

**AFRICAN AMERICAN WOMEN IN SCIENCE, TECHNOLOGY,  
ENGINEERING AND MATHEMATICS (STEM)**

Doctoral Applied Research

Submitted to the Graduate Faculty of

Argosy University

Argosy University Online

In Partial Fulfillment

of the Requirements for the Degree of

Doctor of Business Administration

Marketing

By

Lydia Ross

August 2015

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ENGINEERING AND MATHEMATICS (STEM)**

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## ABSTRACT

Fields that interest students as well as will bring them a high financial benefit in the job market are within STEM education. However, women, especially African American women, continue to experience high unemployment with limited economic opportunity as compared to men and women of other nationalities in the United States. The aim of the study was to encourage African American women to pursue STEM education to the PhD level and then obtain a leadership role in the STEM field? African American woman's influence on future endeavors especially around scientific inventions and technological advances is extremely small. This means, as Americans, we will be lacking in the great wealth an African American woman's perspective brings to technological advances and future inventions for better living (Prince, 2013). The study may allow a platform constructed of successful attributes an African American women needs to successfully operate through the various different experiences faced as minority women underrepresented in STEM. The conceptual framework of this study follows the mega-community model. The methodology used in this phenomenological study is the interview approach. African American women experts in the STEM disciplines were interviewed using a 17 interview questions. The interviews answered the three research questions:

1. What are the barriers for African American women competing to earn a Master's or STEM degree?
2. "What workforce barriers prevent qualified African American women in STEM from being assigned a decision making role?"
3. "What are the lived experiences of AA women working in a STEM industry?"

## ACKNOWLEDGEMENTS

*But those who wait on the Lord Shall renew their strength; They shall mount up with wings like eagles, They shall run and not be weary, They shall walk and not faint.*

*Isaiah 40:31*

I'd like to thank Dr. Kim Ards for her advice, support and encouragement and interest in me and this process. You are a blessing. I'd like to thank Dr. Tim Malone for his advice and his pushing to make me increase my thinking and keep my voice. I'd like to thank my beautiful son Isaiah and his father T.J. for saying words that were always right on time. Just the words I needed for the moment. To my Annie Smith, thank you. I like to thank my sister girls, Vicki, Michelle, ZaZa and Carrie, my Sistah girls from childhood. I'd like to thank President Obama for making STEM a priority for this nation. I'd like to thank George Curry for being an on time big brother. Thanks, George you made me feel really special. I'd like to thank all the beautiful African American women I interviewed. You took me from one glory to the next. You made me remember myself. You are beautiful precious Gems. Thank you for letting us have our say so beautifully.

## **Dedication**

I'd like to thank my dear mother, the late Gertrude S. Ross. Mommie, you said I was your educated child. You taught me to fly. I'm flying! I love you. I'd like to thank my father, Reverend Dr. Ralph M. Ross who continues to depict Mommie's motto and 'keeps moving ahead'. Continue to 'Advance forward and move up in Christ Jesus'! I love you.

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## CHAPTER ONE: INTRODUCTION

The African American family structure has been failing for many years. Problems with the structure include births from unmarried parents, absentee fathers and a lack of a family support network. The breakdown of the African American family has been occurring since the 1960s (Discover the Network, 2012). Due to this breakdown, negative images of African Americans have emerged that has increased a schism in their societal and political life on based on race (Discover the Network, 2012). Wright (2009) ascertained racial classifications were generally linked to economic and social inequities. Racial inequalities were related to domination and exclusion of the party being oppressed (Wright, 2009). According to the Helicon Publishing (2008), more often than not African Americans who live in large cities are part of the low economic area known as the ghetto. Generally the population of African Americans in these cities proportionately with their percentage of the population have fewer jobs, receive less pay than their White counterparts and still face public intolerance. Because of these situations many young African Americans are pushed to a life of crime including drug crimes. While there is a professional highly educated and wealthy class of African American people, there is an underdeveloped population in this nation in the inner city that are underinspired and seemingly have a permanent sense of despair (Helicon Publishing, 2008). These areas contain high crime, social dysfunction, unemployment or under employment and high levels of drug abuse. African American in these areas who suffer these issues also are targets for racism, racial profiling, racial prejudices which affect every part of life including the school systems of children in the inner city. Education is a way to overcome the devastating effects of low economic empowerment and devastated communities. While there has been a focus to overcome these issues in African American boys and men, many times the same attention is not

given to African American girls and women. This project's thrust, therefore, was to determine how to redirect the lives of African American young women and encourage them to be engaged in Science, Technology, Engineering and Math (STEM) fields. The aim was to have these women yield good salaries, be highly productive members of the society, and change devastated communities to productive viable capable energetic high producing communities.

### **Problem Background**

An initiative that the federal government is operating is to encourage more young people to pursue STEM education and STEM careers. According to the Scholarship for Moms website (2014), the white house held a science fair in 2013 that highlighted the need for skilled professionals in STEM education and STEM careers. Technology is advancing at rapid rates and going forward, the need for every generation to be prepared in STEM careers is imperative. The Scholarship for Moms website (2014) reported President Obama participated in the fair and announced his campaign "Educate to Innovate," that emphasizes STEM. President Obama commented:

We've got to do everything we can to make sure that we are giving these young people opportunity to pursue their studies and discover new ways of doing things. And we've got to make sure that we're also leaving behind a world that is safer and cleaner and healthier than the one we found. (Scholarship for Moms, 2014, para. 3)

Looking at the number of people pursuing fields in engineering, the numbers show an increase in the enrolled and graduated engineers. The numbers reveal there were more students earning bachelor degrees in engineering in 2009 being approximately 85,000 versus the 70,000 earned in 1980 (Scholarship for Moms, 2014). Yet with the increase in technological advances throughout the world, these numbers are not keeping pace with the job demand (Scholarships for Moms, 2014).

The high cost of education and the uncertain job market requires people to consider the

financial benefit of pursuing a particular degree (Scholarships for Moms, 2014). Still, fields that interest students as well as will bring them a high financial benefit in the job market are fields of interest. These fields generally are within the STEM education. Technical fields such as computer science give college graduates the best opportunities and yield higher starting salaries (Scholarships for Moms, 2014). The two fields that bring in the highest salaries according to the Pay Scale Human Capital (2014) are petroleum engineering and computer science. Petroleum engineers (Scholarships for Moms, 2014) can expect to start at \$98,000 while computer science majors start at \$58,000. The computer science fields (Scholarships for Moms, 2014) in particular are graduating more students with an increase from 2001-2012 of 22.8%. These fields are also showing an increase in graduating women students. While in the past there was a big gender gap of women in technical fields, today the gap is decreasing (Scholarships for Moms, 2014). Hence, women, especially African American women, continue to experience high unemployment with limited economic opportunity as compared to men and women of other nationalities in the United States (United States Department of Labor, 2012).

Some of the barriers African American women encounter in the workplace include a questioning of their credibility and authority, race based stereotypes, and a lack of institutional support (The Lawyers' Committee for Civil Rights under Law, 2011). African American women in the workplace are many times excluded from informal networks and involved in conflicted relationships with white women that affect working relationships and job performance (The Lawyers' Committee for Civil Rights under Law, 2011). In many cases, diversity programs are ineffective and promotion opportunities are decreasing with the larger Latina and Asian population in the workplace increasing (The Lawyers' Committee for Civil Rights under Law, 2011). Additionally, many African American women do not have a

workplace support system that can encourage and advise them in career goals and aspirations as well as daily support on an ongoing basis in the workplace. In terms of wage disparity, African American women continue to face discrimination as well as job insecurity (The Lawyers' Committee for Civil Rights under Law, 2011). For example, the Lawyers' Committee for Civil Rights under Law (2011) reported African American women earn \$15.50 in public sector jobs compared to their White male counterparts who make \$21.24. The committee further stated (2011) overall women earn 77 cents to every dollar men earn and African American women only 61 cents and Latina women only 52 cents. Over the lifetime of a woman, this could total to up to \$431,000. These issues weaken the longevity of careers of African American women in the workforce and in some cases lead to broken women who live their latter lives in poverty (The Lawyers' Committee for Civil Rights under Law, 2011).

