A PHENOMENOLOGICAL STUDY FACTORS AFRICAN AMERICAN FEMALE COLLEGE STUDENTS FACE PARTICIPATING IN ENGINEERING STEM MAJORS

by

Venessa M. Mitchell

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University of Phoenix

ProQuest LLC.
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106 - 1346

The Dissertation Committee for Venessa M. Mitchell certifies approval of the following dissertation:

A PHENOMENOLOGICAL STUDY FACTORS AFRICAN AMERICAN FEMALE COLLEGE STUDENTS FACE PARTICIPATING IN ENGINEERING STEM MAJORS

Committee:

Frank Czarny, Ph.D., Chair

Robin Chambers, Ed.D., Committee Member

Rockel Etienne, Ed.D., Committee Member

Frank Czarny

Frank Czarny

Robin Chambers

Robin Chambers

Rockel Etienne

Rockel Etienne

Jeremy Moreland, Ph.D.
Dean, School of Advanced Studies
University of Phoenix

Date Approved: October 5, 2014

Abstract

The purpose of this qualitative research methods study with empirical phenomenological research design was to explore the lived experiences of the African American females compared to other populations entering engineering or other Science, Technology, Engineering and Mathematics (STEM) program in colleges. Although African American females have made some strides in educational achievements, there continues to significantly less progress in engineering and other STEM disciplines. Many occupations in the science, technology, engineering, and math fields require degrees in STEM to be considered for interviews and eventual employment. The African American female population in order to be more successful in engineering or other STEM programs it will be necessary to understand what barriers may exist that hinder positive results on an ongoing basis. The general problem of low numbers of female minority college students in STEM programs continues to create concerns for administrators and instructors. Proper evaluation and recommended improvements are needed to improve success rates for the African American female students. The goal of this research was to interview approximately 20 – 25 African America female college students in engineering and other STEM programs to identify what obstacles may exist that might hinder their success in these programs and make recommendations for improvements in the future.

Dedication

I dedicate this dissertation to my loving husband, daughter, son and grandchildren. Throughout this educational journey I have had the love and unconditional support of my family. My husband and children prayed, encouraged me, and gave me hugs that gave me the strength to make my dream a reality. When I could not attend a function or needed to close myself off from the world to meet a deadline, you were understanding and kept cheering me on. I am so thankful and blessed to have each one of you in my life. My Arizona mom, thank you for praying for me, unconditional love and support, and home when I needed a place to stay during my residencies. My youngest sister, for your unconditional love and support throughout this journey, and allowing me to have a break at your house. All my extended family and friends who offered words of encouragement throughout this journey, thank you. In loving memory of my father, maternal and paternal grandparents, although not here always in my heart. God has truly blessed me with the wonderful support of family and I thank him.

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Chapter 1: INTRODUCTION

African American female students have been an underrepresented in the science, technology, engineering, and math (STEM) disciplines in many colleges. The success of African American female students in the engineering field could have positive or negative implications in the future of the workplace in this field. Focusing on recruitment, retention, and graduation rates of this underrepresented population could provide some insight for the need for research in this area. Lewis, Menzies, Nájera, and Page (2009) cited the existence of barriers, which are vital to the understanding of the scientific community for identifying a large population of diverse well-trained applicants in STEM and could continue to hinder a competitive global economy (National Academy of Sciences, 2007). Many occupations in the STEM fields require degrees in those fields to be considered for interviews and eventual employment. Positive implications to attracting and maintaining women from diverse backgrounds could aid the United States to remain competitive in this global economy as noted by Trenor, Yu, Waight, Zerda, and Ting Ling (2008).

Chapter 1 provides the background of the research issue of contributing characteristics about why African American female students have been underrepresented in the STEM disciplines in many colleges compared to other ethnic groups. The problem statement, importance of the study, method, purpose statement, proposed research questions, and interview questions are the basis of this study. A qualitative method and phenomenological design for data collection via face-to-face and phone interviews, and archival data to support the outcomes and recommendations for further research are

instrumental to providing solid results. Lastly, based on the outcomes of the study the hope is to provide a better understanding of why the issue continues to exist.

Background

Institutions of higher education should actively address the barriers faced by African American women in engineering and other STEM disciplines. The number of students majoring in science, mathematics, and engineering declined from the freshman year to the senior year, from 28.7% to 17.4%, a 40% relative decline (Whalen & Shelley, 2010). Retaining and producing graduates in the science, technology, engineering, and mathematics disciplines of the African American female are a major concern. According to Trenor, et al., (2008) to meet the demand for skilled scientific workforce African American women continue to be an underutilized resource. The need exists for more studies to research African American female engineering students compared to other ethnic populations to gain a clearer understanding of their academic and educational experiences as it relates to engineering and other STEM disciplines was noted by Trenor, et al., (2008). Understanding the perception of African American females entering the engineering disciplines with and without a high school STEM background is important to making modifications for increasing the success of this group. The relevance of their decision to enter an engineering field regardless of the recruitment efforts of the college also could add an element of understanding why some are successful and some are not.

Ongoing research is necessary to gain a clearer understanding of the African American female perceptions compared to other groups when preparing to make a decision whether or not to enter the engineering discipline for higher education and

eventual career. Farinde and Lewis (2012) stated, "few researchers have examined how the dual presence of race and gender affect the educational experiences of these marginalized women" (p. 421). Instructors could support the development of the African American women toward the STEM disciplines if there were a better understanding through empirical phenomenological research methods of the myths and truths of this underrepresented population's experiences. According to Moustakas (1994), depicting the core of the African American student's experience based on philosophical structural examination, the empirical phenomenological research method could offer an all-inclusive explanation. The ongoing lack of African American females entering and successfully completing studies in higher education in the engineering disciplines warranted further research. Providing a comprehensive explanation of an experience and its meaning to the person enduring the experience is the goal of conducting the research (Moustakas, 1994).

Problem Statement

The general problem is the underrepresentation of African American female college students compared to other ethnic populations in STEM programs particularly engineering, which creates concerns for administrators and instructors at an upstate New York institute of higher learning. Trenor, et al., (2008) stated, "While the current need to attract and retain diverse students to the profession has been recognized, little attention has been paid to the study of institutions that already model the ethnic diversity" (p. 450). The specific problem is the instructional and personal barriers experienced by African American women in engineering compared to other ethnic populations in similar

programs. Proper evaluation and recommended improvements was needed to improve success rates for the African American female students. According to McLoughlin (2009) an under recognized type of up-and-coming women undergraduate engineering students in the United States continues to exist. McLoughlin (2009) identified these women as "Non-traditional Engineering Organized (NEO) students who differ from the familiar and Traditional Engineering Discipline (TED) students with strong" (p. 151) STEM backgrounds. Recruitment and retention strategies of the NEO students needs to be identified and addressed because NEO students are highly motivated but lack the skills of the TED students with a strong background in the STEM disciplines (McLoughlin, 2009).

Although students considered as NEO have, the skills to be accepted into engineering programs, recruitment and retention efforts of the NEO students' needs to improve in the engineering disciplines going forward. Gaps in the current literature are the "connection between gendered knowledge and gendered identity of engineering students" (McLoughlin, 2009, p. 166). Limited research explores the perception of the African American females entering the engineering discipline both with and without high school STEM background compared to other ethnic populations. A small amount of information regarding the perception of the recruitment efforts before choosing to enter in the engineering field was identified.

The method used for this research project was qualitative with a phenomenological design with the gathering of data through interviews, and from current African American female engineering students and other ethnic groups in the similar

disciplines. The goal was to identify gaps and barriers that hinder the ability of the African American students from completing a collegiate level engineering program and other STEM programs compared to other populations in comparable programs. Including information from other ethnic groups as a comparison aided in identifying how wide the gap is between African America students from other students. Gathering information in this manner was helpful in reporting a more complete assessment to administrators and other education professionals who may be in a position the modify curriculum and instruction to address any issues that are identified from this research.

Purpose Statement

The purpose of this qualitative research methods study with empirical phenomenological research design was to explore the lived experiences of the African American females compared to other populations entering an engineering program or other STEM program in an upstate New York institution of higher learning. Perna, Lundy-Wagner, Drezner, Gasman, Yoon, Bose, & Gary, (2009) commented, "the reported success of programs designed to improve academic preparation further suggests the role of academic barriers in limiting the attainment of students of color in STEM fields" (p. 3). Understanding the perception of the recruitment efforts before the underrepresented population of females choose to enter in the engineering field using a qualitative method of data capture helped in developing new strategies in the future.

According to Fleming (2008), the number of African American women pursing terminal degrees in engineering and continuing to academia should emulate the number of same female engineering or STEM learners to the amount working in the field.

Successful African American women in engineering represent areas where positive intervention assisted in their success. Drawing on the positive examples of African America women in the engineering workforce and incorporating into this study helped in the recommendation of some solid activities that can be used for the underrepresented student population going forward. According to *U.S. Black Engineer & Information Technology* magazine it was noted how professional African American females were successful during their academic career and are currently working in different fields of engineering by having received mentoring, personal motivation, and attended Historically Black Colleges or Universities (HBCU) ("Look Where They Are Now," 2008).

Using a qualitative method was relevant to gathering information from students to establish any trends. The information gathered for analysis was authentic data captured to make recommendations for future enhancements to recruitment, retention, and graduation rates of the African American female engineering students. Information gathered from personal interviews at a college in the upstate New York area provided insight into African American female perceptions on the decision to enter an engineering program whether they had or not had a high school STEM background compared to other populations in a similar situation. The information gathered from current students was used to explore the perception of African American females and their decision to choose to enter engineering or STEM programs in college compared to other ethnic populations in similar situations. The study consisted of a qualitative approach with a phenomenological design. Using information from the original experience the research

goal will be to determine what information can be gained that is significant and tangible (Moustakas, 1994).

Significance of the Study

This study was intended to expand on the knowledge from what other researchers have examined and overcome the challenges. A comparison of the tactics used by the different engineering disciplines and the relative accomplishments may divulge strategies that could specify ways to work together to the escalation of the engineering enrollment and scientific literacy (McLoughlin, 2009). Continued exploration that can identify avenues to pursue or obstacles to increasing this understated group in engineering and other STEM education, occupations, and "pedagogical, institutional, and societal conditions that maintain the factors" is recommended according to Lewis, et al., (2009, p. 973). The objective was to acquire concrete information to add to research previously conducted by designing a qualitative approach and strengthen the validity by incorporating a phenomenological design for data collection. Further, with the information gathered the goal was to provide suggestions for improvements to aid in the advancement of African American females in the engineering and STEM disciplines.

The gap in literature pertaining to retention, perceptions, and graduation among African American females in the STEM disciplines in particular engineering compared to other populations, continues to be an area of concern among researchers. The White male is oftentimes considered the "norm" and quite often in contrast African America women are considered unequal in intellect and ability (Farinde & Lewis, 2012). Understanding the perception of African American females compared to other

populations and whether students possess a high school STEM background or not, affects the decision-making process when deciding to choose an engineering program. Although the number of female engineering students has increased in recent years, the number of women who enter the professoriate is still disproportionately small (Fleming, 2008).

Leaders in the engineering and other STEM fields are concerned with the lack of qualified African American females entering these college programs, succeeding, and joining the workforce in those fields. Lewis, et al., (2009) raised serious inquiries regarding how to symbolize the paths of different ethnic populations in the STEM disciplines. Examining the perceptions of the African American female engineering students and comparing them to other populations provides advisors, faculty, and other engineering professionals with valuable information to aid in the development of mentoring, coaching, and other support programs to improve African American female success in the engineering and similar programs. A secondary benefit of this study provided recommendations for recruiting future African American female students into these types of programs. Scholastic achievement in a STEM field depends, partially, on the competence of previous educational training and accomplishment (Perna et al., 2009). Understanding the specific needs and wants of the African American female during recruiting through graduation can aid professionals, instructors, administrators in the engineering and other STEM disciplines to provide a larger population of diverse well-trained applicants for professions in the engineering and other STEM fields. Fleming (2008) commented the lack of women in engineering "is regrettable in view of the fact that women might well bring perspectives to engineering in some instances that are

reflective of their views of the world, their views of science, their research priorities and, even their interpretations of data" (p. 33). Results from this study may assist the African American women considering engineering as an academic career. The study could enhance recruitment efforts, increase retention, graduation rates, and facilitate positive changes to the curriculum to increase the success rates of this underrepresented population of students.

Nature of the Study

This qualitative study with a phenomenological design was used to achieve the study purpose and address the studied problem, the underrepresentation of African American women success or not in the engineering and STEM disciplines at the collegiate level of education. The data capture occurred through interviews using mainly face-to-face discussions and phone conversations. According to Moustakas (1994), the phenomenological discussion includes "an informal, interactive process, and utilizes open-ended comments and questions" (p. 114). Interviews were conducted with a purposely selected sample population to gather data supporting or not why African American female engineering students entering college as freshman are successful or not in engineering and other STEM disciplines. Moustakas (1994) further states, "Often the phenomenological interview begins with a social conversation or brief meditative activity aimed at creating a relaxed and trusting atmosphere" (p. 114). This method was appropriate given the problem and purpose of study because it analyzed current student perceptions to make recommendations for the future instructional, mentoring, and recruitment activities. The design was appropriate given the problem of study and the

purpose of the study to make recommendations for modifications as needed going forward. According to Moustakas (1994), providing an in-depth investigation and providing a comprehensive explanation from persons enduring an experience is a major strength of phenomenological research. Gathering information from African American female students and comparing to other ethnic groups in the engineering and similar disciplines was instrumental providing strong results for making suggestions for enhancements as needed. Including participants who were in the program and switched to another program about their experiences positive or negative were a great value adds.

Research Questions

The rate of the African American female success in the science, technology, engineering, and mathematics (STEM) disciplines continues to be of concern to many researchers. According to Lewis, et al., (2009) during research when referencing "national statistics concerning minority illustration in the sciences, is twofold: (1) to produce a clear, comprehensive account of enrollment trends across racial/ethnic groups in one STEM discipline, and (2) to offer documentation of the magnitude of the differences in representation" (p. 962). The following questions guided this qualitative phenomenological research approach. Using face-to-face interviews and phone discussions to understand better what motivators or identify barriers for African American females entering and completing engineering or other STEM program at the collegiate level compared to other ethnic groups in the same or similar programs. The following questions will guide the research:

1. What motivates African American females to enter an engineering program at the collegiate level compared to other populations?
2. What do the participants report as the contributing factor(s) for entering the engineering or STEM program?
3. To what extent does the perception of engineering and STEM as an attainable career influence whether or not to choose engineering or a STEM discipline as a major in college?
4. How does parental guidance influence the female's choice to go into engineering as a major or career?

During face-to-face and phone interviews, the intent was to identify barriers that may hinder the success of this underrepresented population compared to other ethnic groups. Another objective of the discussions was to gather information to facilitate success in the future. The following questions directed the meetings with the population sample during the face-to-face interviews and group interviews:

1. Based on your personal experiences explain what it was like for you when you were deciding which educational program to select prior to attending college.
2. Explain the educational and professional influences you experienced in deciding to enter engineering or STEM programs at the collegiate level.
3. Describe specific issues that contributed to your choosing engineering or STEM as a collegiate career.
4. Based on your personal experiences describe your perception of professions in engineering or STEM as attainable careers.

5. Describe whether or how much your parents influenced your decision to select engineering or STEM educational programs in college.
6. Based on your personal experiences explain what you feel is the most important reason to participate in engineering and STEM programs.

Through both face-to-face and phone interviews, the intent was to identify obstacles that may hinder the success of this underrepresented population and identify areas to stimulate success in comparison to other ethnic populations.

Theoretical Framework

Learning theories were the general basis for the framework of this study to understand the effects on African American women's decisions and success or not in the engineering field as a college major or career option compared to other ethnic students in similar programs. Social-cognitive and cognitive theories lead the basic framework to understanding why African American women may choose an engineering focused education in higher education and the success rates or lack of success that occurs in this discipline. In the late 1980s and 1990s, Albert Bandura's social cognitive theory was based on the assumption that people were purposeful, goal-directed beings who were primarily motivated through their beliefs of self-efficacy and outcome expectations stemming from their actions within specific social contexts (Erlich, & Russ-Eft, 2011).

According to Madyun (2011) education researchers continue to be concerned by the lack of achievement of the African American female student based on recent results. Motivational and grounded theories were a basis for focusing on the African American female and the decision to pursue an engineering education at the collegiate level. The

focal point of African American outcomes in STEM normally was based on the achievement gaps between white and African American students (Madyun, 2011). Achievement gaps can be referred to as the experiential and persistent inequality between the performance of students identified by socioeconomic status and gender, race/ethnicity. For the basis of this study, African American females are the focal point of the analysis. Information gathered from the participants regarding enrollment, retention, and graduation of this underrepresented population was the basis for determining how and why this group made the choice to pursue engineering at the collegiate level or not compared to other students in similar programs.

A framework using a social cognitive theory as the basis of this research provides an avenue to assess the learning outcomes using two variables "self-efficacy beliefs and self-regulated learning in academic planning" (Erlich & Russ-Eft, 2011, p. 5). Included as another significant theoretical framework for the analysis of why African American women may choose engineering as a college major is the motivational theory. Kerssen-Griep, (2003) cited "motivational theorists describe learners as innately inclined toward mastery, activity, exploration, and spontaneous interest but also having a vulnerability to passivity that can be elicited by social contextual events" (Ryan & Deci, 2000, p. 76).

Through a qualitative phenomenological study and the understanding of several learning theories, the focus on African American females could bring a clearer understanding to the success or not of this underrepresented population in the engineering discipline at the collegiate level. According to Moustakas (1994), "the theoretical review analyzes the theories that account for the existence of the phenomenon" (p. 112).

Definitions

*Data saturation: "*determined as the point in data collection and analysis when new information produces little or no change" (Nixon & Wild, 2013. p. 1).

Focus groups: "a special qualitative research technique in which people are informally 'interviewed' in a group-discussion setting asked the same questions about his or her perceptions, opinions, beliefs, or attitudes" (Neuman, 2006, p. 412).

*Grounded theory: "*a type of inductive social theory often used in qualitative research that builds toward abstract theory, often by making comparisons of empirical observations" (Neuman, 2006, p. 60).

