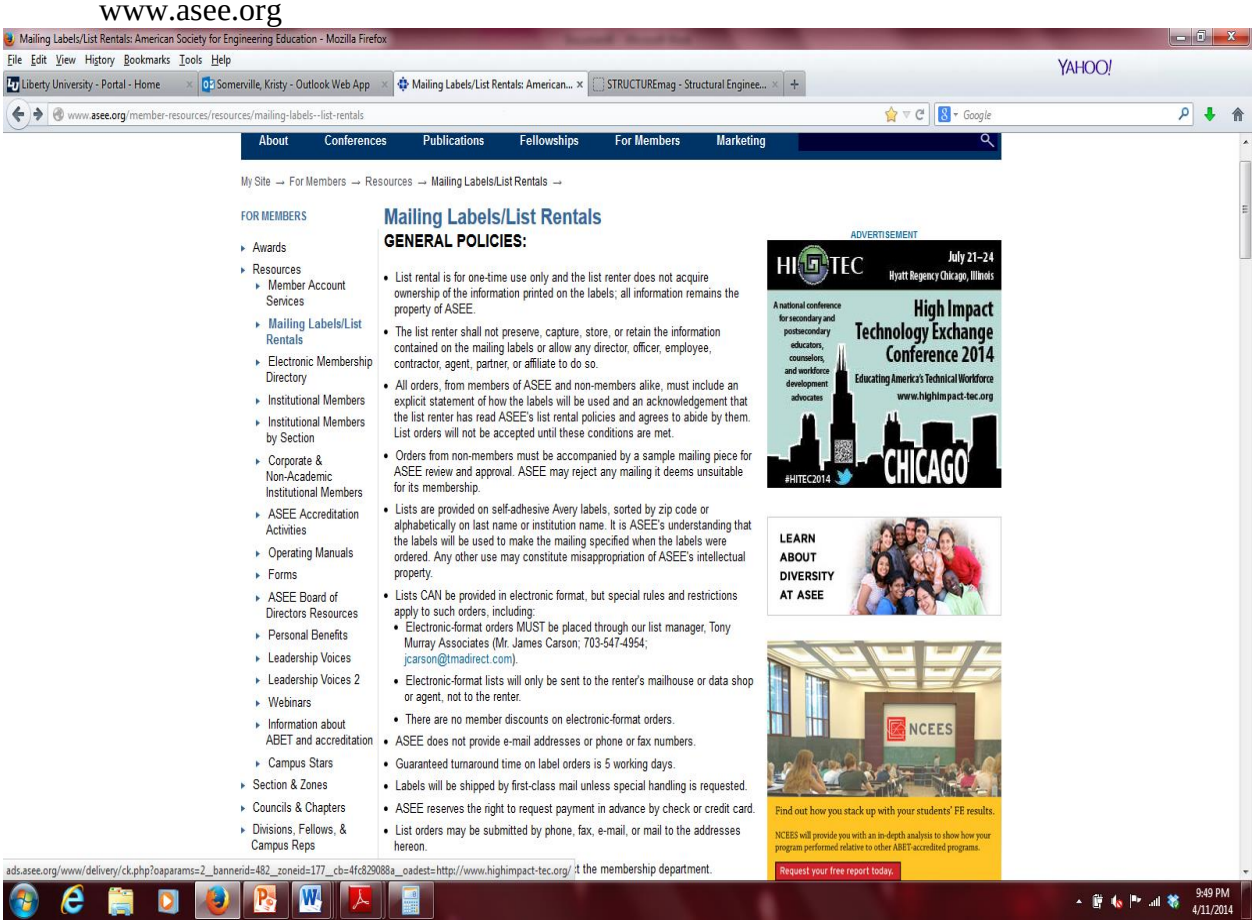
Step 2: By each time period, type the exact milestone, event and/or persistence factor in the "milestone" column.

Step 3: Complete steps 1 and 2 until the timeline is completed. Please make a copy of the document for your records and mail the original to P.O. Box 8007, Clarksville, VA 23927