Racial segregation and discrimination was part of the government and governance of the United States of America in its beginning stages. It is, therefore, very difficult to address these issues in the workplace. Thus, African American women experiencing this dynamic work environment need tips on being successful while maintaining dignity. African American women wisdom for success in this present and future day workforce include:

- Exceeding performance expectations.
- Communicating effectively.
- Connecting with mentors.
- Building positive relationships with managers and colleagues.
- Using their cultural backgrounds to enhance job performance. (Catalyst, 2004, para. 4)

In order to be successful it is important to understand the skills and talents needed and acquire them. According to the lawyers' committee for civil rights under law (2011), gender

based issues of unequal pay, sexual harassment; the old boy network and the economic instability of women in the workplace continue to be unsolved issues in the United States. These issues keep the nation from achieving its maximum productivity and maximum bottom line (Australian Government, 2013). Gender equality allows men and women in the workplace to achieve equal outcomes (Australian Government, 2013). According to the Australian Government (2013) in order to achieve equality, some fundamental essentials must be accomplished including:

- Equal pay for the same work or work of comparable value.
- The removal of barriers that work against women's participation in the workforce.
- Full access for both men and women to all occupations and industries.
- Also leadership equality for both men and women.
- The removal of discriminatory practices of gender in relation to family care responsibilities for both men and women. (Australian Government, 2013)

In order to successfully accomplish these goals we must achieve gender equality and racial equality. The United Nations Population Fund (UNFPA) state that gender equality suggests a society where men and women share the same distribution of power, influence, financial independence, education opportunities, and are equally able to pursue their personal ambitions (UNFPA, 2008). Racial equality suggests the same attributes operating for people regardless of their race. Unfortunately, in these attributes the United States has achieved gender equality or racial equality. Still, in careers that require STEM education, a person is evaluated more on what they know than on their gender or race (Ely, 2011, p. 13,). Ensuring work place parity between men and women and the races including comparable benefits will ensure equality in the workforce and a prosperous nation. This equality must be legislated as the law for the nation and implemented within each state.

For African American women equality in the workplace is not only gender related but

also race related. In these instances, the United States has neither achieved a post gender society or a post racial society. Yet, in careers that require STEM education, a person tends to be evaluated more on what they know than on their gender or race. The research of this paper was to encourage African American Women to pursue STEM education and careers. The result of having African American women in STEM education and careers is a more complete usage of the nation's diverse human resource. At the present African Americans are not equally represented in STEM as other members of the society. The Committee on Equal Opportunities in Science and Engineering (CEOSE) to discuss women of color in STEM confirmed the underrepresentation of African American women in academia for students and faculty (Towns, 2010).

### **Purpose of the Study**

African American women are behind along with other women of color in the STEM disciplines of science, technology, engineering, and mathematics. In 2008 President Obama presented his goal of making the United States of America a STEM leader. According to Prince (2013), President Obama was quoted as saying, "That's why I am committed to making the improvement of STEM education over the next decade a national priority" (para,3). Unfortunately, women of color are still very under-represented in the STEM fields. In statistics (Prince, 2013) collected on the STEM professors only 2.1% were minority women in STEM disciplines. Defining these statistics with more clarity, only 6,400 (Prince, 2013) women of color with doctorate degrees in STEM fields hold assistant, associate, or full professorships. From this information we recognize the extremely small presence of African American woman's influence on future endeavors especially about scientific inventions and technological advances. Even more disturbing, minority women



had the least influence in computer science and mathematics (Prince, 2013). This means, as Americans, we will be lacking in the great wealth African American woman's perspective brings to technological advances and future inventions for better living (Prince, 2013). The society will not be as dynamic and robust as it could and should be unless we increase the number of minority women in STEM education and careers, especially African American women (Prince, 2013).

The United States must implement plans to increase the number of women of color especially African American women in STEM career as well as speed up time for this increase to be noticed. Recommendations have been given to professors, professional societies, the corporate sector, women organizations, and governmental agencies (Prince, 2013). These recommendations include providing funding targeted to African American women. The recommendations are concerned with redeveloping hiring and promotion policies, employing diverse search groups in the hiring process, mentoring and having a scorecard of successful African American women in STEM. "Since STEM fields will be growing, and to increase the number of highly-skilled STEM workers and strengthen the economic security of US families, the nation must engage the entire STEM talent pool" (Prince, 2013, para. 12). Ensuring all groups of the population are engaged in the workforce adds dimensions of creativity and innovation to the nation's advancement into the future.

The United States must include everyone in the talent pool. Accomplishing the inclusion of all people in the talent pool and specifically in STEM is through respect, diversity, and equity. This must become a way of living and not a management of programs. The country has had more than 40 years of civil rights activism and feminism. This nation understands these problems and the consequences of not overcoming the issues leaves a nation underproductive

and hinders innovation and creativity and completely misses inventions that could be world changing. According to Scriven (2013), the most recent information from the National Science Foundation shows African American women and girls as 6% of the population of the United States. While the numbers have been increasing pertaining to college undergraduate degrees obtained for African American women in STEM disciplines, at the doctoral level the number is only 1% (2 of doctorate degrees obtained are in STEM fields; Scriven, 2013). Even though we see increasing numbers of African Americans in STEM fields at the undergraduate and Master level, mathematic degrees are still 800% (Scriven, 2013) less than White females. But there are less than 1% Science and Engineering professionals in the workforce for management and non-management positions (Scriven, 2013). Mathematical degrees assist in high-level research and development. People in mathematics have supportive professional networks that have opened doors into Silicon Valley and other high technical sectors (Scriven, 2013). It is important to increase the numbers of African American women in mathematics degrees. This will increase the number of African American women in research and development, in leadership roles in Silicon Valley and other sectors throughout the STEM fields. Regardless of the numbers, African American women have been hindered from entering STEM in former times due to their limited educational opportunities (Scriven, 2013). Education is therefore paramount for African American women to advance in the global market.

The National Action Council for Minorities in Engineering, Inc. studied the issue of minorities in engineering fields in the United States. The results of the study (McPhail, 2011) found that while African Americans, American Indians, and Latinos represent 34% of the population of the 18 to 24 age group, they only earn 12% of the degrees in engineering. Further, women make up 47% of the labor force of the United States (US Department of Labor, 2011)

but only 10.8% are engineers (McPhail, 2011). If the United States is to remain competitive in the global marketplace, it must educate its entire diverse community to reflect the nation's demographic (McPhail, 2011). Diversity propels innovation and increases dynamic creativity (McPhail, 2011). The United States must tap its hidden talent pool and utilize its resources to incorporate all of America into the labor force. Initiatives taken by the government and the private sector to access the hidden talent are to form public-private partnerships (PPPs). The PPP operate throughout the nation training teachers in STEM education (McPhail, 2011). The purpose of these programs are to increase the number of students studying STEM from grade school to graduate school. The corporations in these partnerships provide computers, funding, internships, and mentors to foster a workforce that encompasses the demographic of the nation while maintaining our global competitive edge (McPhail, 2011).

Another initiative to accomplish a diverse workforce is to ensure all parties are equally trained and educated. For African American women this task is not fulfilled. Typically, for African Americans, education and training is extremely necessary to overcome the gap in their skill set and the skill set of and their counter parts. Education has always been an important element in the advancement of African Americans and in STEM education. Nonetheless, for all STEM educated women, positions in decision making leadership roles in industry is still very slim. According to Scriven (2013) research, the appearance of African American women in decision making roles in management is virtually non-existence in regions of high technology like the Silicon Valley (Scriven, 2013). This issue directed the problem under study. The first issue was what support do African American women need to enter STEM disciplines. Once they enter these fields through education, what did African American women need to ensure

their studies are completed and the degree is obtained? Finally, how did an African American woman get encouraged to continue their education to the PhD level and then obtain a leadership role in the STEM field?

### **Research Questions**

#### **Research Questions**

1. What type of support did African American women need to pursue STEM degrees, complete the degree and enroll in graduate STEM programs?
2. What are the barriers to obtaining this support?
3. What assistance was needed for African American women who are enrolled in Master or higher STEM degree programs?
4. What are the barriers to completing the degree?
5. How did career training prepare African American women become part of the STEM leadership decision makers in technological regions and corporation like Silicon Valley?
6. What workforce barriers were overcome that prevented qualified African American women in STEM from decision making roles?

#### **Limitations of the Study**

While this study determined the support needed to assist African American women in participating globally in STEM innovation and its leadership in the present and future, it will not be able to study the outcome of the effect of the support. A future study could use the research from this project to determine the effect the support achieved in increasing the number of African American women in STEM careers. Also, how did the support increase the number of African American women in leadership roles in STEM in the work-force? The workforce has

become more diverse in the 21<sup>st</sup> century, but the research does not show an increase in African American women in STEM compared to Caucasian women and other ethnicities. Mentoring programs used to acclimate African American women to the company's organizational climate are needed to ensure the success of these women.

Other limitations of the study were obtaining a vehicle to access African American women who need the services, inform them of the services, acquire the services and then follow them through their education to their careers. In areas where the services were needed the most, other services would have to be in place first. These services include housing, transportation, childcare, personal care, family or elder care as well as a steady stream of living income. These types of elements are part of the support requirements given to the women. An additional issue to study is counseling services to encourage African American girls and women to go into STEM. Future studies informed African American women about STEM career choices and provided them information on successful African American women in STEM. Work plans developed that ensure African American make their contributions to STEM and its innovations. Other studies conducted to accomplish these goals.