HBCUs: acronym for Historically Black Colleges and Universities (Mikyong Minsun, & Conrad, 2006).

Interview: "a short-term, secondary social interaction between strangers with the explicit purpose of one person's obtaining specific information from the other" (Neuman, 2006, p. 305).

Informed consent: "written statement that explains aspects of the study to participants and asks for their voluntary agreement to participate before the study begins" (Neuman, 2006, p. 135).

Methodology: "the strategy, plan of action, process, or design behind the choice and use of particular methods and linking the choice and use of methods to the desired outcomes" (Case, & Light, 2011, p. 188).

Phenomenology design: "rooted in questions that give a direction and focus to meaning, and in themes that sustain an inquiry, and awakens further interest and concerns" (Moustakas, 1994, p. 59).

Purposeful sampling: "a nonrandom sample which the researcher uses a wide range of methods to locate all possible cases of a highly specific and difficult-to-reach population" (Neuman, 2006, p. 222).

Qualitative research: an approach to empirical research that relies predominantly on the "collection of qualitative data (i.e., nonnumeric data such as words, pictures, and images)" (Christensen, Johnson, & Turner, 2011, p. 361).

Recruitment and retention strategies: approaches to recruiting and maintaining a population to achieve successfully desired results (Frizell & Nave, 2009).

Self-efficacy: refers to one's confidence in engaging in specific activities that contribute toward progress to one's goals (Bandura, 1997) as cited by Erlich & Russ-Eft (2011).

Social-cognitive theory: based on the assumption that people were purposeful, goal-directed beings who were primarily motivated through their beliefs of self-efficacy and outcome expectations stemming from their actions within specific social contexts (Erlich & Russ-Eft, 2011).

STEM: acronym for science, technology, engineering, and mathematics in educational environments (Frizell & Nave, 2009).

Underrepresented population: insufficiently or inadequately represented who have been traditionally ignored by the government, minority groups such as African Americans, Hispanics or Native-Americans (Frizell & Nave, 2009).

Scope

The research study included 20 – 25 female college students from an institution in upstate New York, who are in engineering or similar STEM programs. In order to be a participant in the research study approximately 50% - 60% of the students have to identify themselves as African American who are pursuing an engineering or other STEM degree or was previously in engineering or STEM program in higher education. The remaining percentage of participants in the study identified themselves as Caucasian, Hispanic/African American, or Asian American. The preferred age of the participants was between the ages of 18 and 25. The participants were selected by word of mouth, email, or referrals from several engineering and other STEM programs. The plan was to interview each participant until data saturation was achieved, which was achieved by conducting interviews lasting approximately 40 – 50 minutes per interview. Data saturation was "determined as the point in data collection and analysis when new information produces little or no change" (Nixon & Wild, 2013, p. 1). NVivo 10 software was one source used for managing, organizing, and analyzing non-numerical information captured during the interviews.

Limitations

Several limitations existed within the study. The three major limitations identified were (1) lack of experience of the researcher in an educational workplace and

the STEM field; (2) the selection of the participants may be too limited; and (3) the participants may not answer the questions in an open and honest manner, which could generate inaccurate information. In the case of a researcher not having worked in the education field or limited experience the questions created for the interviews may not be able to capture the information necessary for a proper analysis. The lack of experience in the STEM, specifically the engineering field may increase the chances of the information gathered as not reliable and valid. Biases may exist that will not be recognized the researcher.

Because the participants will be volunteers, the selection process may be too limited in trying to identify African American females in the engineering and STEM disciplines to participate in the study. Considering there may not be a sufficient pool to draw from to get the intended target audience with the appropriate educational background, the data collection process may not provide enough information to make a solid assessment. The study was intended to capture information that can be shared and added to the plethora of information surrounding the topic with other researchers.

Conducting an in-depth investigation and providing comprehensive explanations from persons enduring an experience according to Moustakas (1994) will be key to capturing concrete data for analysis. The participants may not provide open and honest responses to the questions, which can compromise the information attained. According to Moustakas (1994), qualitative research provides a distinct interpretation of the phenomenon and does not attempt to generalize results. Because opinions of the sample

population may appear in this qualitative study, ensuring the participants are at ease will help to minimize the possibility for any dishonesty in the responses.

Delimitations

The focus of the study was to gather information from African American females at the collegiate level in STEM programs, specifically engineering to determine the contributing factors existing when deciding to enter and engineering program as compared to other ethnic populations in similar programs. Face-to-face conversations and some phone discussions to identify clearly the boundaries between the researcher and participants improved the ability to collect feedback from the participants regarding the lived experiences of this underrepresented group compared to other populations.

Summary

Chapter 1 consisted of providing a background, problem and purpose statements, the significance and nature of the study, guiding research questions, theoretical framework, scope, limitations, and delimitations. Chapter 1 included the methodology and processes for data collection. A qualitative phenomenological research design was defined as the best approach to completing the study. An in-depth investigation and providing comprehensive explanations from persons enduring an experience is a major strength of phenomenological research (Moustakas, 1994). The population for data gathering was defined as 50% - 60% African American female college students and the remaining participants defined as Caucasian, Hispanic/African American, and Asian American females in the same or similar programs. Research participants were identified from an upstate New York institution, enrolled in engineering or STEM disciplines, most

specifically engineering. The concern of administrators and educators regarding the underrepresentation of African American female students in the science, technology, engineering, and math STEM disciplines in college guided this study.

Chapter 2 consists of a literary review and historical perspective surrounding the underrepresentation of African American female students in STEM disciplines at the collegiate level. Chapter 2 contains information for the need to continue to research this situation to provide educators, administrators, federal, state, and local leaders with information to improve the participation in these programs by the African American female students.

CHAPTER 2: Literature Review

A review of the literature provided multiple factors influencing the African American female's decision to pursue a higher educational goal in the engineering discipline and the success thereof are not compared to other ethnic populations. The objective of chapter 2 was to summarize the contributing factors and provide some perspectives on the causative elements. Relevant words and phrases entered as part of the research process during the literature review consisted of African American females in engineering, graduation, retention, underrepresentation in science, technology, engineering, and mathematics STEM disciplines in higher education and similar in the careers of such disciplines. Another part of the research conducted included other words concerning the topic included families impact, social, cognitive, motivation, enrollment, and various research methods. The results of the literature research identified several factors that could be influencing selections African American females choose when electing to pursue either an academic or business career in engineering.

The main purpose of this literature review was to assess the history of this underrepresented group of individuals in engineering and what may be contributing factors that would influence the choices made in pursuing an engineering degree or not. When electing to pursue an academic or business career in engineering, the rates of success, what can be implemented to increase the rate of success, and addressing graduation and retention rates is a focal point to the success of instituting positive changes. McLoughlin (2009) noted there continues to be an "under-recognized type of successful women undergraduate engineering student in the United States" (p. 151). An

abundance of research exists surrounding this topic and the purpose of this literature review was to delve deeper into the contributing factors as the problem continues to exist. Cox, Cekic, & Adams (2010) commented, "Until recently studies focusing on leadership in the higher education (specifically on students) community lacked a sound instrument to explore, describe, or evaluate college students' leadership attributes" (p. 24). Ultimately, the goal of this literature review was to make recommendations to academia and industry of what developments can occur to improve the success, retention rates of this underrepresented population of females in relationship to other populations of students. According to Pritchard & Baillie (2006), identifying and incorporating sustainable development into the curriculum may assist to creating models so engineering education can adapt to the ever-changing environment with ease. Using a phenomenological qualitative study to explore African American female college students' real life experiences and what may be contributing factors in their decisions to pursue engineering careers in college compared to other populations. The literature review of historical and current studies related to the STEM disciplines specifically engineering and the success or lack of success by study population.

Documentation

Scope of Literature

The goal of chapter 2 was to offer a background and cover the historical perspectives for the choices, success or not, graduation rates, and retention of African-American females in the engineering disciplines in comparison to other populations. The literature review aimed to identify gaps in current and previous literature and provide

insights for future research. Several objectives for conducting this literature review include researching scholarly journals and articles to determine what others have done in the past around this topic. Identifying what may have been barriers to this underrepresented population of females when selecting academic careers in engineering, preparation for choosing business careers in engineering, success, graduation rates, and retention of this population. Gaps in the literature were the basis to continue research on the topic because there continues to be concern over the lack of representation of the targeted population in engineering and other STEM disciplines.

Title Searches, Articles, Research Documents, and Journals Researched

The literature review consisted of articles and books. The majority of the articles were from the search engine EBSCOHost obtained from the University of Phoenix Library Internet search engine. Scholarly books were obtained from various classes about curriculum and leadership courses through the University of Phoenix doctoral education leadership curriculum and instruction program. Peer-reviewed scholarly journals and articles from professional publications obtained from the University of Phoenix Internet Library provided the sources for which this review was conducted. The main terms used when conducting the research included African-American females in engineering, graduation, retention, underrepresentation in STEM disciplines in higher education and careers in the STEM fields. The majority of the articles obtained and reviewed were within the past seven years.

Literature Review

The proposed questions that were driving the literature review include the following:

1) What motivates African American females to enter an engineering program at the collegiate level?
2) What do the participants report as the contributing factor(s) for entering the engineering program?
3) To what extent does the perception of engineering as an attainable career influence whether or not to choose engineering discipline as a major in college?
4) How does parental guidance influence the female's choice to go into engineering as a major or career?

Lewis, Menzies, Nájera, and Page (2009) cited the existence of barriers, which are vital to the understanding of the scientific community for identifying a large population of diverse well-trained applicants in STEM and could continue to hinder an economy that is competitive globally (National Academy of Sciences, 2007). Gaining a clearer understanding in the areas that are contributing factors for the small pool of qualified African American females in the engineering discipline was pivotal to this review. Fleming (2008) stated, "Diversity in the engineering curriculum should go beyond disciplinary diversity to include diversity of ideas and perspectives that emanate from such factors as gender, race, and ethnicity" (p. 32). As one who supports and observes in the field of engineering at an institute of higher education, I see firsthand the

need for diversity in a field that has traditionally been reserved for men, particularly white men.

A private institution that was engineering focused, which was established in 1865 found in the late 1960's was burdened with courses that were inflexible that left faculty with minimal opportunities for educational advancement and undergraduates students with limited selections, according to Vaz (2012). When there are obstacles within an institute, the underrepresented population of students may have even less resources that could aid in success in the STEM field. Ensuring diversity succeeds and includes an increased representation of African American females and other underrepresented groups presents a challenge in the engineering and STEM fields according to Fleming (2008). Researching how the underrepresented population decides to choose or not choose to enter the engineering or other STEM disciplines in higher education compared to other populations was necessary to make scholarly recommendations for modifications and improvements. Bennett & Lutz (2009) cited,

> There is an unmistakable racial hierarchy within the United States, one in which blacks occupy multiple locations of disadvantage while whites occupy positions of power and privilege, with Asians and Latinos occupying the space in the middle (Bobo 2000; Bobo and Zubrinsky 1996; Drake and Cayton 1945).

As a result of a cultural shift many students regardless of their background deserve better than the usual adherence to prior experiences and beliefs, there needs to be

a change in the engineering educational experience (Chinowsky, 2009). Engineering education has undergone many changes in recent years and as a result qualitative research emerged as one way for researching issues relating to engineering education (Douglas, Koro-Ljungberg, & Borrego, 2010). When referencing the research inquiries, many assumptions can be anticipated from this critical analysis into African-American students' opinion of engineering (Denson, Avery, & Schell, 2010).

According to Douglas, Koro-Ljungberg, & Borrego (2010), the way researchers position information and authenticity within an investigative venture can influence approaches and techniques that could be seen as applicable to answering research questions from a specific theoretical viewpoint. Methodologies that have been successful provide researchers with the best practices for future research. According to a study conducted by Denson, Avery, & Schell (2010), if educationalists accentuate skills in math and science, and an ethnically pertinent pedagogical method to teaching to attract African American students to pre-engineering programs could be helpful to the success of this underrepresented population.

> Diversification that offers students in engineering the chance to get the most out of the coursework in such fields as science and mathematics so that engineering strategies can develop outside basic technical issues into a domain that is more all-encompassing of other disciplines and one that reflects the humanistic role of the engineer in society (Fleming, 2008, p. 33).

Case, & Light (2011) noted that a more explicit commitment with methodological issues is needed in engineering education research. Denson, Avery, & Schell (2010) cite "for the field of engineering, attracting more African-Americans is further complicated by a generally negative perception of engineering held by many students (NAE, 2008)" (p. 62). Contributor periodicals and responses indicated that for theories to be established and accepted by the community takes time (Douglas, Koro-Ljungberg, & Borrego, 2010). Several authors believe that present-day "achievement gaps on standardized tests between Black and White students are artifacts of racial stereotypes" according to Denson, Avery, & Schell (2010, p. 62).

Historical Perspective on African America Females in STEM

The history of the underrepresentation of African America female student success in engineering and other STEM disciplines compared to other populations dates back several decades. According to Frizell and Nave (2009), in spite of efforts to increase the population of African American female science, engineering, and technology (SET) a current research report by the Center for Work-Life Policy specifies that over time more than half of women who begin SET careers leave these careers and never return to such positions. King (2006) commented, "The challenges that engineers will face in the 21st century will require them to broaden their outlooks, have more flexible career options, and work closely and effectively with people of quite different backgrounds" (p. 25). According to Vaz (2012), engineering curricula across the nation has been slow to change, rather than addressing what is central to the curriculum, reform has occurred mainly at the perimeter of engineering courses. In addition to technical competencies,

professional skills, e.g., communication and teamwork, have been identified to be important in the development of well-rounded engineering students who will be drivers of innovation in a changing global society (Cox et al., 2010).

Women have been pursuing undergraduate studies in science and engineering in growing numbers over several decades, although continue to remain under-represented among baccalaureate degree holders in the STEM disciplines (Sonnert, & Fox, 2012). Growing the amount of African American engineering students must mirror the quantity working in the field, how many go on to attain degrees in engineering and ultimately on to engineering professions as a career in the field or academia (Fleming (2008). Vaz (2012) cited Seely (2005), "The history of engineering education has been described as one of continuous reform, as tensions between theory and practice, content and skill development, and especially, technical depth and liberal learning have existed since the nineteenth century," (p. 8).

> Numerous reports assert that the United States must increase its production of highly educated workers in science, technology, engineering, and mathematics (STEM) fields in order to be competitive in the global marketplace (e.g. Committee on Equal Opportunities in Science and Engineering 2004; National Science Foundation (NSF) 2006a, b; Southern Education Foundation 2005), (Perna et al., 2009, p. 1).

STEM programs and careers in engineering throughout history have been traditionally dominated by white males, has tended to be impersonal, and individualistic. Reasons

identified why women leave engineering and other STEM fields included opinions of an unfriendly and chauvinist environment, feelings of loneliness, work philosophies that encourage risk taking, and time-intensive job pressures that compromise work-life balance (Frizell & Nave, 2009).

According to Frizell & Nave (2009) women, African Americans, and Hispanics earned respectively 20%, 5.1% and 5.4% of the engineering degrees awarded in 2003; percentages lower than their representation in the population. Substantial challenges still exist in the 21st century in engineering education while programs are evaluated to meet the demands of the engineering educator and the engineering profession (Kantonidou, 2010). Drawing attention to people in engineering education is no excuse for not paying more attention to the culture within engineering (McLoughlin, 2009). Cox et al. (2010) commented, "Recently the engineering education community (motivated by internal and external factors) has begun to focus on leadership abilities of college students in engineering fields via reports from ABET (2001), the National Academy of Engineering (NAE, 2004) and the National Research Council (NRC, 2006)" (p. 22). The continued under-representation of African American women in engineering and their capability to thrive in this field may be a result of their negative opinions regarding the field of engineering (Shashaani, 1997) as cited by Rosenberg-Kima, Plant, Doerr, & Baylor (2010). Vaz (2012) cited "ABET's criteria require attention to engineering design, and expect programs to demonstrate that students possess abilities in teamwork, communication, awareness of current events, and the broad education necessary to

understand the impact of engineering solutions in a global, economic, environmental, and societal context (Accreditation Board for Engineering and Technology, 2011)" (p. 8).

According to Borum & Walker (2012), low levels of engineering and STEM success for the African America females as outlined through psychological theories of self-efficacy offer suggestions for the low success rates. A significant amount of discussion has emerged from academic, professional, and political circles regarding the central role of the engineering infrastructure, and the time has come for collaboration and integration regarding the success of the industry (Chinowsky, 2009). Gaining an understanding of student achievement and satisfaction based on different institutions offering possibly different levels and types of support warrants investigating any possible connections between institutions and engineering self-efficacy (Marra, Rodgers, Shen, & Bougue, 2009). According to Brown, Morning, & Watkins (2005), in the 2000 U. S. Census, African Americans represented only represented 6.68% undergraduate engineering enrollment of the total 12.3% of the population as noted in the 2000 Engineering Workforce Commission (EWC).

According to Case & Light, (2011) "phenomenography was first developed as a specific research methodology by researchers in Sweden in the 1970s" (p. 199). The use of phenomenological research methodology investigates the different ways in which phenomena are experienced and understood in various educational and learning settings; maintains a detailed record of the differences in the involvements of people (Case & Light, 2011). The use of the appropriate method when conducting research could provide valuable information and tools other researchers can use in the future. Scientific

investigations are validated when the information acquired comes from actual descriptions, which demonstrates an understanding of the experience using phenomenological principles (Moustakas, 1994).

African-American student accomplishment in STEM is a serious worry for education investigators and continues into the 21st Century (Madyun, 2011). Attracting minorities to STEM educational programs comparable to engineering has its challenges and appears to be compounded by issues related to the American school systems (Wharton 1992) as cited by Denson, Avery & Schell (2010). In addition to individuals of color, females continue as a largely untouched supply in meeting the call for an experienced scientific worker (Trenor, Yu, Waight, Zerda & Ting Ling, 2008). Farinde and Lewis, (2012) stated, "few researchers have examined how the dual presence of race and gender affect the educational experiences of these marginalized women" (p. 421). Johnson (2011) cited females of color were omitted from investigation strategies, or when they were incorporated, their quantities were too minor for any significant examination (Clewell and Ginorio, 1996).