APPENDIX G

American Society for Engineering Education

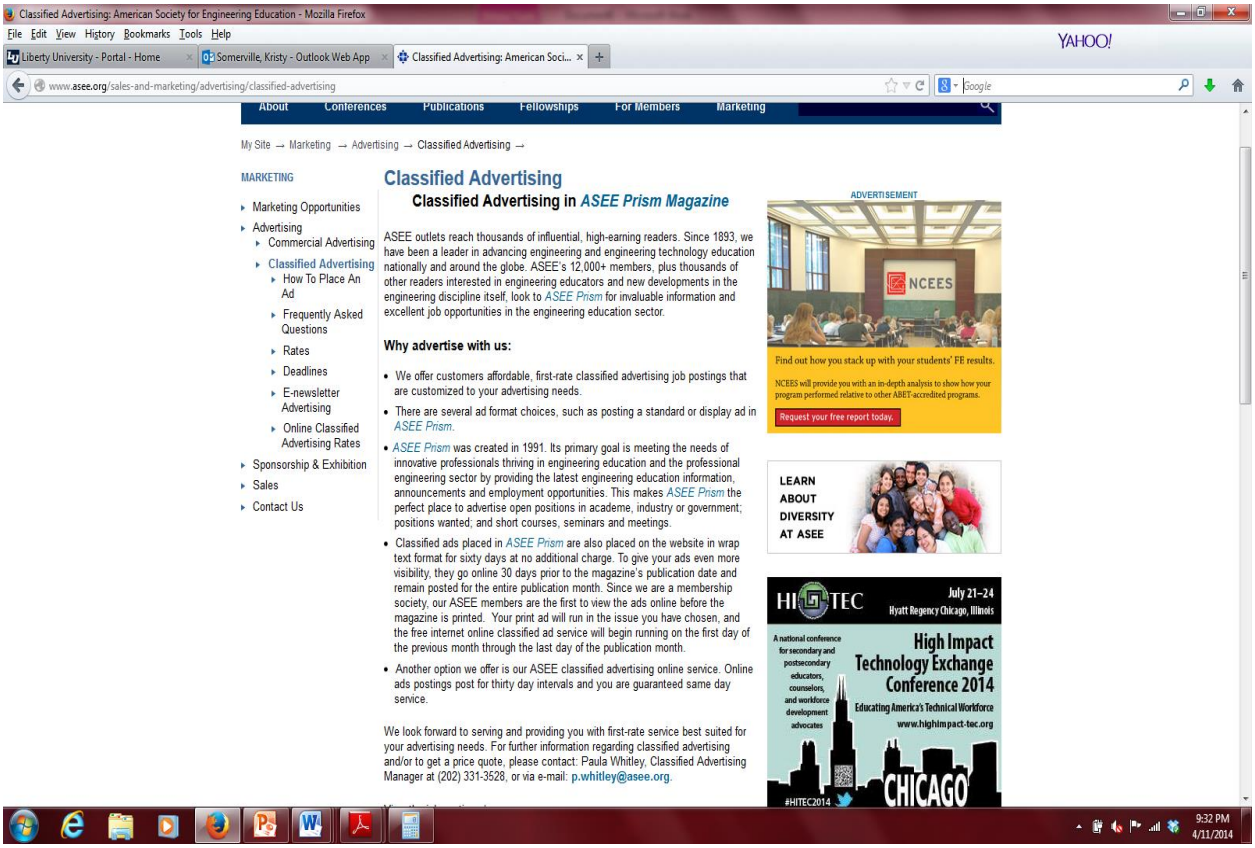
Mailing Label and List Rental Information
www.asee.org



APPENDIX H

American Society of Engineering Education

Classified Advertising in Prism Magazine
www.asee.org



APPENDIX I

Themes and Supporting Statements

Themes	Supporting Statements
Academic Achievement and Interest	• "Early academic achievements would definitely be like honor, I was always recognized with honor roll" • "I don't think I had anything major, I thought it was typical to be on the a/b honor roll, to be selected for good citizenship" • "I mean your standard honor roll, k-12, I was in the national honor society just outside of the top 15 or top 20 in my high school class of 500 something kids" • "AP courses throughout, and took college courses when we could in high school" • "Took the advanced science and advanced math" • "I graduated cum laude and my brother

	graduated with honors"
Factors that led to persistence/Motivation to Persist	• "I think because I approached college as, I didn't look at it as a choice, I really looked at it as a must" • "I think it's an expectation thing. My mom always made it clear, you are going to college and getting a degree" • "If you want something go for it"
Support System	• "I would definitely say the support of my parents" • "Number one my faith. Second definitely family" • "I can talk to my friends and family. • "I think God really, I think all things are possible with God" • "My, I guess my faith or background not that staunch, is Baptist, we have a church covenant, and I think that sums up everything from me" • "Mom and dad still" • "I turn to God, my husband, my father, I turn to my mentors and coach"

African American Female Engineer	• "I'm not sure if it has influenced me as being an African American female as being a female in general" • "not only am I a female representative but I'm an African American representative as well. I want to see my …make a way for future African American females" • "I don't always want to speak for my gender or being a black woman and then sometimes you feel like you got to… " • "I'm here to dispel the myth that African-Americans are given a position because they are underrepresented just because but they actually know what they are doing, or the expectation was to offer them the opportunity to demonstrate their knowledge, skills and abilities and afford them an opportunity whether they succeed or fail" • "I didn't want a lot of the other African American workers to take the brunt if I

	chose a different route” • “I was kind of apprehensive to being an African-American female in a very male dominant, male dominated field, very male , very white male to be specific…I was very worried how clients would react when I showed up on the scene and say that I’m here to supervise the job…” • “As an African American female in the engineering workforce, it is very challenging but doable”

APPENDIX J

LIBERTY UNIVERSITY.
INSTITUTIONAL REVIEW BOARD

May 21, 2014

Kristy N. Somerville
IRB Approval 1871.052114: An Engineering Journey: A Transcendental Phenomenological Study of African-American Female Engineers' Persistence

Dear Kristy,

We are pleased to inform you that your above study has been approved by the Liberty IRB. This approval is extended to you for one year. If data collection proceeds past one year, or if you make changes in the methodology as it pertains to human subjects, you must submit an appropriate update form to the IRB. The forms for these cases were attached to your approval email.

Please retain this letter for your records. Also, if you are conducting research as part of the requirements for a master's thesis or doctoral dissertation, this approval letter should be included as an appendix to your completed thesis or dissertation.

Thank you for your cooperation with the IRB, and we wish you well with your research project.

Sincerely,

LIBERTY
UNIVERSITY.

Liberty University | Training Champions for Christ since 1971

1971 UNIVERSITY BLVD. LYNCHBURG, VA. 24515 IRB@LIBERTY.EDU FAX (434) 522-0506 WWW.LIBERTY.EDU