### **Delimitations of the Study**

Originally, the researcher was going to give surveys to 200 African American women. The women were going to be women in college in STEM and women from a predominately African American community that is economically disadvantaged. After more research and consideration, a Phenomenological research design was used interviewing nine African American women who have been successful in STEM fields and who hold PhDs in STEM fields. The term successful means the nine women hold a leadership position in STEM or are part of academia. The women have been successful in maintaining their career in a STEM

discipline. The women worked and lived in the United States or their home base employment is the United States. The women work in the STEM field, have obtained a degree in a STEM discipline and have successfully obtained a PhD in a STEM field or one that compliments their STEM degree. For example a women could have a Master of Science in Engineering and a Doctorate degree in Business.

A phenomenological research design investigates the experiences lived by individuals or groups to reveal a profound understanding of the experiences according to the individual or group. Subtle and blatant issues were revealed that hinder or prevent African American women from holding leadership positions in STEM areas as well as how the experiences affect their economy. The aim of the study was to interview successful African American women and discover how to overcome unjust salary treatments, promotion treatments as well as overcoming these issues while still gaining success and living a productive abundant life. Generally, African American women as well as minority women are under-represented in the workforce and even more in STEM fields (Dissertation Recipes, 2012).

When speaking of minority women and their underrepresentation in the workforce is expressing populations that have lower representation than the population, as a whole. The 2000 U.S. Census Bureau (2011 statistics revealed African American women were 6% of the population, Native American women at 1%, Asian American women at 2% and Hispanic American women at 6% (Townes, 2010). Hence the term underrepresented women in STEM academia or STEM careers is speaking of the previously mentioned minority women. (Townes, 2010).

The phenomenological study conducted interviews with a theme pertaining to the experience of nine PhD African American women in STEM academia or STEM careers. The

interviews gained information on their educational experiences as well as their experience in the workforce. The researcher looked for the type of support the women needed or had and what type of hindrances they experienced. Information on overcoming road blocks and making good decisions was acquired. Strategies for successfully negotiating the workplace was determined through the interpretation of the interviews and finding themes in the data. Strategies for developing and implementing long term goals was extracted from themes found in the data. Strategies for safeguarding themselves as well as their families was interpreted of the data. The study was limited to the experiences of nine African American women who hold PhD degrees in STEM. Interview questions were limited to the experiences of the women as they pertains to their STEM involvement through education or the workforce. Data was recorded and fell into the broad categories of strategies for success, decision making strategies and overcoming adversity. Further categories included support elements needed to accomplish the education and the position they perform. Since the population of participants is so small, it would be difficult to make generalizations due to the small sample size. The interviews were conducted on the telephone for women in other states. Interviewees were acquired from the advice of African Americans who are involved in STEM (Frillman, 2011).

### **Definition of Terms**

African American Women – Black women who identify themselves as African American.

Disparities-inequality or differences in wage compensation

Minority– A group having small representation in relation to other groups in a society.

Phenomenological Research – research conducted to understand live experiences and human nature through the eyes of the participant (Simon, 2011).

Underrepresented - populations that have lower representation than the population, as a whole.

### **Significance of the Study**

The importance of this study was through the lived experiences studied of the of nine African American women to gain insight on appropriate behavior, skills and techniques needed for African American women to acquire success in STEM careers and academia will be gained. This information was important for up and coming African American girls and women in STEM education and careers goals in their navigation of their career goals. In addition, program designs should be developed using this information to mentor, train and inform African American girls and women. The study allowed a foundation to be constructed of successful attributes an African American women needs to successfully operate through the various different experiences they will probably be faced with as minority women underrepresented in STEM. A good example of this situation spoke of an African American women in an Industrial Engineering classroom in a predominately African American University (Student Advisor, 2014).

The issue was that an adjunct professor of an Asian nationality only faced other internationals when teaching the class. He repeatedly turned his back to the African American women in the class. Due to the high level of analysis that needed to be learned, students needed to understand and engage with the professor to ensure understanding of the information. When the African American women asked the professor questions, the students were not given an answer or the answer was abrupt. For a student struggling with the class this behavior could cause them to give up or not continue. In this case, the student brought the situation to the officials. Since this was a predominately African American University, a committee developed of secretaries, upper classmen and professors who became mentors to assist women giving them advice on how to accomplish the rubric of the courses. The professor in the situation did not teach the course in the following semester. (Student Advisor, 2014)



## CHAPTER TWO: REVIEW OF THE LITERATURE

The STEM stakeholders are very concerned with increasing diversity in the STEM pipeline for the current workforce and for the future. One major stakeholder, the United States government at the federal and state levels, worked to increase diversity programs in higher education and the workforce. For African American women, these initiatives assist in having opportunities in academia and in the workforce. This literature review discussed the current contributions of African American women in STEM fields in academia and the workforce. The review revealed the attributes of African American women in STEM. It also described the difficulties African American Women experienced obtaining STEM education up to the PhD level and difficulties in their careers. The literature explained some of the current activities occurring in STEM education for African American women and girls in the United States. Additionally, the literature discussed recommendations and future goals that this nation might consider moving towards in order to achieve a balance diverse workforce. Finally, the literature defended the need for the study.

The purpose of this study depicted the current situation of African American women in the STEM workforce and academia environment. It described African American women's leadership-decision making roles in STEM and their underrepresentation in STEM. The study discussed models and programs to increase African American women in STEM. According to Flowers (2012), there are inequalities pertaining to minorities in general and African American women specifically existing in hiring practices, salary, and support in academia tenure and promotion realities. This review discussed the inequalities and investigated the causes of the

disparities. This review discussed the gap in information pertaining to PhD level STEM African American women (Flowers, 2012). The conceptual framework of the project provided direction for the study and became an outcome of the study (Green, 2014).

The framework of this study followed the mega-community model. The mega-community model holds collaborations with three different entities namely non-profit groups, government agencies and businesses (Allen, 2014). The mega-community model answered hard complex issues that one entity cannot solve on its own. This model resolved complex issues such as rebuilding urban infrastructure, confronting global climate change, managing the aging population and preventing terrorist attacks (Kelly, C., 2009). These types of problems cannot be solved by government alone. In order to effectively solve large scale issues, the government, the private sector and the non-profit or civil society must work together (Kelly, C., 2009). This type of collaboration is termed a mega-community. In a mega-community model leaders of many organizations work together toward a common goal without any one entity being in control of the whole system (Kelly, C., 2009). The operation of the mega-community initiatives contain focused conversations, plans of action and implementation strategies (Kelly, C., 2009). Unlike private sector initiatives, the mega-community takes on larger roles and is ongoing and mutual over time (Kelly, C., 2009). The mega-community model engaged members of various organizations that use their resources to solve the issues (Kelly, C., 2009).

Three other elements that must be included in mega-community collaborations are convergence, structure, and adaptability (Kelly, C., 2009). The convergence element pertained to the mega-community's member having a commitment for mutual action

(Kelly, C., 2009). The congruence means that instead of the leaders fighting for control of the group, the leaders come together and develop the plan of action (Kelly, C., 2009). The next important component was the structure. In order for the mega-community to operate efficiently, there must be a formal stage of developing the structure (Kelly, C. 2009). Protocols were set with organizing principles governing the order of the team (Kelly, C., 2009). In terms of adaptability, the mega-community allowed new members and new innovative ideas to accomplish the goals of the collaboration (Kelly, C. 2009). Over time, the mega-community became better, speaks the same language, and developed a bond making it one unit versus three separate entities (Kelly, C. 2009). For this study, the mega-community model used techniques to overcome the underrepresentation of African American women in STEM leadership.

In this study, the government's resources were used to solve the following issues:

- Provide federal funding grants and loans for higher education
- Provide grant funding to non-profits organizations to conduct STEM programs
- K-12 STEM education in school
- Commissioner Community Development opportunities for non-profit STEM

In the non-profit realm, the collaboration needed the following sources and opportunities:

- Colleges and Universities with STEM programs to the Doctorate Level
- Tenure opportunities for African American women in STEM
- Afterschool K-12 programs in STEM
- Churches offering STEM programs for youth and the community
- Community Development offering STEM programs for families

The private sector realm needed to provide the following items to the collaboration:

- Hiring policies for African American Women
- College recruitment from HBCUs
- Executive fast track programs for African American women

To overcome the underrepresentation of African American women in STEM in academia and the private sector, a mega-community collaboration operated to solve the complicated issue (Allen, 2014). The conceptual framework for the project depicted the mega-community model in figure 1..