Identifying how many African American females expressed an interest in pursuing a degree in engineering and STEM fields was an important component to analyzing the situation. Mills & Ayre (2003) cited that increasing the representation of African American women could alleviate labor shortages in the profession (European 2000). Fife (2011) sited (Spencer, 1990) stating "ethnic identity has received much attention in the last decade and a half as the U.S. has become increasingly diverse" (p. 142). According to May & Chubin (2003), recent reports by the Commission for the

Advancement of Women and Minorities in Science, Engineering and Technology and National Science and Technology Council have expressively acknowledged the vulnerabilities intrinsic in a society branded by socioeconomic inequality, racial, and gender. Whalen & Shelley (2010) commented, "the impact of the perceived difficulty of STEM disciplines is a global concern is evident from the recent report of the Institution of Engineering and Technology (IET, 2008), which notes that the "alleged difficulty" of STEM course work tends to divert students from potential" (p. 54).

The constant underrepresentation of minorities and females amongst the yearly cohorts of learners who complete bachelor's degrees in science, enter, and complete graduate education for occupations as research scientists has developed as Syed & Chemers (2011) cited a problematic issue in society that has been resistant to rapid resolutions (G´andara & Maxwell-Jolly 1999; Treisman, 1992). The depiction of African American females in most STEM disciplines is significantly less than the illustration of African American men (Perna et al., 2009). The major gender gaps are in engineering, where African American undergraduate female students received only 36% of all bachelor's degrees presented to African Americans in engineering in 2001 (NSF 2004) as cited by Perna et al. (2009). Increasing the participation of non-Asian minorities in STEM has been backed by federal support and policy reforms for more than three decades (Lewis, et al., 2009).

The experiences of African American female undergraduate students in STEM fields have not been fully captured in previous studies (Tate & Linn, 2005). African American females often participate in STEM programs in lower numbers, which

continues to be a contributing factor why they remain underrepresented in those fields and programs of study. The mutual, and continuing, concern of engineering departments connecting to diversity is to expand the enrollment and retention of African American females, especially as engineering undergraduates, but eventually for occupation in the workforce (Mills & Ayre, 2003). Trenor, et al. (2008) cited "While considerable attention has been paid in the literature to the issue of attracting and retaining more females in the engineering pipeline, enrollment numbers have remained virtually stagnant for over 20 years (WEPAN, 2006)" (p. 450).

Brown Jr. (2011), cited Tobias (1992)

> to bridge this disconnect in the so-called pipeline within American engineering programs, university administrators and engineering academicians need to focus more on affirmative education programs that are student-centered and concentrate on the quality of the educational experience for female and minority students" (p. 324).

According to May & Chubin (2003), in a 1998 assessment one third of the minority students and 43 percent of Asian students of first-year undergraduate learners in four-year universities and colleges had goals of majoring in STEM programs. Madyun (2011) commented "given that the achievement gap is an issue present at the social level, a possible danger may exist if research is not focused enough on social explanations as opposed to an over emphasis on individual and/or classroom-level factors" (p. 22). Individuals who are able to make the connection with other ethnic groups tend to have

high expectations of achievement once the degree in a STEM program is completed (Fife, 2011). Data exists from the National Science Foundation specifying a narrowing of the gap in representation of women and minorities among STEM bachelor's degree recipients in the United States (Hill, 2007; Huang et al., 2000) as cited by Whalen & Shelley (2010). According to Fife (2011), people who are confident embracing their ethnic identity and make connections with other ethnic groups tend to perform at a higher level with a great deal of success.

The new STEM workforce is in need of a diverse population of qualified engineers and scientists according to May & Chubin (2003). African American women should not be disqualified from the benefits and rights that accumulate to the professional engineer (Rosser 1995; Glover 2000) as cited by Mills & Ayre (2003). Student enrollment in engineering programs continues to be grounded in the traditional environment of the past in many situations (Brown Jr, 2011). Trenor, et al. (2008) stated, "While the current need to attract and retain diverse students to the STEM profession has been recognized, little attention has been paid to the study of institutions that already model the ethnic diversity" (p. 450). According to Whalen & Shelley (2010), several studies exist that have concentrated on why female students enrolled in STEM fields do no remain in those disciplines. Brown Jr. (2011) asserted the lack of diversity in STEM programs created by barriers never addressed is a concern of researchers. Some of the barriers could include ethnic, sex, and socioeconomic biases within the engineering programs (Brown Jr, 2011).

When considering factors for addressing achievement gaps based on school values and parental/family characteristics, the presence of cultural barriers need to be taken into account (Madyun, 2011). May & Chubin (2003) commented the "issue of diversity is critical since many demographic studies indicate that the ethnicity of the U.S. workforce is changing dramatically" (p.27). Further suggestions equate the decline might be result of the climate in the academic setting, or what students perceive as the climate in the subsequent work setting (Whalen & Shelley, 2010). A considerable amount of the information regarding the African-American student results focuses on what is identified as gaps in achievement that existed between White and African-American students has remained about the same since the 1950's (Madyun, 2011).

The disproportion of African-Americans in STEM presents great concerns for equivalent prospects and the capacity of U.S. educational institutions to produce a sufficient quantity of upcoming scientists and engineers (Denson, Avery, & Schell, 2010). Advantages in the STEM industry labor force can be enhanced by the acknowledging the need for diversity (Mills & Ayre, (2003). New talents and access to a broader candidate pool may open doors to the global marketplace.

Current Perspective on African America Females in STEM

Some progress has been made in recent years but compared to representation in the populations the numbers are still very low. According to Vaz (2012), changes in engineering programs are necessary as the participants call for including cross-cultural experiences and improvement of global awareness. Gender differences in students' participation and performance in undergraduate education within science and engineering

is an important subject in the study of gender and higher education (Sonnert, & Fox, 2012). According to Borum & Walker (2012), recent reform efforts at the secondary and postsecondary levels have focused on practices, policies, and interventions designed to increase the number of women in science, technology, engineering, and mathematics STEM fields although the presence of Black women in literature continues to be minimal.

According to Tate, & Linn (2005), experiences of African American women in science, technology, engineering, and mathematics STEM fields is not fully captured based on research of women and students experiences. Kantonidou (2010) commented, "Engineering educators are expected to search for new approaches to teaching and learning and to opt for new curricular pathways to address calls of change and challenging crossroads" (p. 167). Educators conjecture that several reasons continue to impede the progress of women and other underrepresented groups (Borum & Walker, 2012). According to Brown, Morning, & Watkins (2005), based on students enrolled in engineering and persisting on to graduation, African American women remain underrepresented and are less successful, which supports the need for continued research. Although females are the predominant population in higher education, they still lag behind males when majoring in certain STEM fields (Freeman, 2004) as cited by Borum & Walker (2012). Understanding what may be contributing factors that hinder college attendance and success of the African American female engineering or other STEM students' needs to be clarified to understand the racial differences in academic performance and socioeconomic backgrounds (Bennett & Lutz, 2009). Researchers

could benefit from understanding the racial differences and the role it plays going to college.

Vaz (2012) noted the need to promote effective visual, written and oral communication skills that demonstrate a clear understanding of science, mathematics, humanistic studies with mastery in significant concepts and methods, and can employ the current technological tools. Added to the skills noted success can be improved for the African American female in engineering and other STEM programs also if they could effectively function individually and on teams throughout the educational experiences. "Women are attending college at unprecedented rates and represent more than half of university and college populations, they continue to be underrepresented in science, technology, engineering, and mathematics STEM fields (Planty, Kena, & Hannes, 2009)" cited by Morganson, Jones, & Major, (2010, p. 169).

According to Borum & Walker (2012), as more women are entering college and seeking majors in STEM networks, factors that influence the attrition rate of females and minorities continues to be a concern. Addressing the underrepresentation of African America females in engineering and STEM fields, researchers may choose many different paths to take when addressing the disparities and developing new initiatives. An enhanced body of knowledge that includes economics, cultural awareness, embraces business, global understanding, and leadership are crucial to developing new paths for success of the African American females in STEM and engineering programs (Chinowsky, 2009). Aggressively recruited, women and minority students entering science and engineering undergraduate programs enter an environment in many cases not

favorable to their educational and cultural needs, which is a problem (Brown Jr., 2011). Rosenberg-Kima, et al. (2010), cited "only 8.5% of all professional engineers are women, although women constitute 56.8% of the total workforce (Goodman et al., 2002)" (p. 35). In 2006, only 7% of engineering supervisors were females (Elaine & Philip, 2007). Women's continued lack of representation in engineering and associated fields may be partly because of the effects of work-related labels and the outdated male dominance in the fields (Rosenberg-Kima, et al., 2010).

Promoting a sustainable future that is inclusive will require including all types of the population to be decision-makers and provide the knowledge for development of new programs (Pritchard & Baillie, 2006). The possibility of a shift in the engineering curriculum could be eminent, a move from problem resolving to problem explanation. According to King (2006), engineering educators must look outward and interact with other disciplines more than in the past. While trying to research the success or not of the African American female engineering student when making recommendations it will be key to keep in mind the transition from the university to the workplace according to Pritchard & Baillie (2006).

Douglas, Koro-Ljungberg, & Borrego (2010) commented, "engineering education journals, conferences, and workshops have systematically sought to expand engineering education research beyond the quantitative approaches typical in disciplinary engineering research to include the diverse ways of knowing inherent in qualitative methodologies" (p. 247). Although limited empirical studies of leadership in engineering education have been conducted, leadership abilities of engineering undergraduates have been the focus of

studies in the last two decades (Cox et al., 2010). Using different methodologies to conduct the research can open doors for educators to enhance the educational engineering environment to meet the needs and expectations of the African American female students entering and successfully completing engineering programs. Vaz (2012), commented "calls for change in engineering education from higher education leaders, policy makers, and the private sector have never been so pervasive or compelling, they articulate a need for liberally educated problem solvers and innovators" (p. 11).

An enormous part of student's accomplishment in engineering programs in school is not only attributed to how well the student performs scholastically, but also due to how well that undergraduate adjusts to the principles of his or her section (Brown Jr, 2011). Females of color should not be further disregarded in a group of exploration that, in concept, is about changing females' underrepresentation in male dominated educational disciplines and occupation fields (Johnson, 2011). Generally, the first method to instructing the underrepresented population of undergraduates was to guarantee that minority learners were involved, in contrast to omitted, in lectures and laboratories, giving rise to the term inclusive instruction (Mills & Ayre, 2003). Ong (2011) commented, "Fields that are heavily White and male, such as physics, engineering, and computer science, pose some unique social challenges for women of color students" (p. 33). A sense of isolation exists since at a predominately White institution African America female STEM students may be the only female or minority in the laboratory or classroom.

The standard engineering courses have been blamed for the complications in enrolling and keeping minority women engineering students (Mills & Ayre, 2003). Jobs are increasing in the U.S. in areas that necessitate an understanding and abilities with a strong comprehension of science, engineering, and technology (May & Chubin, 2003). Students who are underrepresented in STEM fields (female or minority students) are considerably less likely to be retained or graduate within six years compared to students who are the traditional STEM majors (male and non-minority students) (Whalen & Shelley, 2010). Researchers have made progress in the exploration of relevant elements that could describe achievement gaps between minorities and White undergraduates such as teacher/school values, family configuration, achievement motivation, and poverty among others (Davis-Kean, 2005; Entwisle &Alexander, 1992; Rankin & Quane, 2002) as cited by Madyun (2011). Not many studies have explored culturally diverse women engineering undergraduate students to better comprehend the educational proficiencies and speculative choices related to engineering (Trenor, et al., 2008).

Brown Jr. commented, "female and AALANA students continue to deal with hidden issues of sexism and racism (i.e., stereotyping, discrimination, etc.) as well as issues that are sexual and racial in nature (e.g., gender and cultural insensitivity by faculty and students, lack of female and AALANA faculty as role models, etc.)" (p. 328). The Federal government and academia have a stake in discovering ways to expanding the pool of science and technology educators and researchers (May & Chubin, 2003). As American universities continue to be majority female, they are increasingly enrolling more minority students, women of color. This represents a growing potential source of

domestic talent to meet the needs of the country in the future (Ong, 2011). Johnson (2011) commented that "ignoring race and ethnicity obscures important dimensions of women's experiences in STEM and fosters the notion of a universal gender experience among women, without considering the differential experiences of women of color or the effects of racial privilege for white women (Atwater, 2000; Collins, 1999; Hanson, 2004)" (p. 75). According to Syed & Chemers (2011) today, National Institutes of Health (NIH) supports training opportunities for underrepresented minority (URM) groups widely through the Minority Opportunity in Research Division of the National Institute of General Medical Sciences. Although there have been some successful gains, it is still unclear what aspects of those programs have promoted the most success for this URM.

According to Mills & Ayre (2003), modifications to the STEM courses are suggested to attract and retain minority undergraduate female undergraduate learners. A study conducted by Perna et al. (2009) highlighted the ways that educational institution's patterns, strategies, and practices can diminish the obstacles that limit completion of African American females in STEM fields. Lewis, et al., (2009), cited the existence of barriers, which are vital to the understanding of the scientific community for identifying a large population of diverse well-trained applicants in STEM and could continue to hinder a competitive global economy (National Academy of Sciences, 2007).

Suggestions for Future Studies

Future studies examining the learning environment in the STEM programs could provide more in-depth factors to improve the involvement and success of African

American female college students become more successful. African American female engineering students could benefit from interactions with their male counterparts, it would be interesting to see how the male students learn to understand the female perspective and how to work together as equals (Fleming, 2008). According to Chinowsky (2009), the ability to be successful in future studies researchers need to interact, contribute to a wide range of professional concerns, and demonstrate a clear understanding of the problems. Academic departments need to be ready to recognize the increasing demand, necessity, and challenges by introducing research initiatives and curriculum that reflect new priorities.

Researching the perception of instructors of what they perceive as barriers that hinder the success of African American females in engineering studies at the collegiate level. To aid in the success of the African American female student in engineering, researching ways leadership may be added to engineering curriculum and recommending ideas to faculty, staff, and administration, which would include professional development opportunities could be a helpful enhancement to the curriculum (Cox et al., 2010). Encouraging and providing professional development opportunities for African America college students in engineering and other STEM programs and gaining an understanding of how this helps or hinders their success could add value to creating a productive learning environment. According to Brown Jr. (2011), understanding associations are significant in maintaining learners from underrepresented backgrounds, particularly in engineering.

The lack of success of the African American female engineering student at the collegiate level of education might warrant deeper research into racial disparities in general. According to Bennett & Lutz (2009), there is the prospect of focusing on racial and generational differences and the effects on postsecondary education. Another area of interest for future studies is to understand the labor market implications and researching how the African American female population attains postsecondary education credentials to meet those demands.

A successful avenue for future research is to continue to explore gender and ethnic differences in STEM educational programs to increase and improve retention rates. Developing research that could capture skills such as the ability to solve problems creatively, identify, and investigate through sustained critical analysis. Whether the underrepresented population is able to integrate information from multiple sources and to make links amongst disciplines could guide future research on the topic of success of the African American female students compared to other population. Continued research could provide administrators, instructors, counselors, government officials with the tools to assist in the success of this underrepresented population and increase the pipeline into STEM careers.

Future studies to examine ways to leverage relationships with other programs that emphasize leadership development, which might involve an interdisciplinary relationship between engineering, business, education, other social sciences, or the humanities (Cox et al. (2010). Because African American females may have a less than knowledgeable perception of the field of engineering it probably would be beneficial to create a seminar

that introduces engineering theories and career exploration as a prerequisite to enrolling in an engineering program. The introduction of capstone design courses may benefit to both students and the profession of engineering (Chinowsky, 2009). The integration of such course should serve all students recognize the importance of integration through the curriculum. Collaboration is an integral part of all stages of changes to the curriculum for all programs.

According to Sonnert & Fox (2012), research on gender and academic performance in science and engineering has been typically hindered. Some of the limitations included studies restricted to single institutions, most frequently the home institutions of the researchers, studies bounded by short timespans, and often, by a single field or narrow range of fields (Sonnert & Fox, 2012). Future research studies can be strengthened by not limiting the study by investigating and involving a larger population and different institutions. According to Case & Light (2011), the use of a phenomenological research method could offer program originators with an outline of the disparity in understanding across all of the participants in the program. Other avenues to research might be the correlation of success or not of the African American female engineering or STEM college student by incorporating and integrating leadership development elements in the curriculum via the senior design (capstone) courses as suggested by Cox et al. (2010).

According to Brown Jr. (2011), research in this area has to involve investigating and creating innovative pedagogical methods that assist in growing the "pipeline" of learners specializing in engineering and STEM-related disciplines. A study by Denson,

Avery, & Schell (2010) suggests that instructors accentuate expertise in mathematics and science, and develop a culturally pertinent pedagogical method to education in science and math ideologies to draw minority students to pre-engineering disciplines. Mills & Ayre (2003) suggests the need for an inclusive curriculum to be developed to create guidelines, offer staff training opportunities, collect resources to support the evolution and the addition of inclusive curriculum that will address the needs of the underrepresented population of students. Fife (2011) recommends that teachers consider issues surrounding culture and identity as a valuable tool to enhancing the educational experience of the African American college student.

A new and vibrant process that is constantly scrutinized and modified when and where needed that goes beyond the "add and stir" technique of growing diversity in engineering disciplines, and moving in the direction of an "add and stew" philosophy (Brown Jr, 2011). According to Mills & Ayre (2003), instructors are urged to reevaluate their instructional techniques to ensure assumptions made about undergraduate minority students' experiences do not exclude undergraduates who came from backgrounds that differentiated them from the primary culture represented in the classroom. The attention given to individual students especially women, examples, and metaphors are suitable for all students regardless of his or her background. According to Farinde and Lewis (2012), "researchers should focus on African American female students' entry in STEM and ultimately professions to secure African American women 'a seat at the table' and increase their power, authority, and influence through the obtainment of financial security" (p. 422).

Ong (2011) recommends that to help women of color negotiate the divide and feel they belong in STEM programs, colleges might offer real-life opportunities to gain expertise, thus, gaining a sense of empowerment in the classroom. Understanding interactions are imperative in keeping undergraduate students from underrepresented upbringings, predominantly in engineering (Brown Jr, 2011). Educators and curriculum developers need to create programs and develop tools to encourage an awareness of the essential university preliminary coursework throughout elementary and secondary education. May & Chubin (2003) noted, the need to increase recruitment opportunities directed at the underrepresented population, enhance the admission procedure, and increase financial and academic support that would increase retention and achievement of the baccalaureate degree. Syed & Chemers (2011) advocates for additional exploration on matters of instructional equity and pinpoints the relationship within psychological elements (mainly individual identity) in underrepresented undergraduate success and the dominant part of situational and institutional contexts.

According to Erlich & Russ-Eft (2011), this underrepresented population could benefit from future research that validates the use of social cognitive theory in academia and more broadly to students' learning development through college. Identifying effective interventions that could benefit the underrepresented population by connecting to social cognitive theory is another avenue to pursue for continued studies. Whalen & Shelley (2010) suggested the creation of innovative mechanisms to entice and maintain underrepresented students in STEM areas. Future researchers could test the reliability

and validity of self-regulated and self-efficacy learning mechanisms established to evaluate the theories in educational planning (Erlich & Russ-Eft, 2011).

When education researchers examine achievement outcomes of an underrepresented population, it will be imperative to provide an explanation for the value of societal connections in the community to avoid any precarious accounts (Madyun, 2011). According to a study conducted by Perna et al. (2009), the authors note that improving the involvement of African American undergraduate female students in STEM disciplines is essential to meet social justice goals and tap into the human resources that guarantee our country's economic competitiveness in a international society. Knowledge is not gained merely because material is obtainable, but the probability of learning is improved when an abundance variables that can influence students are carefully scrutinized (Fife, 2011). Denson, Avery, & Schell (2010) cited the need for

> Teachers at the secondary and post-secondary levels may need to make significant changes in how and what they teach (Lipman 1995; Ladson-Billings 1995a). More specifically, there may be a need for a paradigm shift from the approaches currently used to teach science and math (Tate 1995), (p. 63).

Ong (2011) commented the need for "future studies should include women in all racial/ethnic groups, but especially for those groups about whom information is scarce: Latinas/Hispanics, American Indians/Alaska Natives, and Asian Americans/Pacific Islanders" (p. 34). More should be learned regarding the occupational and educational choices and the vocational paths of women of color in STEM versus the paths of

nontraditional students in STEM careers. A transformation of the STEM curriculum needs to occur to address gender and diversity influences and explore ways to incorporate it appropriately as noted by Mills & Ayre (2003). A study conducted by Lewis, et al. (2009), suggest the ongoing need for exploration that could identify other aspects that support as well as hinder the progression of underrepresented minorities in STEM education and occupation, and the pedagogical, institutional, and societal situations that maintain the factors. According to Trenor, et al. (2008) in order for the U.S. to continue to be competitive in the current worldwide economy, it is imperative to entice and keep more females from all experience in the field of engineering.

Conclusion

Chapter 2 was a literature review on the subject of the lack of African American female students in the STEM disciplines, specifically engineering at the collegiate level. Marra, et al. (2009), commented "a strong sense of self-efficacy, especially for women students who are under-represented in engineering classrooms, can help them persist, and enable them to become practicing engineers" (p. 35). Exploring how a field like engineering instruction progresses, introduces or perhaps rejects epistemological and methodological diversity and how these reactions could guide the work of researchers and their understandings of other researchers' according to Douglas, et al. (2010). As engineering careers enter management levels in businesses and other areas engineering educators need to gain a comprehensive understanding of what engineers will do in the future (King, 2006).

The literature review assists in identifying the need for continued research in the area of under-representation of the African American female successes or barriers at the collegiate level in engineering and other STEM programs. According to Chinowsky (2009), educational preparation that can be easily learned in practice or may be specific to an institution, which could affect the advancement of the African American female student in STEM programs, should have less time spent on them since it may be easily learned in practice. Based on the literature review, time has come for replacing some curriculum with subjects that could have a wider impact, which are not learned through professional training alone. The intent of this study was to explore the lived experiences of the African American females entering an engineering program or other STEM disciplines in college compared to other ethnic populations. In engineering and other STEM education, to understand better the variations in the ways students comprehend the concepts, phenomenological research has been used most often (Case & Light, 2011). Additionally, to provide updated information for educators to use for making enhancement to programs to increase the success of this under-represented population. Guaranteeing there is diversity in the engineering and STEM curriculum to ensure inclusivity that considers the African American female student perspective could aid in their success (Fleming, 2008).

Summary

The chapter 2 literature review was centered on what are the contributing factors when African American female students consider when deciding to enter an engineering program at the collegiate level compared to other populations. With the declining

enrollment in the STEM and the ability to retain this underrepresented population, the pipeline for supplying STEM educated African American females continues to be a concern. The literature review began with a discussion regarding the existence of barriers, which are vital to the understanding of the scientific community for identifying a large population of diverse well-trained applicants in STEM and could continue to hinder a globally competitive economy (National Academy of Sciences, 2007) as noted by Lewis, et al., (2009). The review helped to highlight the lack of African American females in engineering programs at the collegiate level. The review highlighted the need for continued research in this area to assist with identifying barriers that may impede the success of this underrepresented population. According to Chinowsky (2009), future researchers need to recognize the dawning of a new generation and changes to engineering education are necessary and forth coming. "The identification of different conceptions, makes phenomenography particularly well suited for the design of educational learning objectives, pedagogical strategies, assessments, and evaluations (Micari, Light, Calkins, & Streitwieser, 2007)" as cited by Case & Light (2011, p. 199).

Chapter 3 contains information regarding the design and appropriateness. Chapter 3 also includes discussions regarding research questions, population, informed consent, sampling, geographic location, and instrumentation. Finally, chapter 3 will conclude with data collection and analysis, validity and reliability, and a summary.

CHAPTER 3: Methods

The purpose of this study was to investigate and explore the lived experiences of the African American females entering science, technology, engineering, or mathematics (STEM) specifically an engineering program in college as compared to other ethnic populations. The aim is to identify barriers the target population faces when deciding to enter one of the STEM disciplines at the collegiate level. Lewis, et al., (2009) cited the existence of barriers, which are vital to the understanding of the scientific community for identifying a large population of diverse well-trained applicants in STEM and could continue to hinder an economy that is globally competitive (National Academy of Sciences, 2007). African American females continue to be underrepresented at colleges and universities in STEM disciplines and especially more so in the engineering discipline.

Chapter 3 focuses the research design and appropriateness of the design. Further discussion will address the research questions, study population, informed consent, sample, geographic location, instrumentation, data collection and analysis, and the validity and reliability of the study. The chapter will conclude with a summary and identify some key points.

Research Design

The purpose of this qualitative study with a phenomenological design was to research the lived experiences of African American females in engineering and other STEM disciplines in college compared to other ethnic populations. Based on the

literature review, African American females continue to be underrepresented in engineering and other STEM disciplines at the undergraduate collegiate level. A phenomenological qualitative study can incorporate information gathered from the participants that describe the successes and identify barriers that may have contributed to this population of students not successful in these programs. According to Farinde and Lewis (2012), "researchers should focus on African American female students' entry in STEM and ultimately professions to secure African American women 'a seat at the table' and increase their power, authority, and influence through the obtainment of financial security" (p. 422). A tremendous amount of information can be acquired from African American students who have been successful in STEM programs, based on the description of their experiences according to Moody (2003). Using research to listen to stories of successful African American students has the potential of creating information that can aid instructors in creating and developing curriculum. Regarding the educational philosophies and the learning environment generating more success for the targeted population can be gained from the information.

Appropriateness of Design

Maintaining focus on the topic in a deliberate manner, using a qualitative research method that is flexible should assist in establishing reliable results (Neuman, 2006). A phenomenological method of reflection offers a logical, systematic, and coherent manner of analysis necessary to providing vital explanations from a person's experience (Moustakas, 1994). The main purpose of the study was to expand on the knowledge from what other researchers investigated regarding the low representation of African American

female students in engineering and other STEM disciplines in an undergraduate program in college compared to other populations. Gaps in the literature and the ongoing underrepresentation of the targeted population support the need for continued research. Designing a qualitative method with a phenomenological design for data collection could provide concrete information to add to previous research that can assist educators in developing curriculum, creating additional support, and creating a classroom environment conducive to student success. The continued concern for the underrepresentation and success of the African American female students in engineering and other STEM disciplines is a driving force for ongoing research. The phenomenological qualitative research design aided in gathering information from current students in the engineering and STEM programs and students who were in the programs and did not succeed to provide information about their experiences that will assist others following them to be more successful. According to Moustakas (1994), phenomenological design focuses on individual perceptions and research is based on lived experiences.

Research Questions

The proposed questions that will be driving the qualitative phenomenological qualitative study include the following:

1. What motivates African American females to enter an engineering program at the collegiate level compared to other populations?
2. What do the participants report as the contributing factor(s) for entering the engineering program?

3. To what extent does the perception of engineering as an attainable career influence whether or not to choose engineering discipline as a major in college?
4. How does parental guidance influence the female's choice to go into engineering as a major or career?

The face-to-face interviews and phone discussions was guided by a set of interview questions (Appendix D) to aide in identifying any barriers that may have existed when this population was deciding to pursue an academic discipline in engineering or other STEM disciplines compare to other populations. Using open-ended questions in a semi-structured interview format allowed the participants to provide more in-depth responses to the inquiries and hopefully help identify some common themes regarding the research phenomenon.

Population

Northeastern quadrant of the United States is home to many highly acclaimed educational institutions. The populations for this qualitative phenomenological study were selected from the upstate New York area. The target population 50% – 60% self-identified as African American female undergraduate students participating in or having recently participated in an engineering program or other STEM program toward attaining a degree in the field. The remaining number of participants came from female students in similar programs who identified themselves as Caucasian, Mixed Race (Hispanic/African American), and Asian American. The anticipated age of the participants was between 18 and 25. The total number of participants for the study was between 20-25 female students and provided sufficient amount information necessary to answer the research

questions guiding the study. To be included in the study, the participants were solicited from engineering and other STEM departments and word of mouth referrals.

Informed Consent

Participation in the study needed to be voluntary and to ensure each participant was not coerced an informed consent form will be provided for each participant (see Appendix B and C). According to Neuman (2006), an informed consent form is a "written statement that explains aspects of the study to participants and asks for their voluntary agreement to participate before the study begins" (p. 135). In preparing an informed consent form, several items needed to be a part of the statement to ensure full disclosure to the prospective participant. Including the purpose, procedure, and duration will allow the participant with information to make a knowledgeable decision whether to agree to participate or not. Identifying any possible risks and guaranteeing anonymity and confidentiality throughout the study and during the interviews should erase any reservations a potential participant may have.

Explaining how the data would remain confidential to prospective participants presented some challenges. Clearly stating that no names or other identifying information would be included in the study or linked to any data collected assisted the prospective participant to feel confident in sharing open and honest responses to the research and interview questions. Last, informing the potential participants that all data collected relating to this study would be cross-shredded and destroyed five years after the research has been published.

Sampling Frame

The purpose of this qualitative research methods study with phenomenological research design was to explore the lived experiences of the African American females entering engineering or other STEM programs in college compared to other ethnic populations. The sampling method was purposeful. Purposive sampling as defined by Neuman (2006) is "a nonrandom sample which the researcher uses a wide range of methods to locate all possible cases of a highly specific and difficult-to-reach population" (p. 222). Identifying African American female students currently enrolled or previously enrolled in engineering or other STEM programs in the college will require selecting a unique population. A purposeful sampling method provided an avenue for selecting a specific population that has had life experiences for this particular situation.

According to Moustakas (1994), in phenomenological studies, participants will have at least the least of commonalities, such as an involvement in the phenomenon under study and willingness to participate in an interview. The goal was to gather data that provided a thorough understanding of the phenomenon.

Geographic Location

The geographic location of the population was in an upstate New York institution of higher learning that included mainly African American female college students in engineering. Other ethnic populations were included from the same area as a comparison of who have recently enrolled or previously enrolled in engineering or other STEM programs in college. Several technically focused colleges and universities exist in close

proximity of one another and provided an abundance of African American students to gather a sufficient population for the study.

Instrumentation

The purpose of this study was to explore the lived experiences of the African American females entering engineering or other STEM programs in college compared to other populations of students in similar programs. Using a phenomenological research type of approach to data collection resulted in data collected from face-to-face "first-person reports of life experiences" (Moustakas, 1994, p. 84). A primary example of phenomenological principles is demonstrated when the knowledge pursued is attained through descriptions that make it possible for an understanding of the meanings and origins an experience when valid scientific research occurs (Moustakas, 1994). The intended instrument for gathering data for the study for a qualitative research study was face-to face individual and phone interviews with mainly African America female college students in engineering or other STEM programs. In comparison, other students from different cultures were asked to participate in the study who are in similar programs.

The interviews were guided by the research questions for the study that were general and allowed the participants to expand on their responses. The interview questions were more specific in the hopes of allowing the participants the opportunity to reflect and share openly their lived experiences in an engineering program or other STEM discipline at college. The intended interview questions (see Appendix D) were open-ended to provide the opportunity for the participants supply thoroughly thought out responses.

Pilot Testing

To validate the instrument tool for the study, a pilot test was conducted on a much smaller scale. According to Neuman (2006), the purpose of a pilot test is to conduct a smaller test of the study procedures and make revisions as appropriate based on the pilot test results. A pilot test was conducted prior to conducting the full-blown research. The pilot test consisted of two individuals to determine the clarity and the appropriateness of the interview questions. Based on the study, purpose the goal was to conduct a pilot to determine alignment of the questions and the purpose. Upon completion of the pilot, the hope was to identify any need for expanding and any revisions that may be necessary. Another benefit to conducting a pilot test was to determine the validity and reliability of the questions to capture the information necessary to report out on the research project. Based on the verbal feedback from the pilot participants, they provided some insights into how comprehensive the questions were in relation to the purpose of the study.

Participants for the pilot study were recruited by word of mouth, email, and via referrals in several engineering departments. Once identified an informed consent form was provided to ensure the pilot test participants understand the project, how to contact the researcher, how confidentiality will be maintained, risks, how to withdraw, how long, and where the data will be stored.

Data Collection

The intended source for data collection was face-to-face interviews and phone discussions. To ensure the information was captured accurately for analysis later the interviews were audio recorded. Prior to conducting any data collection, each participant

had to read and sign an agreement, which demonstrates an understanding of the process, and return an informed consent form to the researcher (see Appendix B & C). Interviews were conducted until data saturation was achieved using 23 participants. The plan was to interview each participant until data saturation was achieved, which should be achieved by conducting interviews lasting approximately 40 – 50 minutes per interview. Data saturation is "determined as the point in data collection and analysis when new information produces little or no change" (Nixon & Wild, 2013, p. 1). The amount of time allotted for each interview allowed each participant to answer each question in complete detail. Open-ended questions were used during the interviews to gather a deep description of the lived experiences. Using the phenomenological method, "descriptions keep the phenomenon alive, illuminate its presence, accentuate its underlying meanings, enable the phenomenon to linger, retain its spirit, as near to its actual nature as possible" as noted by Moustakas (1994, p. 59). The use of NVivo 10 software tool was used to assist in organizing information captured during the interviews.

Potential participants in the study have to meet certain criteria and be pre-screened to be considered for the study. Participants needed to be female college students in engineering or STEM programs in college, 50% - 60% of all the participants had to identify themselves as African American, and the others will identify themselves as any of the following: Caucasian, Mixed Race (Hispanic/African American), or Asian American. The expectation was to conduct the interviews in a conference or classroom on the college campus.

Data Analysis

The data analysis for this qualitative phenomenological research study required the collection, organization, and analyzing data collected by interviewing African American female college students in engineering and other STEM programs. Once data has been collected for analysis it was evaluated for themes, patterns, and meanings to make sense of the volumes of information collected (Christensen, Johnson, & Turner, 2011).

NVivo 10 software was the one source used for managing, organizing, and analyzing non-numerical information gathered during the interviews. The guiding principle of the interviews will be to answering interview questions to gain an understanding of the lived experiences of the participants (see Appendix D).

The foundation of this phenomenological qualitative research study was to identify the lived experiences of African America female college students in engineering and other STEM programs to determine contributing factors to the successes and identifying any barriers that may exist. Transcribed interview data will need to be studied using methods and procedures of phenomenal analysis (Moustakas, 1994). One procedure for analysis could be the horizonalizing and clustering the information gathered. According to Moustakas (1994), horizonalizing similar meanings or meaning units are listed and clustered information are grouped by themes or categories. Using these methods of analysis assisted in removing redundancies in statements that are similar.

Confidentiality

Maintaining confidentiality throughout the research study was essential to ensuring the participants would provide information that was valid, reliable, and accurate. The participants received a printed assurance of confidentiality. A printed assurance of confidentiality improved the probability of truthful responses from the participants. Before voluntary participation in the study, interested participants had the opportunity to view the confidentiality agreement and ask questions. The informed consent forms addressed confidentiality of responses. Participants had the opportunity to review, make inquiries, adjust responses, or withdraw at any time during the interview process. Alphanumeric coding concealed the participants' identity, ensuring the students' confidentiality. The participants were informed the data will be maintained for several years; after that, all data will be deleted and shredded.

Validity

Throughout the entire qualitative phenomenological research study, the data needed to be verified and validated. As this is occurring, writing a short narrative similar to an annotated bibliography was helpful when referring to the information as the data is analyzed. According to Neuman (2006), validity is part of a dynamic process that is achieved through accumulating data over time. Validity is one principle often used by researchers and is applied differently by qualitative researchers. Validity means truthful according to Neuman (2006). The combination of interviews of the targeted population over time and from participants in different phases of the academic career ensured valid data for later analysis.