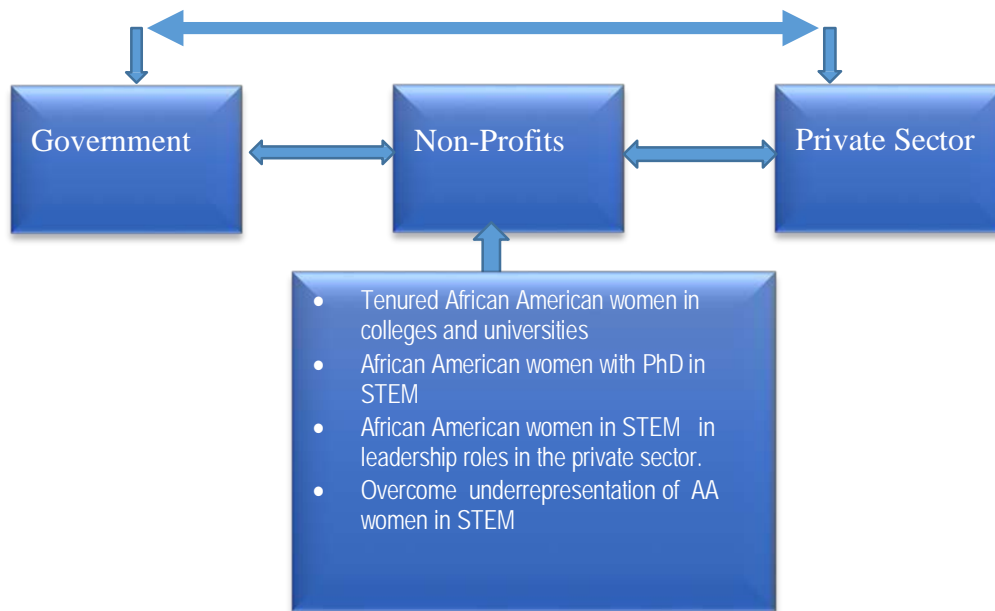


Figure 1. Mega-Community Model of This Study

### **African American STEM Current Activities**

#### **Contributions**

African Americans made several important contributions to the STEM fields in

the past and more recently (Pinckney, 2012). According to Pinckney (2012), some African Americans highlights for contributions in STEM included Dr. William E. Massey a pioneering mathematician and physician. Pinckney (2012) named several other notable contributors to the STEM disciplines. These contributors included Lewis Latimer, writer of the Central Office electric power systems manual, Elijah McCoy, a mechanical engineer, and Freeman A. Harbowski, a college president and role model for tomorrow's youth. Pinckney noted several other African American contributors to STEM. Derrick Pitts and Frederic Bertley worked with youth in science and the study of planets (Pinckney, 2012). Dr. Charles F. Bolden Jr. was the 12<sup>th</sup> administrator of NASA (Pinckney, 2012). Dr. Guion S. Bluford Jr. was an astronaut who orbited the earth (Pinckney, 2012). Dr. Mae Jemison an African American flew into space (Pinckney, 2012). General Motor credits Edward T. Weiburn Jr., a vice president for some of its global design (Pinckney, 2012). Finally, Pinckney (2012) spoke of the contributions in medicine by African Americans. These contributors (2012) included Dr. Gregory C. Bolton leader in robotic surgical options, Dr. Yvonne S. Thornton board certified in high-risk obstetrics and Dr. Benjamin Carson for separating Siamese twins joined at the head. Pinckney (2012) honored Dr. Keith Black for his contributions as a neurosurgeon, professor and scientist.

Other contributions made by African Americans specifically women according to Brown (2014) pertained to preparing girls for STEM during the ages of 7 to 17. One organization, 'Black Girls Code' worked with girls. According to Brown (2014), Black girls taught girls to become innovators by building Web pages and mobile apps. The program proposed to build self-confidence in the girls in order to compete in a diverse

environment (Brown, 2014). Brown (2014) also discussed other programs developing STEM skills in African American girls, boys and other underserved groups as:

- Eunique Jones Gibson, a cultural architect, media specialist and artist, used her talents and skills to encourage youth to know historical figures by the use of photos, video and technology.
- Danielle N. Lee, an animal behavior biologist used his talents to provide youth with outdoor programs and social media.
- Kalimah Priforce, the co-founder of Qeyno Labs mission was to transform children's lives through social media (Qeyno Labs, 2014). This program worked to increase STEM diversity in K-12.
- Kimberly A. Scott, the Executive Director of Com-pu Girls, used technology to advance adolescent girls in the Arizona district.
- 2014 White House Champions of Change director Kevin Clark of the Digital Media Innovation and Diversity at George Mason University worked with specialist to create digital media products and resources to embrace diverse audiences.
- Christopher Emdin, the Director of Science Education for Columbia University's Center for Health Equity promoted competitions for students who fuse science with the hip hop culture.
- Andrea Hence Evans owner of Kidgineer was a STEM enrichment program whose purpose is to assist children to retain their interest in math and science.
- C-STEM Teacher and Student Support Services credited its founder Reagan Flowers for its success. This program was the nation's first pre-k-12 STEM

platform that affected more than 100,000 participants (Brown, 2014). African American Historically Black Colleges and Universities (HBCU) played a major role in contributing to the STEM fields in inventions as well as increasing the number of African Americans in STEM areas (Brown, 2014).

### **HBCU Contributions**

According to Frillman (2011), historically Black Colleges and Universities (HBCU) were able to gain academic success in STEM fields in a nurturing environment. HBCUs assisted minority students in developing self-esteem and confidence. Minority's students with confidence and self-esteem competed in the global marketplace. One study suggested students who participate in Pre-Freshman Academic Program aimed at improving the academic success of students at the University of Maryland had higher retention rates in STEM degrees than those who do not (Perna, 2009). Nevertheless, preparation for STEM disciplines should begin in K-12 (Kendricks, 2011). According to Kendricks (2011), studies showed that in order for African American women to excel in STEM fields, they must have a steady pre-college background that gave them a strong math and science acumen. Many African American students did not have adequate preparation for STEM disciplines (Kendricks, 2011). It is, therefore, imperative that schools, parents and the community provided the means to increase each child's science and math intellect through after-school programs, tutoring programs and homework assistance (Kendricks, 2011). Many HBCUs have assisted in these areas with science, technology and mathematics scholarships for their students in STEM programs that mimic some K-12 STEM programs. One University in particular that offers this type of program was Central State University a HBCU located in Durham, North Carolina. The

program instituted by Central was the Scholars Program (SP), which incorporates sixK-12 practices. These practices included:

- Supportive family environment built self-esteem and provide a student with a sense of belonging.
- Caring teachers was the strongest indicator of a student's success.
- High expectations, encouraged students to work harder and meet the goals of the program.
- Academic rigor, described a change in the learning environment not the curriculum.
- Dynamic classroom strategies, such as positive reinforcement; mentors and roles models; development of social skills; weekly or monthly meetings with advisors; small group sessions and enrichment activities increased academic achievement.
- Discipline, students performed better in arenas in which compliance to rules and policies was expected and mandatory (Kendricks, 2011).

In this program, Central State University was keeping with the theory that HBCUs provide a more nurturing and supportive environment. SPs enroll scholars in academic learning environments (Kendricks, 2011). Participants enrolled in two STEM courses at a time with other participants in the program (Kendricks, 2011). SP students took courses together (Kendricks, 2011). The SP classes caused natural study groups to form (Kendricks, 2011). The scholars lived together in the Honor dormitory that is a living learning environment (Kendricks, 2011). Each month, a required mentoring meeting conducted advising sessions that included announcements and a symbolic family gathering session (Kendricks, 2011). Qualified scholars having a GPA of 3.2 or above



were encouraged to become part of the Honor's program (Kendricks, 2011). Finally, the SP program required all participants to attend two professional development workshops and attend two graduate school visits per year (Kendricks, 2011). These program requirements followed K-12 STEM program formats (Kendricks, 2011). HBCUs were major contributors to the education of African American women in STEM (Frillman, 2011). The Integrated Postsecondary Education Data System (IPEDs) reported that HBCUs were responsible for 22% of all the bachelor's degrees earned for African American students in this nation and 30% of STEM degrees to Blacks (Perna, 2009). HBCUs were also responsible for graduating more African American women in STEM fields (33%) compared to African American men in STEM fields (26%) (Perna, 2009). Studies conducted by Wenglinsky determined that HBCUs were important sources of enrollment of African American men and women into graduate programs of science, engineering, or business (Perna, 2009). Additionally, HBCUs were 30 among the 50 top producers of African American women Doctorate programs in science and engineering between 1980 and 1990 (Perna, 2009). Another important factor for increasing the number of African American women in STEM fields was the single sex college format. Single sex colleges or universities had only male or only female students. Spelman College was one such college that produced African American women in STEM graduates (Perna, 2009).