Reliability

Reliability means consistency according to Neuman (2006). Qualitative researchers tend to be more focused on providing a fair and honest account of social life from the viewpoint of someone who lives or has lived the experience. In this qualitative phenomenological research study, the intent was to have the reliability and validity concepts complement one another. Reliability was achieved through interviewing the participants along with audio-recording of the responses. The use of audio recording of the face-to-face and phone interviews was helpful to ensure details of the conversation were not lost when it was time to analyze the data. Reliability is another principle often used by researchers and is applied differently by qualitative researchers based on the circumstances. The combination of interviews of the targeted population over time and from participants in different phases of the academic career ensured the reliability data for later analysis. Conducting the pilot study assisted in determining the reliability of the questions to capture the information necessary to report out on the research project. Based on the results of the pilot study the comments indicated how comprehensive the questions were in relation to the purpose of the study and no changes were necessary.

Summary

The focus of Chapter 3 was to provide the proposed method for this qualitative phenomenological research study. This chapter included discussions relating to the research design and appropriateness of the design. Further discussions addressed the research questions, study population, informed consent, sample, geographic location, instrumentation, data collection and analysis, and the validity and reliability of the study.

Exploring the African American female undergraduate college student and their experiences whether positive or negative in engineering or other STEM programs was the focal point of the discussions throughout Chapter 3. Attaining the appropriate consents, using the research questions to drive the interviews, and accomplishing data saturation will aide in gathering data necessary to perform a complete analysis of the issue under investigation. Using the modified van Kaam methodology (Moustakas, 1994) with audio-taped and open-ended questions during the interviews should allow the participants to describe openly and honestly their lived experiences as it relates to positives and negatives in engineering or other STEM programs in college.

Chapter 4: Data Analysis and Results

Chapter 3 included a discussion on the research design and appropriateness of the design. The study appropriateness was explained through discussions regarding the research questions, study population, informed consent, sample, geographic location, instrumentation, data collection and analysis, and the validity and reliability of the study. The chapter concluded with a short summary identifying some key points.

Chapter 4 presents the results and findings of the qualitative phenomenological study seeking information about female African American college students compared to other cultural groups to identify what may contribute to their successes and failures in engineering and other STEM programs at the collegiate level. Seven thematic categories resulting in seven themes were identified in the process of data collection and analysis during the interviews with the study participants. Twenty-three female college students agreed to share their knowledge and experiences related to their choice to enter engineering or STEM programs at the collegiate level. The data collected helped to describe the participant's steps and other factors that contributed to their decisions to pursue programs in engineering and other STEM programs. This chapter presents perspectives shared during interviews from the study participants through summaries and recorded descriptions.

A purposeful sample of twenty-three females African American, Caucasian, and Mixed Race (Hispanic/African American) college students from an Institute in the North Eastern New York, New York who participated in engineering and STEM programs were selected. Participant ages ranged from 18 to 28 years of age. The purpose of this

qualitative phenomenological study was to explore the experiences of the African America females to other cultural groups to identify possible factors for success or failure in engineering and STEM programs at the collegiate level.

In-depth audio-recorded interviews consisting of six open-ended questions were used in an effort to produce themes from the data collected. New patterns of information that emerged from the information collected increased the understanding of what may contribute to the African American female's selection of engineering or STEM program in college and identified success or failure factors thereof compared to other cultural groups. Chapter 4 outlines the method of data analysis, which captured the themes directly related to the research questions and presents the findings.

Data Collection

Before gathering any data, a pilot testing of the interview questions was conducted with 2 individuals outside the study population, however meeting the inclusion criteria. To be included in the study population, participants had to: (a) to be female, (b) self-identify as African American and any other cultural group, (c) be a college student in an engineering or STEM program, (d) be between 18 and 28 years of age, and (e) attend the Institute in North Western New York, New York.

In preparation for collecting data, emails were sent to faculty and staff at the participating institution to attain a list of students who met the inclusion criteria as possible participants in the research study. The faculty and staff selected to attain possible research participants was purposively conducted. The specific characteristics of the population of interest were defined in the initial request to the faculty and staff in

order to locate individuals with those characteristics (Christensen, Johnson, & Turner, 2011). Within 48 hours, a list of about 80 students was supplied as possible research study participants.

Using the list provided from the faculty and staff each prospective participant was contacted via email to inquire about their interest to participate in the study and to arrange for a face-to-face interview if interested. Prior to any interviews, each participant was provided with the informed consent form (see Appendix B) electronically for their review and requested to bring the signed form to the interview. The informed consent explained the procedure for data collection, the nature of the study, voluntary participation, the amount of time required for the interview, and the confidentiality of the data collection. Prior to beginning any interviews the potential participants were informed of the risks, which there were no foreseeable risks and benefits as well as the option to not participating in the study. Before the interviews, each participant was informed that the interviews would be consisting of providing their personal lived experiences in response to six open-ended questions (see Appendix D), would take approximately forty-five to sixty minutes to complete (See Appendix B). Prior to the interview the participant was given an opportunity to ask any questions regarding the process, informed consent contents, or any other concern they may have. The researcher responded and addressed all questions to the full satisfaction of the participants. Participants were informed that the interview would be audio recorded to ensure accuracy of the data collected and reassured that their identity would remain anonymous. In addition, the participants were reminded that their responses and personal reflections

would provide the necessary information needed to gain a better understanding of the specific needs and wants of the African American females during recruiting through graduation in engineering and STEM programs in college. Also noted to the participants was this research study is to aid professionals, instructors, administrators in the engineering discipline to provide a pool of well-trained and diverse applicants for professions in the engineering and other STEM fields. Participants had to read, sign, and return the informed consent form (See Appendix B) before the interviews started.

The collection of data via the interviews lasted approximately 3 weeks. The majority of the interviews were conducted at the premises of the Institute in North Western New York, New York. Interviews for 2 of the participants had to be conducted over the phone because of their being away from the institute on a co-op assignment. The researcher asked some demographic questions (see Appendix E) at the beginning of each interview to ensure the participants met the criteria for the study. Interviews were conducted using open-ended questions (see Appendix D) until data saturation was reached. Data saturation was reached after 23 college students were interviewed. The final step of the data collection phase of the research study consisted of transcription of the interviews from the notes taken during the interview and the audio recording of the interviews. This final step provided an accurate and complete record for the analysis. To maintain the confidentiality of the participants, codes were created for each participant. Each participant received an alphanumeric coded as P1 through P23 to represent each of the 23 participants. If there appeared to be any confusion about the questions asked during the interviews, clarification and elaboration was provided for ease of getting a

proper response. The researcher stressed to the participants the importance of gaining their perspectives and how it would enhance the success of the research. After stressing the importance of the study results and again ensuring confidentiality of the responses, the participants were more willing to engage in extensive conversation.

The length of the interviews varied between 40 minutes and 70 minutes with the average interview lasting 50 minutes per interview. After all twenty-three interviews were conducted and transcription of the interviews was completed. The data was imported into NVivo 10 software to assist with analyzing unstructured and semi-structured data that is a result of conducting data interviews as a data collection method.

Pilot Study

The purpose of the pilot study was to review the interview questions for validity and clarity. The pilot testing took place prior to conducting the interviews with the 23 female college students who participated in the study. Verbal feedback from the pilot study participants aided in providing insight to the comprehension of the interview questions, the appropriateness, and clarity in regard to the research objectives. Pilot testing can alert researchers to elements of their interview techniques that support the objectives of the study and to those that detract from those objectives (Seidman, 2006). Based on the feedback from the pilot study participants regarding the content and format of the interview questions, no modifications were necessary.

Sample Population

The study consisted of 23 participants who were female college students in engineering or STEM programs. Thirteen or 57% self-identified as African American, 3

or 13% mixed race African American/Hispanic, 2 or 9% Hispanic, 4 or 17% Caucasian, 1 or 4% mixed race Asian/Caucasian. All of the participants were current students attending the Institute in North Western New York, New York and at the time of the study between 18 and 28 years of age. The information in more detail is summarized (see Appendix F) about the participants in the study.

Participant Demographics

The original intent of the study was to interview 20 to 25 participants. The actual study consisted of 23 participants. Recorded interviews were conducted with all 23 participants. Table 1 provides some of the demographic characteristics of the 23 participants.

Table 1 –*Ethnicity, Current year level, and Programs of study*

Ethnicity	#	Current year level	#	Programs of Study	#
African American	13	First Year	4	Sciences	5
African American/Hispanic	3	Second Year	5	Technology	6
Hispanic	2	Third Year	6	Engineering	12
Caucasian	4	Fourth Year	4	Mathematics	0
Asian/Caucasian	1	Fifth Year	3		
		Grad	1		
Total	23	Total	23	Total	23

Data Analysis

Each participant was asked six demographic questions (see Appendix E) prior to the in-depth interview. The purpose of the demographic questions was to help the

researcher ensure the criteria for inclusion were met. The other benefit to the demographic questions was to put the participant at ease and build a connection between the participant and the researcher. The following questions were the guides for the overall research study: (a) What motivates African American females to enter an engineering program at the collegiate level compared to other populations?; (b) What do the participants report as the contributing factor(s) for entering the engineering or STEM program?; (c) To what extent does the perception of engineering and STEM as an attainable career influence whether or not to choose engineering or a STEM discipline as a major in college?; and (d) How does parental guidance influence the female's choice to go into engineering as a major or career? The actual in-depth interviews used six open-ended interview questions which assisted the participants in providing in-depth responses. Each of the interview questions addressed various aspects of the research questions that guided the study. The first research question (a) What motivates African American females to enter an engineering program at the collegiate level compared to other populations?, was addressed using the following interview questions: (i) Based on your personal experiences explain what it was like for you when you were deciding which educational program to select prior to attending college?; (ii) Describe specific issues that contributed to your choosing engineering or STEM as a collegiate career.; and (iii) Based on your personal experiences explain what you feel is the most important reason to participate in engineering and STEM programs. The second research question (b) What do the participants report as the contributing factor(s) for entering the engineering or STEM program? was addressed using the following interview question:

(iv) Explain the educational and professional influences you experienced in deciding to enter engineering or STEM programs at the collegiate level. The third research question (c) To what extent does the perception of engineering and STEM as an attainable career influence whether or not to choose engineering or a STEM discipline as a major in college? was addressed by stating (v) Based on your personal experiences describe your perception of professions in engineering or STEM as attainable careers. Finally, the last research question (d) How does parental guidance influence the female's choice to go into engineering as a major or career? Was addressed with (vi) Describe whether or how much your parents influenced your decision to select engineering or STEM educational programs in college. During the interviews, the researcher to gather as much information as possible while keeping the participant at ease with the questions used a probing technique. According to Neuman (2006), using the probing technique allows the researcher to request in a neutral manner for clarification of an "ambiguous answer, to complete an incomplete answer, or obtain a relevant response" (p. 306).

The current research explored the participant's perception on the reasons for pursing an engineering or other STEM program at the collegiate level. This helped to better understand what motivates and persuades females mainly of African American background to choose a program in engineering or STEM as their choice of higher education. Themes were generated from the interviews after the interviews were completed and transcribed. The process of analyzing the data gathered from the interviews was a form of content analysis. Neuman (2006) describes content analysis as "research in which the content of a communication medium is systematically recorded

and analyzed" (p. 44). These configurations were coded and analyzed. NVivo 10 for windows qualitative data analysis software was the source used to analyze the interview transcripts. The NVivo 10 software was helpful for evaluating, interpreting and explaining specific phenomena. NVivo 10 was a tool for the researcher to analyze unstructured or semi-structured data attained through the collection of data using interviews, meeting notes, and audio recordings of said meetings. Modification of the van Kaam method of analysis of phenomenological data (Moustakas, 1994) was the method used to conduct the research study data analysis. By using this approach lists were created and grouped together representing expressions relevant to the various experiences. Information was clustered and grouped to identify relevant experiences and information identified as irrelevant was eliminated. The data collection and analysis stopped once data saturation was reached. Data saturation was "determined as the point in data collection and analysis when new information produces little or no change" (Nixon & Wild, 2013. p. 1). The researcher assumed data saturation had been reached after the themes were identified and no new information appeared.

Findings

Each of the interviews consisted of six questions that explored the reasons female African American college students compared to other cultural groups identify what may have contributed to their decision to enter engineering and other STEM programs at the collegiate level. Furthermore, the researcher aimed to identify successes and possible failures. The questions prompted the participants to share their lived experiences as they were deciding which education program to pursue prior to attending college.

The results of the study and are presented throughout the remainder of this section. The data analysis of 23 participants in the current study resulted in seven relevant thematic categories:

1. Factors that influenced African American compared to other minority & Caucasian females to major in engineering & STEM programs in college.
2. Challenges or issues experienced between the African America compared to other minority & Caucasian females that influenced the program choices.
3. Positive factors for pursuing engineering or STEM programs in college.
4. Perceived factors influencing completion of engineering and STEM program.
5. Perception of African America & other minority females compared to Caucasian females of educational or professionals who influenced the decision to enter engineering & STEM programs.
6. Strategies and perception for attaining a career in the engineering or STEM field.
7. Perceived involvement of parents in pursuit of a college career in engineering or STEM.

Seven themes emerged from these thematic categories from the data collected and reflect the perception, opinions, and lived experiences of the entire sample population:

1. The factors that influenced African American compared to other minority & Caucasian females to major in engineering & STEM programs in college

included strong high school programs focused on high achievement in science and math.

2. The challenges or issues experienced by the African America & other minority compared to Caucasian females that influenced the program choices were lack of preparedness and financially related.
3. Pursuing engineering or STEM programs in college through hard work and dedication could prepare them for positive career and future.
4. Strong support of co-op opportunities and the high demand for women and minorities in the field were perceived factors influencing completion of engineering and STEM programs.
5. African America and other minority females compared to Caucasian females perception of educational or professionals who influenced their decision to enter engineering & STEM programs varied in the decision making process in entering these programs.
6. Co-ops and internships were the perceived approaches for attaining a career in the engineering or STEM field.
7. The perception of parental involvement in pursuit of a college career in engineering or STEM was slightly higher for African American and other minority females than for Caucasian females.

The remainder of this section presents the findings of the qualitative phenomenological research study. The ten themes that emerged from the thematic

categories resulting from the data collection are organized for the purpose of the presentation.

Theme 1: The factors that influenced African American compared to other minority & Caucasian females to major in engineering & STEM programs in college included strong high school programs focused on high achievement in science and math.

Based on the thematic category, *factors that influenced African America compared to other minority & Caucasian females to major in engineering & STEM programs in college,* six responses emerged as the most common responses (see table 2 for summary). The most common responses for the thirteen African American female participants were "enjoyed math and science" (3 of 13 participants, 23%), "high school teacher or counselor" (5 of 13 participants, 39%), and "family background in engineering/STEM" (4 of 13 participants, 30%). The numbers are relative because of the different numbers of participants from Other Minorities (Hispanic & Mixed African American/Hispanic), only five participants and Caucasians (includes Mixed Asia/Caucasian) with five participants. For the purpose reporting findings for the remainder of the chapter, participant responses are grouped as follows: African American (AA) 57%, Other Minorities (OM) 22%, and Caucasian (C) 22%.

Many of the African American participants believed the most significant factors that influenced their decision to major in engineering and STEM programs was having a high school teacher or counselor promoting engineering/STEM, family background in the field, and enjoying science and math. The most common responses were echoed in several different comments for example, Participant 13 stated, "Her uncle was her main

influence who worked in electrical engineering and basically pushed her into the electrical engineering field in college". Participant 16 indicated a similar sentiment relating to her sister stating, "If her sister could enter the field and be successful, then she wanted to do the same". Participant 15 commented, "My father worked as a civil engineer, brothers were also in civil and aero engineering which was very instrumental in my deciding to pursue an engineering program in college". While having family members in the field were contributing factors to choosing an engineering or STEM program in college having a high school teacher or counselor promoting engineering/STEM was an even more popular reason for choosing to enter an engineering or STEM program in college.

Across all the participants in the study the most common factor that influenced their decision to pursue and engineering or STEM major in college was having a high school teacher or counselor who promoted engineering or STEM. African American participants responded at a 39% rate of the importance of having high school teachers or counselors promote engineering or STEM as major factors to going into those programs. Participant 1 stated, "I attended an all-girls college prep school where the teachers and administrators main focus were on majors in STEM." Participant 12 commented, "I attended many enrichment programs throughout high school that were STEM related, which aided in my decision to pursue a technical field in college." Participant 14 shared, "I had to choose a major in high school and wanted to attend a specific college, so with the help of my high school counselor I chose industrial engineering." Participant 6 commented, "My interest was piqued during high school when I

participated in a bridge program where one of my teachers exposed me to information technology."

Similarly, the majority of the Caucasian participants (60%) stressed the importance of having a high school teacher or counselor who promote engineering or STEM as a contributing factor to their decision to choose an engineering or STEM program in college. These participants referred to taking shop classes, encouragement from teachers in math and science classes, and participation in tech classes in high school as different exposure to these types of programs.

Table 2 - *Factors that influenced African American compared to other minority & Caucasian females to major in engineering & STEM programs in college.*

Responses	African American (AA)	% of (AA) Total	Other Minorities (OM)	% of (OM) Total	Caucasian (C)	% of (C) Total	% of Grand Total
Enjoyed science & math	3	23	2	40	1	20	26
High school teacher or counselor promoted engineering/STEM	5	39			3	60	35
Family background in engineering /STEM	4	30					17
None			1	20	1	20	9
Conducted research on own	1	8					4
Always knew			2	40			9

Theme 2: The challenges or issues experienced by the African America & other minority compared to Caucasian females that influenced the program choices were lack of preparedness and financially related.

Based on the thematic category, *challenges or issues experienced between the African America compared to other minority & Caucasian females that influenced the program choices,* six responses emerged as the most common responses (see table 3 for summary). The most common responses for the thirteen African American female participants were "not well prepared" (5 of 13 participants, 39%), "lack of sufficient financial resources" (3 of 13 participants, 23%), and "No issues" (3 of 13 participants, 23%).

Many of the total participant population, 8 participants, 35%, across the different racial backgrounds agreed not being well prepared was the biggest challenge that influenced their program choice. Participant 21 commented, "I doubted my abilities because everyone kept telling me I wouldn't be successful in an engineering program." Participant 6 stated, "I felt unprepared to enter a STEM program because I had no background in the field from my high school education". Another response from Participant 23, "Although I eventually entered an engineering program in college, I didn't know what I was getting into because I didn't know what an engineer did". Participant 4 echoed similar sentiments stating, "I had such self-doubt in my skills that I floundered around several programs before making the decision to pursue degree in the STEM field".

While the feeling of being not well prepared was the response most received from all the participants the remaining responses vary across racial backgrounds. The African American participants responded equally that the lack of sufficient financial resources and having no issues as the next highest two responses behind not feeling well prepared.

The participants whose responses were they had no challenges or issues that influenced their program choice indicated they knew what they wanted to do and what was necessary to achieve their goal. Participant 3 stated, "I had no problem selecting my program because I was surrounded by many encouraging family and friends". This same participant indicated how she had a strong math and science background and was motivated to be entering a STEM program.

African American participants was the only ethnic group to be concerned with the lack of sufficient financial resources and indicated that it was a big issue when deciding what program to choose in college. A common theme throughout those who gave this response was they had to go into a program that would give them the best financial package. Participant 16 remarked how she felt like her options were limited because she did not have the resources like some of her Caucasian classmates. Based on the responses received the Caucasian participants were not concerned at all with the financial implications of securing a college education in engineering or STEM.

Only the African American and Other Minorities (OM) [Hispanic & mixed race Hispanic/African American] were most concerned with the engineering and some of the STEM programs as being a lonely field that lacks diversity, and is too male dominated. The respondents indicated how strongly this influenced their program choices. In conducting her research on which program to pursue Participant 14 commented, "I was concerned there were too few black engineers and I was not sure I would be able to successfully complete an engineering program in college". She was equally concerned with the number of African American females who leave engineering programs because

they ultimately cannot handle the stress of being the only African American and female in the classes. Many of these same participants indicated that even now in engineering or STEM programs how lonely they feel because their male counterparts exclude them from class projects and ignore their opinions.

Table 3 - *Challenges or issues experienced between the African American compared to other minority & Caucasian females that influenced the program choices.*

Responses	African American (AA)	% of (AA) Total	Other Minorities (OM)	% of (OM) Total	Caucasian (C)	% of (C) Total	% of Grand Total
Lack of sufficient financial resources	3	23					13
Not Motivated					1	20	4
Family pressure					1	20	4
Not well prepared	5	39	1	20	2	40	35
Lonely field, lack of diversity, male dominated	2	15	3	60			22
No issues	3	23	1	20	1	20	22

Theme 3: Pursuing engineering or STEM programs in college through hard work and dedication could prepare them for positive career and future.

Based on the thematic category, *positive factors for pursuing engineering or STEM programs in college,* four responses emerged as the most common responses (see table 4 for summary). The most common responses across all of the different ethnic groups included "increase # of African America & other minority females in the field" (6 participants, 26%), "solve problems and bring about change" (8 participants, 35%), and "attain a good job and securing a higher salary" (7 participants, 30%). The African American and Other Minority participants replied with these same responses as their

most popular reasons for pursuing an engineering or STEM program in college in the same order with the following outcomes: 6 participants, 33%; 5 participants, 28 %; and 6 participants, 33%.

All of the participants wanted to be able to solve problems in society and bring about positive changes as a direct result of attaining an engineering or STEM degree in college. Participant 11 commented, "Science, math and technology drive the world and I want to be a part of the change." Participant 12 stated, "I want to change the way people think and solve some of the political problems." Participant 4 reiterated similar feelings stating, "I want to stay in the forefront of progress like Bill Gates and Steve Jobs." Another participant (7) indicated how passionate she was about environmental issues and she wants to able to make products that may address those issues.

African American and Other Minorities responded frequently to wanting to increase the number of African America & other minority females in engineering and STEM as their positive factors for pursuing these programs in college. Some of the respondent's comments included statements such as from Participant 9, "I want to attain my degree then give back to students of color coming behind me, so they will be encouraged and prepared to enter these programs in the future." Participant 4 indicated how she wants to be a strong representative for the female minority community and demonstrate that women and minorities can be successful in the field. Participant 20 shared her feelings how she wanted to be an example to others by demonstrating how uplifting succeeding can be in these fields.

Another response that resonated across all ethnic groups was attaining a good job and securing a higher salary as very positive factors for pursuing engineering or STEM programs in college. Some of the comments from across the various ethnic groups included from Participant 9, "Engineering is a stable field with many opportunities and I want to be able to take care of myself and my parents in the future." Participant 8 felt that attaining a degree in engineering would secure her future well in to the later years of her life. Participant 22 commented, "I want to gain the respect of others in engineering, get a good job with a high salary, and put myself in a position to call the shots." Participant 3 added how she felt with an engineering degree, financial security would come with that.

Table 4 - *Positive factors for pursuing engineering or STEM programs in college.*

Responses	African American (AA)	% of (AA) Total	Other Minorities (OM)	% of (OM) Total	Caucasian (C)	% of (C) Total	% of Grand Total
Increase # of African America & other minority females in the field	4	31	2	40			26
Solve problems & bring about change	4	31	1	20	3	60	35
Attain a good job & securing a higher salary	4	31	2	40	1	20	30
Encourage others to enter the field	1	7			1	20	9

Theme 4: Strong support of co-op opportunities and the high demand for women and/or minorities in the field were perceived factors influencing completion of engineering and STEM programs.

Based on the thematic category, *perceived factors influencing completion of engineering and STEM program,* 4 replies emerged as the most common responses (see table 5 for summary). The most common responses across all of the different ethnic groups included "co-op opportunities" (8 participants, 35%) and the "high demand for women and/or minorities in the field" (11 participants, 48%). The reply that was a distant third reply was "acquiring financial stability" (3 participants, 13%). Although the responses were similar across the different ethnic groups of participants, the African American and Caucasian participants really put a high emphasis on the top two responses as major factors for completing an engineering or STEM program in college.

The high demand for women and minorities in engineering and STEM fields were of the utmost importance to motivating the participants to complete their programs in college. Many of the participants in their responses recognize that these fields are heavily male dominated. Because of that fact, the participants were highly motivated and felt confident in their ability to complete their programs in college. Participant 11 commented, "Society is changing and there is a high demand for women and minorities in these fields and I feel motivated by this and confident I will successfully complete the program and have a great career." Participant 13 stated, "I know there are not many African American females in the field and this is what drives me to complete my program." Participant 18 echoed a similar sentiment, "The lack of African American females and diversity overall is what motivates me." Based on the conversations with the participants the African American participants appeared to be highly motivated by the fact that there is a high demand for women and minority women in the field.

The other response that appeared to get the students motivated and excited was the requirement of a co-op component to their curriculum. Co-op opportunities enabled the participants to see and experience the real world in their fields and get paid for it. Participant 15 stated "Co-ops allowed me to prepare for the real world and will ultimately help me attain a job in my chosen field after I graduate." Participant 18 had several co-op experiences at United Tech Airspace and Ceiling Corporation and only saw 1 person in her field in the companies. Participant 20 had co-ops at GE and Toyota and expressed how, "Those experiences really prepared me for the real world after graduation".

The participants overwhelming agreed that the high demand for women and minorities and co-op requirements were strong motivators for completing engineering and STEM programs. There did not appear to be a clear separation between the different cultural groups of participants as to what were the most important factors that influenced their completing programs in engineering and other STEM programs.

Table 5 - *Perceived factors influencing completion of engineering and STEM program.*

Responses	African American (AA)	% of (AA) Total	Other Minorities (OM)	% of (OM) Total	Caucasian (C)	% of (C) Total	% of Grand Total
Co-op opportunities	5	38	1	20	2	40	35
Support of faculty, advisors as mentors	1	8					4
High demand for women and/or minorities in the field	6	46	2	40	3	60	48
Acquire financial stability	1	8	2	40			13

Theme 5: African America and other minority females compared to Caucasian females perception of educational or professionals who influenced their decision to enter

engineering & STEM programs varied in the decision making process in entering these programs.

Based on the thematic category, *perception of African America & other minority females compared to Caucasian females of educational or professionals who influenced the decision to enter engineering & STEM programs,* five responses emerged as the most common responses (see table 6 for summary). The most common responses included "Strong high school influence from teachers, counselors, and the curriculum" (7 of the total African American participants, 54% and 2 of the total Caucasian participants, 40 %). Of the total participant population, the percentage influenced by activities in their high schools was 39%. The second most common response at 30% was there was a feeling that no one influenced the choices of several of participants to pursue engineering or STEM programs which were commented on by only the participants representing African American (23%) and Other Minorities (80%) of their respective groups. The two equally split third responses clearly divided by racial backgrounds as "Family members in the field" (3 participants, African American and Other Minorities, 17%) and "Professors during college visits" (3 Caucasian participants, 60%) which was equally 13% of the total population.

These were some surprising results because the majority of the African American participants felt and articulated how they perceived the importance of their involvement in high schools with the teachers, counselors, and their curriculum as strong influences in their choice to pursue engineering and STEM programs in college. To add to the interesting results was that although the participants were from the same higher

educational institute they represented many areas across the country. Participant 11 remarked how her biology instructor in high school showed her laboratory techniques, which really increased her interest in pursuing a STEM discipline in college. Participant 16 commented, "My advanced placement (AP) biology teacher in high school impressed me because she was so young and I could really relate to her. I wanted to be like her because she had a doctoral degree in an interesting field." Another participant, 18 explained how her interest was influenced by a teacher in her high school who had previously worked in an engineering position. This participant further expressed how she was impressed by his sharing the real world of engineering and bringing it to the classroom.

Seven of the participants all African American or other minorities, 30% of the total participant population commented that there was no one in particular who influenced their decision to pursue an engineering or STEM program at the collegiate level. Some of the comments consistent across many of the participants included "I knew what I wanted to do". Participant 4 commented, "I liked computers and wanted to pursue that". Participant 19 expressed how she felt no one influenced her decision but were told by others that people told her to go after what she enjoyed. Participant 12 conveyed how she did her own research to make her own determination what to pursue in college without the assistance or influence of anyone else.

The third response split across cultural backgrounds. The African American and Other Minority participants expressed family members in the fields were most influential in their decision to pursue engineering or STEM programs in college. Participant 13

commented, “My uncle was and electrical engineer and he pushed me in that direction.” Participants 21 and 9 expressed how their fathers were most influential in their decision to pursue an engineering program because of they had degrees and employment in the field.

The Caucasian participants were most influenced by professors who conducted their initial college visits. The responses from these participants were strong in that they were undecided but when they attended, a college they were influenced by the professor conducted the tour in engineering. One participant conveyed had it not been for the professor showing and explaining what a race team did in engineering, she would not be in the engineering program today. Participant 8 commented, “I was so impressed during my visit to the college and discovered the mechanical engineering program offered many broad options. I was immediately hooked and knew then what program I was going in.”

Table 6 - *Perception of African America & other minority females compared to Caucasian females of educational or professionals who influenced the decision to enter engineering & STEM programs*.

Responses	African American (AA)	% of (AA) Total	Other Minorities (OM)	% of (OM) Total	Caucasian (C)	% of (C) Total	% of Grand Total
Strong high school influence from teachers, counselors, curriculum	7	54			2	40	39
Family members in the field	2	15	1	20			13
Exposure to various companies in the field	1	8					4
Professors during college visits					3	60	13
No one influenced the decision	3	23	4	80			30

Theme 6: Co-ops and internships were the perceived approaches for attaining a career in the engineering or STEM field.

Based on the thematic category, *strategies and perception for attaining a career in the engineering or STEM field,* four responses emerged as the most common responses (see table 7 for summary). The overwhelming response from all the participants was "Co-op/Internship opportunities" as the main strategy for attaining a career in engineering and STEM fields (17 of the total participant population, 74%). A distant second response was "College to career workshops for females" (3 of the total participant population, 13%).

Co-op and internship opportunities came out in the forefront of the majority of the participants' comments as an outstanding strategy for assisting students to eventually achieve a career in engineering and STEM fields. Several of the participants referenced peers who have gone on co-ops and eventually were offered jobs in those same

organizations after attaining their college degree. While many of the participants had not secured a co-op they were excited to look forward to them. Many made remarks similar to going on a co-op or internship would help them "get their foot in the door".

The second response from a few participants was they felt they could benefit from a workshop geared towards females centered on college to career as it relates to engineering and STEM programs. As mentioned previously some of the participants felt since the field is so male dominated, they could benefit from a little more guidance going from college to career in these fields.

Table 7 - *Strategies and perception for attaining a career in the engineering or STEM field*.

Responses	African American (AA)	% of (AA) Total	Other Minorities (OM)	% of (OM) Total	Caucasian (C)	% of (C) Total	% of Grand Total
Co-op/Internship opportunities	10	77	2	40	5	100	74
Mentors	2	15					7
College to Career workshops for females	1	8	2	40			13
None Response			1	20			4

Theme 7: The perception of parental involvement in pursuit of a college career in engineering or STEM was slightly higher for African American and other minority females than for Caucasian females.

Based on the thematic category, *perceived involvement of parents in pursuit of a college career in engineering or STEM,* four responses occurred as the most common responses (see table 8 for summary). The three top responses emerging from the

participants was “Strong parental involvement” (11 of the total participant population, 48%), “Moderate parental involvement” (5 of the total participant population, 22%), and “No parental involvement” (6 of the total participant population, 26%). These responses demonstrated how they perceived the parental involvement in their decisions to pursue a college career in engineering or STEM programs.

The African American participants (7 of 13 for 30%) felt their parents were very instrumental in their decision to pursue a college programs in engineering and STEM. While this group of participants felt their parents heavily influenced them, part of that influence came because of their parents not completing their own degree programs in similar fields or other issues. Participant 15 commented, “My father was interested in civil engineering and kept trying to push me in that direction.” Participant 16 looked back on her father’s situation as an electrical engineer. He worked at a company for many years, lost use of his hands due to an accident and lost his profession. She felt because of her father’s hardship that he pushed harder to have her enter an engineering program. Participant 21 commented, “Both of my parents were very instrumental and encouraging in my decision, my father never finished his degree in a similar field and my mother was just a strong advocate for an engineering degree.” Many of the comments centered on hearing what their parents said, did, and the circumstances of their life, which influenced them to complete what their parents, may not have been able to do. Participant 5 commented, “My mother practically forced me into a STEM program because she wanted me to be able to take care of myself.”

The other minorities and Caucasian respondent who gave this as their top response provided similar comments why they felt their parent had a strong influence on their decision to pursue engineering or STEM in college. Participant 23 commented, "My mother kept telling me it might be difficult but she understood because she completed a similar program." This participant also commented, "My father was a hands-on learner and I used to help him fix things and I knew I wanted to do something with my hands." Participant 8 commented, "My parents were a tremendous influence on my decision to pursue engineering, my father especially because he was an engineer."

The second most common response from the participants was they did not feel there was any parental influence on their decision to pursue engineering or STEM program in college. This response was evenly split across all cultural backgrounds of the participants. Many felt their parents were supportive and encouraged them to attend college but did not direct them to a particular program. Participant 9 commented, "My parents never told me what to pursue only to pursue what I was good at." Participant 4 remarked, "My parents were supportive, encouraging, helped with filling out the applications but never directed me to any specific program." Participant 22 remarked, "My parents did not influence my decision at all, I made my own decision on my own." Participant 7 commented, "My parents were supportive but did not influence my decision what program to pursue in college."

The third response, the participants felt they received what they referred to as moderate parental involvement in their decision to pursue engineering or STEM programs in college. Participant 1 emphatically stated, "Out of 10 my parents were a 5

and that was mostly my mother when it came to influencing my decision to enter my program in college." Based on the respondents remarks moderate parental involvement consisted of little to no discussions on the topic, only one parent in the house knew or commented the topic. Participant 20 commented, "My father did not have a degree but wanted me to go into STEM but my mother did not think higher education was necessary." Participant 10 stated, "My mother was a big influence in my decision, my father was not because he did not feel it was a field for women." Participant 2 reflected on her father being a machinist as influencing the direction she took in college, not so much any particular conversation with her parents.

Table 8 - *Perceived involvement of parents in pursuit of a college career in engineering or STEM*.

Responses	African American (AA)	% of (AA) Total	Other Minorities (OM)	% of (OM) Total	Caucasian (C)	% of (C) Total	% of Grand Total
Strong parental involvement	7	30	1	20	3	60	48
Moderate parental involvement	3	23	2	40			22
No parental involvement	2	15	2	40	2	40	26
Other family members involved	1	8					4

Chapter Summary

The purpose of this phenomenological qualitative research study was to explore the lived experiences of the African American female college students compared to other populations entering engineering or other STEM programs to identify what may be

contributing factors for selecting these programs. The guiding research questions for this study were:

1) What motivates African American females to enter an engineering program at the collegiate level compared to other populations?
2) What do the participants report as the contributing factor(s) for entering the engineering or STEM program?
3) To what extent does the perception of engineering and STEM as an attainable career influence whether or not to choose engineering or a STEM discipline as a major in college?
4) How does parental guidance influence the female's choice to go into engineering as a major or career?

The answers to these questions should assist in understanding African American female college students' decision-making, feelings, and perceptions as they enter engineering and STEM programs in college compared to other racial groups.

This research was conducted by capturing data via face-to-face and phone interviews. The interviews were audio recorded and transcribed. NVivo10 software for qualitative data analysis helped generate themes and analyze the data. Seven thematic categories were identified with the following themes: (a) The factors that influenced African America compared to other minority & Caucasian females to major in engineering & STEM programs in college included strong high school programs focused on high achievement in science and math; (b) The challenges or issues experienced by the African America & other minority compared to Caucasian females that influenced the

program choices were lack of preparedness and financially related; (c) Pursuing engineering or STEM programs in college through hard work and dedication could prepare them for positive career and future; (d) Strong support of co-op opportunities and the high demand for women and/or minorities in the field were perceived factors influencing completion of engineering and STEM programs; (e) African America and other minority females compared to Caucasian females perception of educational or professionals who influenced their decision to enter engineering & STEM programs varied in the decision making process in entering these programs; (f) Co-ops and internships were the perceived approaches for attaining a career in the engineering or STEM field; (g) The perception of parental involvement in pursuit of a college career in engineering or STEM was slightly higher for African American and other minority females than for Caucasian females.