Spelman College, an African American female college, had a successful 2006-year graduating the highest number of bachelor's degrees to African American women in mathematics, ranked third in physical science and ranked fourth in biological sciences (Perna, 2009). Spelman College was very interested in promoting STEM education to its

students and promoted programs and career relations that increase African American women in STEM (Perna, 2009). Perna (2009) stated students attend Spelman College for several reasons including:

- The institution was well known for graduating African American women who become successful in STEM fields.
- African American women have high aspirations towards STEM disciplines educationally and occupationally, which the college encourages and supports.
- Student and faculty were aware of the academic, psychological and financial barriers that hinder African American women in STEM and strategized how to overcome them together (Perna, 2009).
- Institutional characteristics of Spelman to overcome barriers were structural characteristics, a cooperative peer culture, and faculty mentoring of students, academic support and finally undergraduate opportunities for research.

Another important role Spelman played for academic success of African American women in STEM was that one third of its graduates go to Medical school and another one third go on to pursue PhD degrees (Perna, 2009). Finally, many of Spelman's graduates pursued master and doctorate degrees in dentistry and other STEM related fields (Perna, 2009). Spelman College worked with African American women in STEM to ensure that African American women were decision makers and leaders, in the now and up and coming global market. The college was also very aware of the underrepresentation of African American women in STEM education and the STEM workforce.

Research showed that typical responses to the argument of African American

women underrepresentation in the STEM workforce included the Conefrey cultural myth about science (Conefrey, 2001; Frillman 2011). Frillman (2011) said the Conefrey cultural myth concerning science stated that science was gender free and value free. Science taught knowledge regardless of cultural diversity (Frillman, 2011). It also stated that women need no special accommodation and challenge and competition are part of the weeding out process for those who do not have the acumen for science or engineering (Frillman, 2011). Frillman (2011) implied many in the workforce adhere to this myth and develop policies that use the assumptions of this myth.

### **Community Contributions**

The mega-community model of cooperation was being used by educators and community stakeholders to address the racial disparities in science and engineering careers in the United States (Allen, 2014). The model approached solving real world problems using collaboration between non-profits, government and the business sector. According to Lex Town Publications (2014), the mega-community was an effective approach to engage talent for a long-term solution. These long-term solutions functioned for many years (Lex Town Publications, 2014). Businesses anticipated the operation of the mega-community approach for the next 20 years in STEM career and STEM workforce solutions (Lex Town Publications, 2014). Currently the rate of job growth for jobs dependent on STEM employees was 17% (Allen, 2014). While 17% of the current job market over the age of 25 was African American and STEM educated, the actual employment of these African American workers was only 4% in STEM fields (Allen, 2014).

One effort to overcome the dilemma of underrepresented African American

STEM educated workers by the government was to utilize them in the Obamacare initiative. Reginald Van Lee of Booz Allen Hamilton addressed health care providers at a symposium conducted at Howard University (Allen, 2014). According to one of the participants of the symposium, Herbert C. Buchanan, CEO of Howard University Hospital (Allen, 2014) stated the mega community would allow a community to know and understand their needs and identify members in the community that can fill those needs. With the need for future doctors, nurses, and engineers, making educational investments taps the resources domestically was a good long-term investment solution and a win for the public, the private and non-profit groups. STEM had effects on the health, the environment, the protection of the country, technological advances and global warming (Allen, 2014). STEM careers included the healthcare field with doctors, nurses, technicians and dentist. It affected the environment through scientific research on global warming, water, the atmosphere, and the o-zone layer. The military used scientific knowledge to protect the homeland, the airways, and other countries with tracking instrumentation and aeronautics. STEM careers were part of the technology innovations and maintenance. It was easier to train and educate resources locally to ensure that all the STEM needs of the community were met (Allen, 2014). The local community had experience of the community. The African American community had gaps with preparing qualified STEM students to be qualified STEM professionals (Allen, 2014). In order to develop the African American community, youth needed to be educated in STEM before college.

Youth must enter STEM education prior to going to college (DiLisi, 2011). Community programs were a source of STEM education for children K-12. These

programs developed self-efficacy in children and provide them with early exposure to STEM based careers. Programs aimed at preparing youth for STEM were the Association of Science and Technology Center's "Today's Youth Tomorrow's Teachers", Sci-Tech Hands-On Museum, St. Louis Science and Industry's "Yes" team and Museum of Science and Industry's teen (DiLisi, 2011). These programs provided students with an informal education of STEM while allowing them to practice teaching the STEM education material. Programs that provided informal education to STEM increase children's awareness of career opportunities and influence their decision to pursue STEM degrees in college (DiLisi, 2011). A non-profit organization that encouraged African American girls to pursue tech careers is the Black Girls CODE organization.

The goal of an organization for increasing African American women in STEM was to overcome the underrepresentation of African American women in STEM careers and in academia (Jones, 2014). To overcome this problem, the Black girls CODE organization held workshops to introduce girls from 7 to 17 to basic computer programming (Jones, 2014). The program's purpose was to teach African American girls to be competitive in the workforce and to have the skills that were in demand now and over the next several decades (Jones, 2014). Since technology and programming careers such as 'c++' were growing the fastest through the global marketplace, it is imperative that African American girls prepare themselves to take part in STEM computer career choices. In addition, African American women were one of the least represented groups with only 3% in the STEM workforce (Jones, 2014). The Black Girls Code event had three programs including: Build a Mobile App in a Day, Build a Game in a Day, and

Build a Website in a Day (Jones, 2014). The girls needed no prior programming experience to participate in the workshop. According to Vanessa Paugh, president of Goddess Software, the program allowed girls to be ready for more advanced programming like C++ or Java computer languages (Jones, 2014). African American girls needed to diversify the cyber world particularly programming for entertainment. Their input and ideas allowed for games that are fun, exciting, interesting and non-violent. The Black Girls CODE organization had presented this workshop in the Bay Area, Miami, Memphis, Detroit, Chicago, Atlanta, Pittsburgh and Las Vegas and now in Dallas (Jones, 2014).

### **Barriers African American Females Face**

African American girls and women operated in a state of uncertainty due to their race, their gender, and for older women their age (Hunt, 2014). African American girls living in the United States dealt with a society that still had biases against them even in 2014 (Hunt, 2014). Thus, conversations with caring African American women and men needed to occur with African American girls according to Monique Morris (Hunt, 2014), author and president of the National Black Women's Justice Institute. The purpose of the conversations about biases was to give girls an understanding of the societal structure they were living in and assisted them to develop the language and analysis on how to navigate these systems. While in some cases society oppressed African American girls, the girls' defense to this oppression were in some instances self-destructive to their own wellbeing. One program that was operating to address these issues and overcome them is Saving Our Lives, Hearing Our Truths (Hunt, 2014).

The Saving Our Lives, Hearing Our Truths program located in the Champaign-

Urbana metro area provided a safe space to speak and gave support and advice from eight African American women. The National CARES Mentoring Movement, which provided services to boys and girls, recognized the unique needs of African American girls.

Another program, the National Council of Negro Women (NCNW) Los Angeles View Park (Hunt, 2014), gave programming to girls of South Central L.A. Imperial Courts housing projects. In this program, girls who were from a disadvantaged community are exposed to colleges; careers to allow them to have an idea of things that interest them. According to Carolyn Martin, president of NCNW, lack of exposure resulted in the underrepresentation of African American women in industry and in career levels. This problem was particularly prevalent in STEM fields leaving the few in these fields without roles models and mentors in leadership positions (Hunt, 2014).

Barriers in the corporate environment for African American women increased with the lack of mentorship and role models according to Kimberly Bryant, founder of Girls Code (Hunt, 2014). Once a woman got a position in the corporate setting, it was hard to find someone to relate to on the cultural level (Byrd, 2006). According to the Diversity MBA Magazine (2009), Kenya, a participant in a survey of African American women in leadership roles stated,

To find a company of White employees, where I could sit and talk to any one of them on any given day and share a success or challenge and feel like they understand is pretty unfathomable. If I transitioned back to a White firm, I would probably question my skills and censor my words a whole lot more. I imagine being extra careful about what I say and how I say it and always being prepared to defend myself professionally. (In that kind of environment) it wouldn't take too much for me to begin looking for work elsewhere. (Diversity MBA Magazine, 2009, p. 1)

Many times African American women in STEM fields had made it to leadership roles spent their time and energy performing and overcoming issues that were specific to

their race and gender (Byrd, 2006). The lack of representation and discussions on the experiences of African American women in science was a consequence of racial practices that have silenced the voices of African American women in science (Byrd, 2006).

According to Collins, using the experiences of White women in the West instead of using a diverse group of women experiences in STEM settings only increased racial privilege structures instead of overcoming gender biases (Byrd, 2006). The statistics of White women did not present an accurate picture of the barriers African American women face specific to gender, race, societal, and historical experience (Byrd, 2006). The one-sided statistics prohibited gaining a true understanding of the issue pertaining to African American women in STEM (Byrd, 2006).