Chapter 5 contains the summary of the findings presented in this chapter. Chapter 5 presents recommendations, interpretations, limitations of the study, recommendations for leaders, and suggestions for future research.

Chapter 5: Summary and Recommendations

The purpose of this phenomenological qualitative research study was to explore the lived experiences of the African American female college students compared to other populations entering engineering or other STEM programs to identify what may be contributing factors for selecting these programs. Twenty-three female college students attending the Institute in North Western New York, New York already enrolled in engineering or STEM programs were interviewed to identify what factors contributed to their selecting these programs. To be included in the study participants had to: (a) to be female, (b) self-identify as African American and any other cultural group, (c) be a college student in an engineering or STEM program, (d) be between 18 and 28 years of age, and (e) attend the Institute in North Western New York, New York.

Chapter 5 presents a discussion of the summary and findings, interpretation of the themes, limitations of the study, recommendations for leaders, and suggestions for future research. The research questions guiding the research were: 1) What motivates African American females to enter an engineering program at the collegiate level compared to other populations?; 2) What do the participants report as the contributing factor(s) for entering the engineering or STEM program?; 3) To what extent does the perception of engineering and STEM as an attainable career influence whether or not to choose engineering or a STEM discipline as a major in college?; 4) How does parental guidance influence the female's choice to go into engineering as a major or career? Face-to-face and phone interviews were conducted to allow the participants to provide in-depth responses. Open-ended questions were used in the interviews to allow more in-depth

answers to the questions, which assisted in later identification of common themes. Chapter 5 also links the discussion on findings to the literature review and any limitations to the study.

Summary and Findings

To ensure each participant met the inclusion criteria prior to the in-depth interviews, each participant answered six demographic questions (see appendix E). Once the criteria had been met the data collection commenced via face-to-face or phone interviews using open-ended questions so the participants could provide more depth to their responses. The interview questions resulted in seven thematic categories. From the thematic categories the following seven themes were identified: 1) The factors that influenced African America compared to other minority & Caucasian females to major in engineering & STEM programs in college included strong high school programs focused on high achievement in science and math; 2) The challenges or issues experienced by the African America & other minority compared to Caucasian females that influenced the program choices were lack of preparedness and financially related; 3) Pursuing engineering or STEM programs in college through hard work and dedication could prepare them for positive career and future; 4) Strong support of co-op opportunities and the high demand for women and/or minorities in the field were perceived factors influencing completion of engineering and STEM programs.; 5) African America and other minority females compared to Caucasian females perception of educational or professionals who influenced their decision to enter engineering & STEM programs varied in the decision making process in entering these programs; 6) Co-ops and

internships were the perceived approaches for attaining a career in the engineering or STEM field; and 7) The perception of parental involvement in pursuit of a college career in engineering or STEM was slightly higher for African American and other minority females than for Caucasian females.

The participants were in various engineering and STEM programs and different year levels in their respective programs (see appendix F). The total participant population of 23 was represented by 57% (13 participants) African American, 22% (5 participants) Other Minorities (Hispanic/African American), and 22% (5 participants) Caucasian. Sixty-five percent (15 participants) of the participants were in engineering programs and equally represented year levels 1 through 5 and graduate level. The cultural backgrounds of the engineering students was as follows: 47% (7) African American, 33% (5) Caucasian, and 20% (3) Other Minorities. The remaining participants (8) 35% were enrolled in other STEM programs and included the following cultural backgrounds: 75% (6) African American and 25% (2) Other Minorities.

Social cognitive and cognitive learning theories were the basic framework for this research study. Albert Bandura's social cognitive theory was based on the assumption that people were purposeful, goal-directed beings who were primarily motivated through their beliefs of self-efficacy and outcome expectations stemming from their actions within specific social contexts (Erlich, & Russ-Eft, 2011). The motivational theory was an additional aspect of the framework for this research study to identify factors that are contributing factors why African American females choose engineering or STEM programs compared to female other populations. Kerssen-Griep, (2003) cited

"motivational theorists describe learners as innately inclined toward mastery, activity, exploration, and spontaneous interest but also having a vulnerability to passivity that can be elicited by social contextual events" (Ryan & Deci, 2000, p. 76).

Interpretation of Themes

The purpose of this section is to answer the research questions that guided this research study. Each theme that emerged from the data will be presented and discussed. The goal is to interpret the themes in response to the research questions, the theoretical framework, and literature review.

Theme 1: The factors that influenced African America compared to other minority & Caucasian females to major in engineering & STEM programs in college included strong high school programs focused on high achievement in science and math.

The participants expressed they felt the most important factor that influenced their decision to major in engineering or STEM programs in college was the strong influence of high school teachers or counselors. The majority of the African American participants felt the influence of the high school educators made a major difference in the direction they took when they pursued a college education. Also noted was the importance of their high school educators in directing them to achieve high in science and math. Many commented had it not been for the high school educators they were not sure what they would have pursued in college. The majority of the Caucasian participants also noted the importance of their high school educators as contributing factors to their choice in college.

Attracting minorities to STEM educational programs comparable to engineering has its challenges and appears to be compounded by issues related to the American school systems (Wharton 1992) as cited by Denson, Avery & Schell (2010). In contrast to the previous statement the majority of the participants give enthusiastic reviews to their high schools of the late 1990's and early 2000's for making positive contributions which aided in their ability to begin an engineering/STEM program in college. Based on the responses from both the African American and Caucasian participants it appears the American high schools are placing a higher importance on science and math, which was recognized by the students as they pursued their college careers. Enrichment programs were becoming more accessible to the participants, which also better prepared them for college in engineering and STEM programs and ultimately careers in the field. The African American participants were more insistent about their high school involvement in their decision whereas the Caucasian participants appeared to take their high school involvement for granted, although they did appreciate it.

Theme 2: The challenges or issues experienced by the African America & other minority compared to Caucasian females that influenced the program choices were lack of preparedness and financially related.

The most common challenges experienced by the majority of the participants were the feeling of not being well prepared to participate in engineering or STEM program. African American participants noted this as a much bigger concern than their counterparts from other cultural backgrounds. According to Vaz (2012), changes in engineering programs are necessary as the participants call for including cross-cultural

experiences and improvement of global awareness. Many of the participants felt although they selected these programs and want to be successful because of their own lack of preparedness for whatever reason; making changes in some of the programs would be helpful. Addressing the differences amongst the female students of different cultural backgrounds and providing additional support to close the gaps has the potential to increase the achievement levels of the African American students going forward. Some of the underlying comments from the African American participants indicated the need for more intense mentoring. Some also felt their curriculum advisors were not supportive in guiding them through their particular programs and indicated they were quite the opposite. Drawing attention to people in engineering education is no excuse for not paying more attention to the culture within engineering (McLoughlin, 2009). Being told for example, the program is not for you, you should find something a little easier. Mills & Ayre (2003) noted, modifications to the STEM courses are suggested to attract and retain minority undergraduate female undergraduate learners.

Participants from other cultural backgrounds did not feel or have the same experiences and tended to focus on the fact that engineering and STEM programs is a lonely field lacking diversity and male dominated.

Theme 3: Pursuing engineering or STEM programs in college through hard work and dedication could prepare them for positive career and future.

The motivating factors for persevering in engineering and STEM programs in college regardless of the obstacles that may still exist generated several responses. The African American and Other Minorities participants split equally in that they wanted to

increase the number of African American and Other Minority females in their respective fields, attain a good job to secure a higher salary and bring about change to solve problems. Bennett & Lutz (2009) cited, "there is an unmistakable racial hierarchy within the United States, one in which blacks occupy multiple locations of disadvantage while whites occupy positions of power and privilege, with Asians and Latinos occupying the space in the middle (Bobo 2000; Bobo and Zubrinsky 1996; Drake and Cayton 1945)". Overcoming what has been the norm for many years as it relates to African Americans being underrepresented or at a disadvantage when it comes to attaining positions of power, these participants appeared to be motivated to bring about a change. By putting themselves in in a powerful position in the future by working hard to complete their programs was an example of letting the negative bring about a positive change.

The majority of Caucasian respondents appeared to be most focused on bringing about changes in society, e.g. the environment, as their motivating factor for persevering in engineering and STEM programs in college. Both African American and Caucasian participants were motivated by the thought of making a change, the type of change varied between the two groups. The African American participants were highly focused on changing the negative stereotypes, which have plagued their group for many years. Growing the amount of African American engineering students must mirror the quantity working in the field, how many go on to attain degrees in engineering and ultimately on to engineering professions as a career in the field or academia (Fleming (2008).

Theme 4: Strong support of co-op opportunities and the high demand for women and/or minorities in the field were perceived factors influencing completion of engineering and STEM programs.

The most noted response was the participants felt, as influencing them to complete engineering and STEM programs is the continuous need for females and minorities in the associated fields. A significant amount of discussion has emerged from academic, professional, and political circles regarding the central role of the engineering infrastructure, and the time has come for collaboration and integration regarding the success of the industry (Chinowsky, 2009). The feeling that there would be more opportunities once they graduated from college to attain a career in their field of study helps them overcome obstacles while continuing their education.

Coupled with that, for the institute the participants attended, was a co-op opportunity as a portion of their curriculum requirements. There was no clear delineation between the different racial backgrounds on this point. Everyone who mentioned the co-op opportunities as a dominant contributing factor for completing their respective programs through to graduation felt, with the high demand for women and minorities, co-op opportunities gave them a realistic picture of what to expect once they entered the workforce. The general feeling from the participants of what factors influenced completion of engineering and STEM programs at the collegiate level did not vary by racial background.

Theme 5: African America and other minority females compared to Caucasian females perception of educational or professionals who influenced their decision to enter

engineering & STEM programs varied in the decision making process in entering these programs.

The African American participants appeared to be more emphatic about how their educational and professional exposure to people in engineering or STEM fields had a significant impact on the choice they made as they prepared for college. According to May & Chubin (2003), the "issue of diversity is critical since many demographic studies indicate that the ethnicity of the U.S. workforce is changing dramatically" (p.27). Companies such as GE, Lockheed Martin. IBM, and ATT were mentioned as companies the participants had been exposed to at a young age during high school, which would eventually be contributions to the direction they ultimately selected in college. Mills & Ayre (2003) cited that increasing the representation of African American women could alleviate labor shortages in the profession (European 2000). Many of the participants mentioned that many their high school teachers previously employed in the field had returned to teaching to share their experiences. Another interesting point that came out was the African American participants did not feel a sense that these careers were unattainable as others might think.

The Caucasian participants did not express any prior involvement with engineering or STEM professionals until they were about to enter college. They were influenced by the people conducting college tours versus prior exposure to those in the field. The majority of the participants whether during high school or right before college had some type of interaction with people who would eventually influence their decision to enter engineering or STEM programs.

Another interesting point that only the African American and Other Minorities participants felt no one influenced their decision to enter engineering or STEM programs. In those cases they described an innate skill for math and science, their enjoyment of the subjects as the driving force to an engineering or STEM program. This group further described their as simply pursuing what they enjoyed.

Theme 6: Co-ops and internships were the perceived approaches for attaining a career in the engineering or STEM field.

The African American participants overwhelmingly noted that they did not feel the possibility of attaining a career in engineering or STEM fields would be possible without co-op or internship opportunities as a prerequisite for their degree requirements. An enhanced body of knowledge that includes economics, cultural awareness, embraces business, global understanding, and leadership are crucial to developing new paths for success of the African American females in STEM and engineering programs (Chinowsky, 2009). Co-ops and internships provide the opportunity for the students to meet and build relationships with potential employers for the future. The Federal government and academia have a stake in discovering ways to expanding the pool of science and technology educators and researchers (May & Chubin, 2003).

Theme 7: The perception of parental involvement in pursuit of a college career in engineering or STEM was slightly higher for African American and other minority females than for Caucasian females.

Strong parental involvement was perceived as an invaluable resource to close the achievement gaps in these programs. When considering factors for addressing

achievement gaps based on school values and parental/family characteristics, the presence of cultural barriers need to be taken into account (Madyun, 2011). The African American participants who responded referenced how important their parent's involvement was to leveling the playing field once they got to college. That is not to say those with moderate or not parent involvement cannot succeed, only this population of respondents placed a high importance on the need to have that involvement.

Many of the participants did mention parental involvement as crucial to their success in pursuing engineering or STEM programs. Those with the strong parental guidance did not seem to be concerned with the male dominance in the fields. The perception of parental guidance and their influence on college choices indicated that in many cases of the participants saw things in their parents that helped shape their opinions. Parents had a plethora of backgrounds, e.g. careers, education, or innate skills at home that influenced the participants in one direction or another.

Limitations of the Study

Typical of qualitative phenomenological research studies, this study has limitations. According to Moustakas (1994), qualitative research provides a distinct interpretation of the phenomenon and does not attempt to generalize results. The limitations were mainly based on (1) lack of experience of the researcher in an educational workplace and the STEM field; (2) the selection of the participants was very limited; (3) the interview questions overlapped in the information requested; and (4) the participants may not have answered the questions in an open and honest manner, which could generate inaccurate information.

Several other areas that presented some limitations to the study included: (a) only selected the participants from institution; (b) participants volunteered who were out of town on a co-op assignment; (c) participants work schedules caused delays and cancellations for the prescheduled interviews; (d) phone interviews were interrupted by participants taking another call in the midst of the interview; (e) some of the participants were in the midst of taking final exam and had to reschedule appointments; (f) the semester was coming to a close and there were a limited number of people available to participate in the study; (g) interruptions during the interviews by cell phones; and (h) technological restraints where the researcher did have a skype or google chat to have virtual interviews with the students.

All of the issues that arose throughout the interview data collection phase of the research study were addressed and accommodations were made to keep the students at ease during the interviews. Conducting an in-depth investigation and providing comprehensive explanations from persons enduring an experience according to Moustakas (1994) was be key to capturing concrete data for analysis. Overcoming the obstacles that occurred either during or before the interviews required ensuring there was a rapport between the researcher and participant to get open and honest responses to the interview questions. Adequate time was allowed for the participants to answer the questions and any questions the participant had were immediately addressed.

Recommendations for Leaders

The purpose of this qualitative research methods study with empirical phenomenological research design was to explore the lived experiences of the African

American females compared to other populations pursuing engineering or other STEM programs in college. Based on the results of this study the need still exists to increase the number of African American females in engineering and STEM programs in college. The intent of these recommendations is to provide leaders in both education, local, state, and federal government suggestions for making enhancements to the educational systems to better prepare the African American for college and ultimate careers in engineering and STEM fields.

The first results indicate African American females appear to be motivated by educators and professionals in engineering and STEM fields at a younger age that have made an impact on their lives. It is essential for leaders to focus on high school students to build a solid pipeline for future entrance into engineering and STEM programs in college. Not to diminish the need of students already or about to enter college in those programs, based on the results of the study, leaders can be instrumental in changing the mindset of the educational and business professionals to be more inclusive when dealing with this traditionally underrepresented population of students. The feeling of male dominance in engineering and STEM fields needs not to continue as the norm. There needs to be more people in those areas that look like them and eventually are them. There is a willing and able population ready to take on the challenges of the world that need the leaders to tap into.

Second, African American students were highly motivated by participation in co-ops and internships in preparation for careers in their appropriate fields. Leaders need to continue to make those opportunities available for current and future students as a part of

the degree requirements. As for preparing students to enter these programs during the recruitment phases there could be an entrance requirement which promotes involvement with an organization of their interest prior to beginning their college education.

Third, many of the African American students are motivated and want to solve problems in society. Leaders need to gravitate to that excitement because this population of people can bring a new perspective to old ideas. There needs a safe environment with respect towards the African American females and not one of belittlement. Engineering is in so many arenas that it would be a waste to not have someone new at the table with fresh ideas.

Lastly, the value of parental involvement is essential to the success of the African American student as they pursue engineering or STEM programs in college and ultimately a career. Leaders cannot make parents become more involved but for those who are willing, an outreach program may be helpful and may open doors for the parent. Some hardships that the parents endured were motivating factors towards the direction they eventually pursued. Academic leaders who understand and are empathetic to the parental involvement may be able to gain some top notch students into their programs.

Suggestions for Future Research

The purpose of this phenomenological qualitative research study was to explore the lived experiences of the African American females compared to other populations pursuing engineering or other STEM programs in college and was exploratory in nature. One goal of this study is to stimulate future research on the topic. Other studies may conduct similar research using a different institution in another geographic area. There

are many opportunities to explore similar situations with a focus on another cultural group and different educational programs. There are many variables available for future studies to pursue.

Future qualitative studies could focus on high school students with several variables: (a) minority students' achievement in math and science; and (b) planned program choices for college. The current study did not address high school students but many of the responses referenced their feeling from their high schools and contributing factors for making specific program choices.

Another qualitative research study can be conducted with a focus on the engineering and STEM workforce. Many variables are abound which could include the following: (a) African American females in engineering and STEM careers; (b) research different geographic areas for trends in the workforce as it relates to African American females.

Lastly, research can be conducted to get the perceptions of males from different cultures regarding their thoughts and feelings of the African American females in engineering and STEM programs in college and in the workforce. This last subject has the potential to take the research in a completely new direction.

Chapter Summary

Chapter 5 presented a discussion of the summary and findings, interpretation of the themes, limitations of the study, recommendations for leaders, and suggestions for future research. Seven themes emerged from the data collection and provided insight into the thoughts and feelings of African American females compared to other cultural groups

when deciding to pursue engineering or STEM programs in college. Motivational and grounded theories were the basis for focusing on the African American female and the decision to pursue engineering or STEM education at the collegiate level.

Upon completion of this research study seven thematic categories were identified from the 23 participants in the study as: 1) Factors that influenced African America compared to other minority & Caucasian females to major in engineering & STEM programs in college; 2) Challenges or issues experienced between the African America compared to other minority & Caucasian females that influenced the program choices; 3) Positive factors for pursuing engineering or STEM programs in college; 4) Perceived factors influencing completion of engineering and STEM program; 5) Perception of African America & other minority females compared to Caucasian females of educational or professionals who influenced the decision to enter engineering & STEM programs; 6) Strategies and perception for attaining a career in the engineering or STEM field; and 7) Perceived involvement of parents in pursuit of a college career in engineering or STEM.

For further validation, future studies may replicate this study using a different geographical area or using a quantitative study to test archival data to current data in a more controlled design. The intent of this study is to stimulate researchers to use these findings and expand on the literature regarding what factors influence African American females to pursue engineering and STEM programs in college compared to other females of different racial backgrounds.

References

Bennett, P. R., & Lutz, A. (2009). How African American is the net black advantage? Differences in college attendance among immigrant blacks, native blacks, and whites. *Sociology of Education, 82*(1), 70-99.

Borum, V., & Walker, E. (2012). What makes the difference? Black women's undergraduate and graduate experiences in mathematics. *Journal of Negro Education, 81*(4), 366-378.

Brown Jr., E. E. (2011). A multicontextual model for broadening participation in STEM related disciplines. *US-China Education Review, 8*(3), 323-332.

Brown, A., Morning, C., & Watkins, C. (2005). Influence of African American engineering student perceptions of campus climate on graduation rates. *Journal of Engineering Education, 94*(2), 263-271.

Case, J. M., & Light, G. (2011). Emerging methodologies in engineering education research. *Journal of Engineering Education, 100*(1), 186-210.

Chinowsky, P. S. (2009). An Open Letter to the Profession: Civil Engineering Education at a Crossroads. *Leadership & Management in Engineering, 9*(2), 55-56. doi:10.1061/(ASCE)1532-6748(2009)9:2(55)

Christensen, L. B., Johnson, R. B., & Turner, L. A. (2011). *Research methods, design, and analysis* (11th ed.). Boston, MA: Allyn & Bacon.

Cox, M. F., Cekic, O., & Adams, S. G. (2010). Developing leadership skills of undergraduate engineering students: Perspectives from engineering faculty. *Journal of STEM Education: Innovations & Research, 11*(3/4), 22-33.

Denson, C. D., Avery, Z. K., & Schell, J. W. (2010). Critical inquiry into urban African American students' perceptions of engineering. *Journal of African American Studies, 14*(1), 61-74

Douglas, E. P., Koro-Ljungberg, M., & Borrego, M. (2010). Challenges and promises of overcoming epistemological and methodological partiality: Advancing engineering education through acceptance of diverse ways of knowing. *European Journal of Engineering Education, 35*(3), 247-257

Erlich, R. J., & Russ-Eft, D. (2011). Applying social cognitive theory to academic advising to assess student learning outcomes. *NACADA Journal, 31*(2), 5-15.

Farinde, A. A., & Lewis, C. W. (2012). The underrepresentation of African American female students in STEM fields: implications for classroom teachers. *US-China Education Review B, 2*(4b), 421-430.

Fife, J. (2011). Correlates and predictors of academic self-efficacy among African American students. *Education, 132*(1), 141-148.

Fleming, L. N. (2008). Diversity in engineering education: an African American female professor's perspective. *Leadership & Management in Engineering, 8*(1), 32-34.

Frizell, S. S., & Nave, F. M. (2009). Increasing the retention of females of color in engineering and technology degree programs through professional development activities. *Journal of Systemics, Cybernetics & Informatics, 7*(1), 56-59.

Johnson, D. R. (2011). Women of color in science, technology, engineering, and mathematics (STEM). *New Directions for Institutional Research, 2011*(152), 75-85. doi:10.1002/ir.410

Kantonidou, M. M. (2010). Engineering education and engineering practice: A student teacher perspective. *Electronics & Electrical Engineering*, (102), 167-170.

Kerssen-Griep, J. R. (2003). Sustaining the desire to learn: dimensions of perceived instructional facework related to student involvement and motivation to learn. *Western Journal of Communication, 67*(4), 357.

King, C. (2006). Let engineers go to college. *Issues in Science & Technology, 22*(4), 25.

Leedy, P. D., & Ormrod, J. E. (2009). *Practical research: Planning and design* (9th ed.). Upper Saddle River, NJ: Prentice Hall.

Lewis, J. L., Menzies, H., Najera, E. I., & Page, R. N. (2009). Rethinking trends in minority participation in the sciences. *Science Education, 93*(6), 961-977.

Look Where They Are Now. (2008). *U.S. Black Engineer & Information Technology, 32*(2), 17-22.

Madyun, N. H. (2011). Connecting social disorganization theory to African American outcomes to explain the achievement gap. *Educational Foundations, 25*(3/4), 21-35.

Marra, R. M., Rodgers, K. A., Shen, D., & Bougue, B. (2009). Women engineering students and self-efficacy: A multi-year, multi-institution study of women engineering student self-efficacy. *Journal of Engineering Education, 98*(1), 27-38.

May, G. S., & Chubin, D. E. (2003). A retrospective on undergraduate engineering success for underrepresented minority students. *Journal of Engineering Education, 92*(1), 27-39.

McLoughlin, L. A. (2009). Success, recruitment, and retention of academically elite women students without STEM backgrounds in US undergraduate engineering education. *Engineering Studies, 1*(2), 151-168.

Mikyong Minsun, K., & Conrad, C. F. (2006). The impact of historically black colleges and universities on the academic success of African American students. *Research in Higher Education, 47*(4), 399-427. doi:10.1007/s11162-005-9001-4.

Mills, J., & Ayre, M. (2003). Implementing an inclusive curriculum for women in engineering education. *Journal of Professional Issues In Engineering Education & Practice, 129*(4), 203-210. doi:10.1061/(ASCE)1052-3928(2003)129:4(203)

Moody, V. R. (2003). The ins and outs of succeeding in mathematics: African American students' notions and perceptions. *Multicultural Perspectives, 5*(1), 33.

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

Neuman, W. L. (2006). *Social research methods: Qualitative and quantitative approaches (6th ed.)*. Boston, MA: Allyn & Bacon.

Nixon, A and Wild, D (2013). Methodologies for assessing and demonstrating data saturation in qualitative inquiry supporting patient-reported outcomes research. Retrieved from http://www.oxfordoutcomes.com/library/conference_material/posters/PRO/Methodologies%20for%20assessing%20and%20demonstrating.pdf

Ong, M. (2011). Broadening participation the status of women of color in computer science. *Communications of the ACM, 54*(7), 32-34. doi:10.1145/1965724.1965737

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.

Pritchard, J. J., & Baillie, C. C. (2006). How can engineering education contribute to a sustainable future? *European Journal of Engineering Education, 31*(5), 555-565.

Rosenberg-Kima, R. B., Plant, E., Doerr, C. E., & Baylor, A. L. (2010). The influence of computer-based model's race and gender on female students' attitudes and beliefs towards engineering. *Journal of Engineering Education, 99*(1), 35-44.

Seidman, I. (2006). *Interviewing as Qualitative Research: a guide for researchers in edcuation and the social sciences.* (3rd ed.). New York, NY: Teachers College Press.

Sonnert, G., & Fox, M. (2012). Women, men, and academic performance in science and engineering: The gender difference in undergraduate grade point averages. *Journal of Higher Education, 83*(1), 73-101.

Syed, M., & Chemers, M. M. (2011). Ethnic minorities and women in STEM: Casting a wide net to address a persistent social problem. *Journal of Social Issues, 67*(3), 435-441. doi:10.1111/j.1540-4560.2011.01708.x

Tate, E., & Linn, M. (2005). How does identity shape the experiences of women of color engineering students? *Journal of Science Education & Technology, 14*(5/6), 483-493. doi:10.1007/s10956-005-0223-1

Trenor, J., Yu, S. L., Waight, C. L., Zerda, K. S., & Ting Ling, S. (2008). The relations of ethnicity to female engineering students' educational experiences and college and career plans in an ethnically diverse learning environment. *Journal of Engineering Education, 97*(4), 449-465.

Vaz, R. (2012). Designing the liberally educated engineer. *Peer Review, 14*(2), 8-11.

Whalen, D. F., & Shelley, M. C. (2010). Academic success for STEM and Non-STEM majors. *Journal of STEM Education: innovations and Research, 11*(1-2), 45-60.

Appendix A

[redacted] Permission for the Study

University of Phoenix®

PREMISES, RECRUITMENT AND NAME (PRN) USE PERMISSION

[redacted]

Name of Facility, Organization, University, Institution, or Association

Please complete the following by check marking any permissions listed here that you approve, and please provide your signature, title, date, and organizational information below. If you have any questions or concerns about this research study, please contact the University of Phoenix Institutional Review Board via email at IRB@phoenix.edu.

☒ I hereby authorize Venessa M. Mitchell, a student of University of Phoenix, to use the premises (facility identified below) to conduct a study entitled **A PHENOMENOLOGICAL STUDY FACTORS AFRICAN AMERICAN FEMALE COLLEGE STUDENTS' FACE PARTICIPATING IN ENGINEERING OR STEM MAJORS – to gain a better understanding of the specific needs and wants of the African American female during recruiting through graduation to aid professionals, instructors, administrators in the engineering discipline to provide a pool of well-trained and diverse applicants for professions in the engineering and other STEM fields.**

☒ I hereby authorize Venessa M. Mitchell, a student of University of Phoenix, to recruit subjects for participation in a conduct a study entitled **A PHENOMENOLOGICAL STUDY FACTORS AFRICAN AMERICAN FEMALE COLLEGE STUDENTS' FACE PARTICIPATING IN ENGINEERING OR STEM MAJORS – to gain a better understanding of the specific needs and wants of the African American female during recruiting through graduation to aid professionals, instructors, administrators in the engineering discipline to provide a pool of well-trained and diverse applicants for professions in the engineering and other STEM fields.**

☒ I hereby authorize Venessa M. Mitchell, a student of University of Phoenix, to use the name of the facility, organization, university, institution, or association identified above when publishing results from the study entitled **A PHENOMENOLOGICAL STUDY FACTORS AFRICAN**

1

AMERICAN FEMALE COLLEGE STUDENTS' FACE PARTICIPATING IN ENGINEERING OR STEM MAJORS – to gain a better understanding of the specific needs and wants of the African American female during recruiting through graduation to aid professionals, instructors, administrators in the engineering discipline to provide a pool of well-trained and diverse applicants for professions in the engineering and other STEM fields.

Heather Foti 07/12/2013

Signature Date

Name Heather Foti

Title Associate Director

Address of Facility HSRO

141 Lomb Memorial Dr

[redacted]

Appendix B

Informed Consent University of Phoenix Participants 18 years of Age and Older

Dear ,

My name is **Venessa M. Mitchell** and I am a student at the University of Phoenix working on an **EDD/CI** degree. I am doing a research study entitled **A PHENOMENOLOGICAL STUDY FACTORS AFRICAN AMERICAN FEMALE COLLEGE STUDENTS' FACE PARTICIPATING IN ENGINEERING OR STEM MAJORS**. The purpose of the research study is to **gain a better understanding of the specific needs and wants of the African American female during recruiting through graduation to aid professionals, instructors, administrators in the engineering discipline to provide a pool of well-trained and diverse applicants for professions in the engineering and other STEM fields.**

Your participation will involve **participation in a face-to-face interview with the researcher for 45-60 minutes**. **The interviews may be recorded to maintain the accuracy of data for later analysis. The intended sample size is proposed to be approximately 20 – 25 participants.** You can decide to be a part of this study or not. Once you start, you can withdraw from the study at any time without any penalty or loss of benefits. The results of the research study may be published but your identity will remain confidential and your name will not be made known to any outside party.

In this research, there are **no foreseeable risks** to you.

If you have any questions about the research study, please call me at **585-426-9968** or email **vmar1121@email.phoenix.edu**. For questions about your rights as a study participant, or any concerns or complaints, please contact the University of Phoenix Institutional Review Board via email at IRB@phoenix.edu or Heather Foti, Associate Director, Human Subjects Research Office via email hmfsrs@rit.edu.

As a participant in this study, you should understand the following:

1. You may decide not to be part of this study or you may want to withdraw from the study at any time. If you want to withdraw, you can do so without any problems.
2. Your identity will be kept **confidential**.
3. **Venessa M. Mitchell**, the researcher, has fully explained the nature of the research study and has answered all of your questions and concerns.
4. If interviews are done, they may be recorded. If they are recorded, you must give permission for the researcher, **Venessa M. Mitchell**, to record the interviews. You understand that the information from the recorded interviews may be transcribed. The researcher will develop a way to code the data to assure that your name is protected.
5. Data will be kept in a secure and locked area. The data will be kept for three years, and then destroyed.
6. The results of this study may be published.

"By signing this form, you agree that you understand the nature of the study, the possible risks to you as a participant, and how your identity will be kept confidential. When you sign this form, this means that you are 18 years old or older and that you give your permission to volunteer as a participant in the study that is described here."

(☐) I accept the above terms. **(☐) I do not accept the above terms.**

(CHECK ONE)

Signature of the interviewee _____ Date _____

Signature of the researcher _____ Date _____

Appendix C

Informed Consent University of Phoenix Focus Groups ≥ 18 years of Age

Dear ,

My name is **Venessa M. Mitchell** and I am a student at the University of Phoenix working on an **EDD/CI** degree. I am doing a research study entitled **A PHENOMENOLOGICAL STUDY FACTORS AFRICAN AMERICAN FEMALE COLLEGE STUDENTS' FACE PARTICIPATING IN ENGINEERING OR STEM MAJORS**. The purpose of the research study is to **gain a better understanding of the specific needs and wants of the African American female during recruiting through graduation to aid professionals, instructors, administrators in the engineering discipline to provide a pool of well-trained and diverse applicants for professions in the engineering and other STEM fields.**

Your participation will involve a **focus group discussion with the researcher for 45-60 minutes**. **The discussion may be recorded to maintain the accuracy of data for later analysis. The intended sample size is proposed to be approximately 5-10 participants.** You can decide to be a part of this discussion/study or not. Once you start, you can withdraw from the study at any time without any penalty or loss of benefits. The results of the research study may be published but your identity will remain confidential and your name will not be made known to any outside party.

In this research, there are **no foreseeable risks** to you.

If you have any questions about the research study, please call me at **585-426-9968** or email **vmar1121@email.phoenix.edu**. For questions about your rights as a study participant, or any concerns or complaints, please contact the University of Phoenix Institutional Review Board via email at IRB@phoenix.edu or Heather Foti, Associate Director, Human Subjects Research Office via email hmfsrs@rit.edu.

As a participant in this study, you should understand the following:

1. You may decide not to be part of this study or you may want to withdraw from the study at any time. If you want to withdraw, you can do so without any problems.
2. Your identity will be kept **confidential**.
3. **Venessa M. Mitchell**, the researcher, has fully explained the nature of the research study and has answered all of your questions and concerns.
4. If focus group discussions are done, they may be recorded. If they are recorded, you must give permission for the researcher, **Venessa M. Mitchell**, to record the discussions. You understand that the information from the recorded group discussions may be transcribed. The researcher will develop a way to code the data to assure that your name is protected.
5. Data will be kept in a secure and locked area. The data will be kept for three years, and then destroyed.
6. The results of this study may be published.

“By signing this form, you agree that you understand the nature of the study, the possible risks to you as a participant, and how your identity will be kept confidential. When you sign this form, this means that you are 18 years old or older and that you give your permission to volunteer as a participant in the study that is described here.”

(☐) I accept the above terms. **(☐) I do not accept the above terms.**

(CHECK ONE)

Signature of the interviewee _____ Date _____

Signature of the researcher _____ Date _____

Appendix D

Face-to-face interview questions

1. Based on your personal experiences explain what it was like for you when you were deciding which educational program to select prior to attending college.
2. Explain the educational and professional influences you experienced in deciding to enter engineering or STEM programs at the collegiate level.
3. Describe specific issues that contributed to your choosing engineering or STEM as a collegiate career.
4. Based on your personal experiences describe your perception of professions in engineering or STEM as attainable careers.
5. Describe whether or how much your parents influenced your decision to select engineering or STEM educational programs in college.
6. Based on your personal experiences explain what you feel is the most important reason to participate in engineering and STEM programs.

Appendix E

Demographic Questions

1. How do you self-identify your race?

2. Are you between 18 and 28 years of age?

3. Are you a current student at the institute?

4. What is your program/major of study?

5. What year level are you in your program?

6. Where are you from?

Appendix F

Participants of the Study

Participant	Name of the Institute (pseudonym)	Self-Identified Ethnicity	Participated in Engineering or STEM program in the last 5 years	Year Level Completed	College Major
P1	Institute in the North West New York	African American	Yes	1	Biomedical Engineering
P2	Institute in the North West New York	Caucasian	Yes	4	Mechanical Engineering
P3	Institute in the North West New York	African American	Yes	1	Science Exploration
P4	Institute in the North West New York	Mixed Race African American & Hispanic	Yes	3	Networking & Sys Admin
P5	Institute in the North West New York	Hispanic	Yes	5	Mechanical Engineering
P6	Institute in the North West New York	African American	Yes	3	Info Security & Forensics (Computing Security Dept.)
P7	Institute in the North West New York	Caucasian	Yes	2	Mechanical Engineering
P8	Institute in the North West New York	Caucasian	Yes	3	Mechanical Engineering
P9	Institute in the North West New York	Mixed Race African American & Hispanic	Yes	Grad	Mechanical Engineering
P10	Institute in the North West New York	Hispanic	Yes	1	Industrial & Systems Eng.
P11	Institute in the North West New York	African American	Yes	1	Biology
P12	Institute in the North West New York	African American	Yes	2	Game Design & Development

P13	Institute in the North West New York	African American	Yes	4	Elect. Eng. Tech
P14	Institute in the North West New York	African American	Yes	2	Industrial & Systems Eng.
P15	Institute in the North West New York	African American	Yes	5	Mech. Eng. Tech
P16	Institute in the North West New York	African American	Yes	4	Packaging Science
P17	Institute in the North West New York	Caucasian	Yes	2	Mechanical Engineering
P18	Institute in the North West New York	African American	Yes	4	Chemistry
P19	Institute in the North West New York	Mixed Race African American & Hispanic	Yes	3	Packaging Science
P20	Institute in the North West New York	African American	Yes	5	Electrical Engineering
P21	Institute in the North West New York	African American	Yes	3	Mechanical Engineering
P22	Institute in the North West New York	African American	Yes	3	Elect. Eng. Tech
P23	Institute in the North West New York	Asian/Caucasian	Yes	2	Mechanical Engineering