Barriers in STEM academia resulted in a continued underrepresentation of African American women faculty in the college and university setting (Flowers, 2012). While there were many programs to increase diversity in STEM at the state and federal level, there was still a shortage of African American women in a tenure-track position in academia (Flowers, 2012). According to research conducted by the National Science Foundation in 2008, the minority rate in the United States is growing rapidly (Flowers, 2012). But, underrepresentation of African Americans still exists in STEM disciplines in colleges and universities (Flowers, 2012). Broadening participation programs consisting of laboratory research experiences, teaching, and technology training sessions used to overcome the underrepresentation of African American women at the college and graduate levels (Flowers, 2012). The thrust of these programs were as minority student graduates, they became mentors to encourage those behind them to complete their degree in STEM (Flowers, 2012). These programs were very successful, but more work is



required to increase African American STEM faculty (Flowers, 2012). Reasons given for the underrepresentation of African American women in STEM academia include their individual characteristics, institutional characteristics, lack of mentoring, poor recruiting and outreach strategies, unsociable department environments, and deficiencies in scholarship production (Flowers, 2012).

The individual characteristics of African American Women in STEM provided benefits to students (King, 2013). According to Umbach (2006) a diverse faculty increased the variation of perspectives and approaches. These variations of approaches and perspective made the learning environment more robust (Umbach, 2006). In addition, for African American students, a diverse faculty created a comfortable and nurturing learning environment (King, 2013). Students of color looked to faculty of color who they believe understand their problems and concerns (King, 2013). Students of color were more inclined to look to faculty of color for mentoring and encouragement to succeed (King, 2013).

In terms of the college or university institutional characteristics, underrepresentation of African American women in STEM depicts a type of institution in which diversity was a challenge. Overcoming this stigma would require increasing faculty diversity. Increasing diversity in the faculty showed an organization that is committed to diversity (King, 2013). The image of the organization would be it supported diversity (King, 2013). An ethnically diverse faculty meant African Americans and other minorities had equal opportunities for career advancement along with everyone else (King, 2013).

Equity for African Americans means equal career opportunities exist. A diverse

faculty promotes academic success of students of color. A diverse faculty raises career aspirations of minority students. It also provides them with a diversity of role models. A diverse faculty brings a unique perspective to research and teaching due to the diverse experiences. (Perna, 2007, p. 196)

According to Harley (2008), African American women had been involved in higher education for over a century. Still, many African American women experienced stereotypes' in the workplace (Harley, 2008). African American women depicted as inferior to their White counterparts in many instances (Harley, 2008). Wounds caused by these portrayals are not publicized (Harley, 2008). Instead, African American women changed their behavior. Behaviors of these women sometimes manifested as arrogant and aggressive (Harley, 2008). These were shifting tactics used to overcome stereotypes (Jeffcoat, 2008). Shifting was a maneuver Africans Americans practice to ensure their survival in society (Anglin, 2006). Shifting involved modification of behaviors due to stereotypes or discrimination (Anglin, 2006). These stereotypes included characteristics such as promiscuity, lawlessness, stubbornness or unfeminine (Angling, 2006).

These women faced twofold minority designations. That was at some predominately- White institutions (PWI) African American women found themselves at risk for being not only female but also Black (Harley, 2008). The two-fold designations became a problem in the legal system (Jeffcoat, 2008). Apparently, African American women did not receive the same protection under the Title VII gender discrimination law (Jeffcoat, 2008). The laws provided for racial discrimination or gender discrimination, not both (Jeffcoat, 2008). African American women were unprotected due to their two-fold designation (Jeffcoat, 2008). Additionally, African Americans women struggled with under-representation in mainstream campus life at PWI (Harley, 2008). This caused a form of racial fatigue (Harley, 2008). The racial fatigue phenomenon made a person

over extend themselves, experience humiliation, and unappreciative behaviors from supervisors. The African American women with racial fatigue phenomenon were the Negro in residence responsible for representing diversity in another capacity (Harley, 2008). African American women in academia were misrepresented and isolated, underutilized, and demoralized (Harley, 2008).

President Obama addressed this issue with the national STEM initiative to employ all available resources and capital to overcome this crisis in academia and in all STEM careers and fields (Flowers, 2012). This was imperative in the United States because scientific innovations and an improved scientific workforce create the economic success of the country (Flowers, 2012). Diversity in STEM education increased the global competitiveness of the country (Flowers, 2012). Other items to address were salary disparities and promotion strategies for African American women in STEM academia. Salaries and promotion opportunities must be equalized (Flowers, 2012).

### **Future Recommendations**

There was a lot of information given through statistics, censure and studies on the subject of the underrepresentation of African American women in STEM (King, 2013). Hence, to address the complex national problem of underrepresentation of African American women in STEM required a tri-sector approach by the government, the private sector and non-profit civil organizations (Allen, 2014). In terms of the individual persons who have a STEM background and are in leadership roles companies had developed HR policies to increase diversity in the workplace. Providing STEM grants and scholarships to African American women to achieve bachelor, master, and doctorate degrees in STEM disciplines was a way to increase

African American women in STEM. An example of this was Dr. Ashanti Johnson who received the Presidential Award for Excellence in Science, Math, and engineering from President Obama (Talbert, 2011). In her position as executive director of the Institute of Broadening Participation Dr. Johnson has helped 159 underrepresented minorities receive a PhD in earth system sciences (Talbert, 2011). The US Army Core of Engineers sought to increase the diversity of education, technical expertise, personal experience, as well as gender and ethnicity (Bostick, 2014).

Diversity in gender ethnicity, background, and experience was vital to solving complex problems and achieving innovative solutions (Bostick, 2014). The Army worked to build a STEM pipeline through their recruitment efforts of diverse individuals. Once recruited the US Army Core of Engineers (USACE) nurtured its soldiers and civilians to gain professional credentials through training, certification and professional competence workshops (Bostick, 2014). Through the Army's mentoring programs, college students in HBCUs received incentives to join the Army either as soldiers or as civilians in STEM careers. In order to ensure students gained experiences necessary to be effective for the Army, students received internship training at districts and divisions of the Army Engineer, Research, and Development center (Bostick, 2014).

Communities used the mega community model and established collaboration within the community (Allen, 2014). These collaborations included the local, state, and federal government, the school system, the church, the private sector, and other community stakeholders (Allen, 2014). With the use of collaborations, programs developed community to teach, train, educate and develop the minds of the youth of

the community in STEM (Allen, 2014). For K-12 educators and schoolsystems, STEM education must be part of the curriculum for all students at every grade level (Kendricks, 2011) Afterschool programs needed to be developed specific toSTEM and designed to keep up the current STEM curriculum and activities (DiLisi, 2011). Higher education must use broadening participation programs (Downey, 2010). Colleges and universities nationally employed these strategies to assist African American women become equal members of STEM leadership and the STEM population (Downey, 2010). Higher education must graduate more African American women trained and educated by their universities and colleges (Downey, 2010). These institutions needed to encourage African American women to pursuegraduate and doctorate degrees and become part of the leadership of the STEM community (Downey, 2010).

Colleges and universities hired African American women for their faculty in STEM fields and provided tenure tract opportunities and promotion opportunities (Flowers, 2012). They also provided equal pay incentives and equalized benefits for African American women (Flowers, 2012). The government continued with its initiatives aimed at increasing African American women in STEM including scholarships, education opportunities, and incentives for hiring educated African American women (Washington, 2011). Innovation programs ensured competitiveness with the increase of African American women and minorities in the STEM workforce for the nation (McPhail, 2011). The private sector pursued all minorities to ensure its competitiveness but specifically African American women who were currently underrepresented (McPhail, 2011). Hiring practices, search committees, and

recruiters developed new programs to ensure African American women were hired into STEM (McPhail, 2011). These programs recognized that without the leadership and presence of African American women, they lost the creativity, innovation and knowledge of a whole market (McPhail, 2011). These programs aimed to move African American women from the underrepresented category to the represented category (McPhail, 2011).

## **Defense of Study**

### **Purpose of Study**

The study explored lived experiences of African American women who have earned PhD degrees in STEM fields of academia or the workforce. The exploration of the lived experience gained a better understanding of how to encourage more African American women to seek STEM education. The study interviewed nine African American women who have PhD degrees in STEM fields in academia or with the STEM workforce and better understand how to encourage more African American women to seek STEM educations. Participants were acquired through University and college networks. Participants requested African American women peers who also have STEM PhD degrees to be participants in the study. The research strategy used was expert sampling. Expert sampling was used because the sample was considered to have the highest skill level or knowledge (Soest, 2012). For this proposed study, all participants had the highest skill level with all holding a PhD. For this study, an expert was an African American woman with a PhD working in STEM academia or the industry. Colleges, universities, or those worked in STEM fields identified participants. Participant gave names of their peers who may want to participate in the proposed study.

Persons received a description of the study with a request to participate. Participates received a copy of the interview questions, and a copy of the summary of their interview.

Interview data gained a better understanding of how to increase African American women in STEM education and encouraged African American women to pursue graduate and PhD degrees in STEM. Lived experiences occurring in the sample group produced models as an education tract for students. The lived experiences were examples of what was occurring in colleges and universities. The findings of the proposed study generated strategies to increase the tenure tract of STEM African American women. The findings in the study gave an understanding of the issues causing an underrepresentation of African American women in STEM. The findings of this study may produce improved hiring practices and new diversity policies and procedures to increase African American professors in science, engineering, technology, and mathematics. The findings of the proposed study may increase African American women pursuing PhDs in STEM fields by better understanding the support they need. Information from findings initiated plans for STEM education and STEM careers even in the K-12 years of life. Untapped resources revealed African American girls and boys with the interest and acumen for STEM disciplines. African American girls pursuing STEM education and careers realized through better preparation in science and math in K-12 education and through engaging classroom environments. (Jackson, 2013). Finally, African American girls needed to have a full understanding of STEM career choices and pathways (Jackson, 2013).

### **Explanation of the Void in Literature**

One void in literature, as it pertains to African American women in STEM, was in

academia. The void that persists was the deficiency of tenure-track and tenured faculty. One way to overcome the lack of tenure track for African American women was to increase the number of African American professors. This benefited undergraduate and graduate African American women students by affording students with positive role models. Interviews measuring critical parameters of the productivity of faculty members were useful for the development of faculty training programs.



### CHAPTER THREE: METHODOLOGY

This proposed research study was a hermeneutic phenomenological (Frillman, 2011) study of the experiences of successful African American women who have earned doctorate degrees in a STEM discipline. The phenomenological approach looked for the essence and hidden meanings in the information obtained from the participant (Kafle, 2011). Further, a hermeneutic phenomenological focused on lived experiences of the participants in the sample and sought to understand their experience through the participant's voice and eyes (Frillman, 2011). For this study, the qualitative study used a hermeneutical phenomenological approach to code themes found in the participants' responses to in-depth interview questions. During multiple stages of data analysis, patterns or themes that emerged were coded using the data analysis tools of Microsoft Excel (Frillman, 2011; Kafle, 2011).

#### **Research Design**

The objective of using the hermeneutic phenomenological research approach in this study was to find meaning through the interpretive process. This type of qualitative study design (hermeneutic phenomenological) unveiled life experiences of the subject through their world experiences. The hermeneutic phenomenological research design aimed to produce rich textual descriptions of phenomena in the life of a specific group that could connect to all collectively (Kafle, 2011). Data generated from this hermeneutic phenomenological research design was collected by interview or assessments. For this study, the interview technique and surveys were used to collect data. The data analysis of a hermeneutic phenomenological design goes through a multi-level cycle. This cycle includes in order interpreting, reflective writing, and finally

reading (Wilcke, 2002). In this study, the loosely structured interviews of participants were used to construct robust textual descriptions of lived experiences of African American women in STEM providing a clear understanding of the path to success while overcoming adversity. The analysis of the path that led to success resulted in wisdom characteristics formulated from the experiences that can be used by African American women entering STEM careers (Frillman, 2011; Kafle, 2011).

Hermeneutic phenomenology research addresses ethical issues like any other research paradigm. Since hermeneutic phenomenology research is a qualitative research design, it follows qualitative research guidelines for ethical issues. These issues include “assigning aliases to the participants, clarifying the purpose and procedure performed beforehand, obtaining informed consent and not disclosing the identities of the participants and places of employment” (Kafle, 2011, p. 197). The trustworthiness of qualitative research includes four standards; credibility, transferability, dependability, and conformability (Kafle, 2011). The qualitative research design requires sharing the research results with the participants (Kafle, 2011, p. 198). The hermeneutic phenomenological research process studies the major concern of the research and reports participant’s responses in a rich textual format (Kafle, 2011).

### **Research Questions**

The research questions this study answered were:

1. What are the barriers for African American women competing to earn a Masters or higher STEM degree?
2. What workforce barriers prevent qualified African American women in STEM being assigned to decision making roles?

3. What are the lived experiences of African American women working in a STEM industry or academia (Goes, 2011)?

These questions were answered by collecting data through interviews with 20 African American women who have earned a PhD in a STEM field or an earned PhD working in a STEM career.

### **Sample Selection**

The selected sample for this proposed study were African American women who have earned a doctorate degree in a STEM discipline and have entered the workforce in industry or academia using their STEM skills. The targeted number, for this sample, was nine African American women in STEM fields in the United States. The targeted sample for the study were African American women who have obtained a terminal degree in a STEM field or have a terminal degree and were working in a STEM field. In order to obtain qualitative data, the African American women were interviewed over the phone. The interviewer asked the women if the interview could be taped in order to ensure all their responses are captured. Each targeted participant was assigned a letter. All information from participants was presented as participant (A,B,C,...). The participants were not identified by name, place of employment or school from which they received their doctorate degree. The age of the participant, the length of time they have had their terminal degree and whether they graduated from a HBCU or a PWI college or university was identified. This information was analyzed to see if unique themes emerge due to age, duration of having the degree, or the type of college or university attended.

Information gained from participants was acquired by asking leading questions' pertaining to participant's lived experiences. Permission to record the interviews as well

as to make notes of the interview was requested from each participant at the time of the interview. Prior to the interview, participants were sent a pre-interview survey of demographic information through email. A request for their initials to ok the recording and note taking was required on the form. Once an interview was completed, each question was entered into an Excel Spreadsheet by the participant's assigned letter of identification. Initial information acquired from participants was their age, the industry they work, the type of degree obtained, the type of school, the year the degree was obtained, and the time in the workforce using the terminal degree. This information was acquired through a survey (Identifier and Segmentation Survey). Again, this information was used to determine if themes and patterns emerged due to age, type of work, type of degree, and length of time degree held. Other interview questions used were leading questions to gain the lived experiences the participants were engaged in as African American women in STEM careers.

### **Instrumentation**

A pilot study conducted to determine the feasibility of the research questions and determine new questions that should be asked to gain pertinent information was helpful to overcome disastrous problems prior to conducting the full study. A pilot study can assist the researcher in overcoming issues with the recruitment and retention of participants (Morin, 2013). Methodological and conceptual issues pertaining to the study are revealed in a pilot study allowing the researcher to address and overcome the issues prior to the implementation of the study (Morin, 2013). According to Morin (2013), pilot studies contribute valuable information to assist with the conduct of interviewing targeting potentials. The pilot study for this research targeted three African American

women. Specific questions were asked participants to gain information pertaining to their lived experiences as African American women in STEM. The interview questions determined the experiences they lived that were specific to them as individuals, African Americans, and as women. The instrument used to gain this information was called the “African American Women Qualitative Interview Questions of Lived Experiences” (AAWQIQLE; Ross, 2014). The collection instruments were the human interviewer, the electronic recorder of the interview and the note taking of the interviewer. The AAWQIQLE instrument was a series of 17 open-ended questions that lead the participant to explain their lived experiences in gaining their education and their work in the workforce (Ross, 2014). The interview was therefore loosely structured. Pre-questions data collected was used to categorize the participants into age of the participant, amount of time they have had their terminal degree and whether they graduated from a HBCU or a PWI of higher learning. The pre-questions demographic data will sought themes and patterns that emerged due to the variables age, time with terminal degree and type of institution. The targeted participants were only be identified by the letter assigned to them. The actual AAWQIQLE instrument is as follows:

**African American Women Qualitative Interview Questions of Lived Experiences**

1. What are the lived experiences of African American women in STEM with a doctorate degree (Goes, 2011)?
2. What are your positive experiences pertaining to getting your STEM education?
3. What are your negative experiences in getting your STEM education?
4. Why did you pursue an education in STEM?
5. What are the goals you plan to achieve using your STEM education?
6. What barriers, if any, have you encountered to achieving your goals?

7. What racial or gender biases did you encounter in your pursuit of your education in STEM?
8. What type of support did you receive to get your education in STEM (i.e. grants, scholarships, mentoring...)? From family? From the government? From the private sector? Please explain if the support was adequate or if some other type of support was needed.
9. Were there any barriers you encountered to completing your master degree or doctorate degree in STEM? How did you overcome these barriers?
10. What advice would you give to an African American woman desiring to obtain a Master or Doctorate degree in terms of choosing the degree to pursue? What advice would you give in terms of career goals (i.e. certifications, companies to pursue)?
11. How would you define leadership decision-making roles?
12. What type of career training does an African American woman need to be promoted to a decision making leadership role in STEM careers and regions (i.e. Silicon Valley)?
13. What are the different types of attitudes toward STEM are found in different regions across the United States? For example, Silicon Valley is very interested in STEM. However, in other regions what are the attitudes toward STEM?
14. What changes need to occur in the industry to open more opportunities to African American women? What changes need to occur in academia to open more opportunities to African American women?
15. What workforce barriers need to be overcome that prevent qualified African American women from acquiring leadership decision making roles in STEM?
16. What assistance is needed for African American women who are enrolled in Master or higher STEM degree programs?
17. Would STEM education be beneficial in elementary school? Would STEM education be beneficial in high school?

### **List of Instruments**

1. African American Women Qualitative Interview Questions of Lived Experiences (AAWQIQLV).
2. Identifier and Segmentation Survey
3. AAWQIQLE instrument Coded Themes Spreadsheet

### **Methodological Assumptions**

To be considered valid, this phenomenological study had appropriate procedures and be rigorous about illuminating issues pertaining to African American women in STEM academia and workforce. The study also provided insights on the barriers, support needs and extrapolated themes from the participant's lived experiences on workplace behavior that achieve the best results toward promotions into leadership (Goes, 2011). In a qualitative study, rigor and trustworthiness determines the validity and reliability of the study. In order to obtain rigor and trustworthiness, triangulation of the data amongst different sources must be achieved (Goes, 2011). Triangulation of data comprised of using different sources or multiple perspectives of information to increase the validity of the research (Guion, 2002). For this study, nine African American women with PhDs in STEM fields were interviewed. Some of these women were in the government, industry and some were in academia. The different area of the careers of the women, as well as their different fields of study created the triangulation of the data. The validity of the study was increased by conducting a pilot study and through member checking. The pilot study was exact replication of the full study with a smaller sample. For the proposed study three African American women in STEM degrees were provided consent forms, were given the identifier and segmentation survey and the actual

interview, the AAWQIQLE. The pilot study helped to determine if all pertinent questions have been asked to gain the information the study requires. In the member checking, participants reviewed summaries of their interviews to ensure the information was recorded correctly.

Methodology determined the knowledge and presence of values emerging from the phenomena being studied (Caelli, 2003). Methodology represented the conceptual or theoretical framework for how the research should proceed. Within a qualitative study, a clear recognition of values and assumptions were evident and are shown. An assumption of this study was racism and gender biases exist against African American women (Essed, 1991, p.57). The existence of the racial and gender bias produced conflict against African American women's educational advancement and in their promotional opportunities (Essed, 1991). This conceptual framework further stipulated that if racism and gender bias exist there is a dominant group consensus on race as part of the problem of racism (Essed, 1991). These assumptions fall under the umbrella of the reality that racism and genderism was socially constructed (Solanski, 2013). This meant the culture of the society or racism was socially and politically constructed (Solanski, 2013).

In qualitative research, the process was the concern of the study (Phiri, 2011). For instance, how were the participants chosen, how was information gathered from participants, and how was the data coded? Qualitative research gathered data on how people see their own lives, lived experiences and their views of how the world is structured (Phiri, 2011). Qualitative research was interested in the participant's point of view. In qualitative research the primary instrument for data collection and analysis was the researcher (Phiri, 2011). This means that data is not gathered through questionnaires



or through computers. Instead data was gathered through observation, focus groups, or interviews (Phiri, 2011). In qualitative research, the participant was observed in their natural setting. Qualitative research was descriptive because it sought to understand process and meanings acquired through conversations (words, interviews) or pictures (Phiri, 2011). In qualitative research, the process was inductive (Phiri, 2011). The researcher extrapolated themes and built hypotheses and theories from the details gained (Phiri, 2011).

Rigor in qualitative research was established by addressing credibility. “A study is credible when it presents truthful descriptions and interpretations of human experience,” according to Evans (Evans, 2009, p. 152, para 2). To verify the adequacy of this study, it was necessary to guarantee that research processes and outcomes were grounded, convincing, reasonable and significant (Evans, 2009). In qualitative research, rigor adhered to the principles that match the approach used (Caelli, 2003). For example, in the participatory approach, individuals or groups studied participate directly in the construction of the research (Mercer, 2009). The participants were actively part of the creation of the finds and in the conclusions (Mercer, 2009). If the research does not have rigor it becomes fiction and loses its usefulness (Morse, 2002).

Since qualitative research does not have *p* values and hard numbers, the verification process becomes important to establish rigor. Verification was the mechanism used to ensure the study was reliable and had validity (Morse, 2002). The verification process involved checking, confirming, making sure, and being certain (Morse, 2002). During the verification process data was checked to see if it was correctly stated and verified with the participant to ensure the information was accurately

presented. The verification process was woven into every step of the inquiry to ensure the study was valid, reliable, and possesses the rigor it needed (Morse, 2002).

Qualitative research was reviewed backward and forward between the design and implementation to ensure congruence in the collection of data, the interview questions, the literature review, and analysis (Morse, 2002). “Data are systematically checked, focus was maintained, and the fit of data and the conceptual work of analysis and interpretation were monitored and confirmed constantly” according to Morse (Morse, 2002, p 17). Verification allowed the investigator to make sure everything was correct along the way which overcomes an incorrect study and analysis.

### **Verification Strategies**

The activities that ensured methodological coherence, sampling sufficiency, development of a relationship between sampling, data collection and analysis, theoretical thinking, and theory development were the verification strategies (Morse, 2002). These activities ensured the validity and reliability of the study. The methodological coherence consisted of the research question matching the method, the data, and the analytical procedures (Morse, 2002). During the research, it may be necessary to alter the research question or alter the method. It also may be necessary to alter the sampling plan or change the participants due to scheduling or some other unforeseen situation. In order for the study to be useful, the sampling plan, the research question and the data verified the methodological coherence (Morse, 2002). The sample must be suitable for the study by best representing the topic of research. This allowed for quality data that completely saturated the categories under study. In order to know saturation of the phenomenon under study has occurred, the categories of the study started to be duplicated (Morse,

2002).

Replication verified and ensured completeness of the study (Morse,2002).

Collection and analysis of data concurrently making an iterative interaction between data and analysis produced reliability and validity (Morse, 2002). During data collection, ideas that emerged in data were confirmed in new data (Morse, 2002). Once data was confirmed, new ideas emerged that were verified in data that has already been collected. The theory developed through understanding the outcomes of the research and through comparison of the outcomes with development of the theory (Morse, 2002). Finally, the methodological and interpretive assumptions of the researcher on his data were assessed. This assessment was concerned with how the researcher engaged with the data (Caelli, 2003). Research has basic assumptions about disposition of nature (Caelli, 2003). Thus, the basic assumptions of the approach guided the progression of the study (Caelli,2003). This study's basic assumptions followed a heuristic phenomenological approach.

In a heuristic process of analysis for a phenomenological design study, there are five basic assumptions considered (Creswell, 1998). The first one was immersion. In immersion the researcher became part of the world of the experience (Creswell, 1998). In order to become part of the world of the experience, one must understand the philosophical perspectives behind the approach (Creswell, 1998). Research questions investigated the meaning of the lived experiences and enabled the participants to describe their daily experiences (Creswell, 1998). Data was collected from participants that have experienced the phenomenon through interviews (Creswell, 1998). The phenomenological data analysis was divided into statements. Themes emerged from the statements that develop into a general description of the experience. These descriptions

included a textual description which defined what was experienced, and a structural description describing how it was experienced (Creswell, 1998). The phenomenological report of the data analysis described the essential structure of the experience (Creswell, 1998).

The data analysis process began with the first collection of data. The data was collected with the aim to understand and describe the phenomenon. To understand the meaning of each individual's experience the method of reduction approach was used (Goes, 2011). The method of reduction analyzed specific statement to squeeze out principle themes. The participants ensured the interviewer correctly understood their responses to questions. An audit trail of the investigation allowed the interviewer to gain an understanding of the responses. Auditability was another way to demonstrate credibility (Goes, 2011). The participants were identified using pseudonyms in order to maintain confidentiality. Interviews allowed participants to give their in-depth feeling about their experiences of the phenomenon (Goes, 2011). An auditable study was one in which another researcher can follow the same steps used in the study and arrive at the same conclusion given the original researcher's data. The procedures of the research were laid out with the decision trail placed in a logical sequential order (Evans, 2009).

### **Constructivist Approach**

Qualitative research used the constructivist approach (Hussain, 2012). The constructivist approach assumed doing the task repeatedly makes the study more efficient (Hussain, 2012). Constructivism was concerned with four communication processes including message production, listening, interaction coordination, and social perception (Burlison, 2011). Message production involved producing verbal and non-verbal

behaviors to elicit desired responses from others (Burleson, 2011). The listening process encompassed interpreting the communication behavior of others with an aim to understand the behavior (Burleson, 2011). The interaction coordination process involved organizing message production and listening activities to have a clear smooth interchange. Finally, social perception involved identifying and making sense of objects and activities in the society including self-experiences, others, relationships, situations and limitations (Burleson, 2011). Constructivism addressed four issues pertaining to the general processes including the nature, the determinants, the antecedents, and the consequences (Burleson, 2011). The nature issue dealt with what counts as skill behavior (Burleson, 2011). The determinants dealt with the competency of communication (Burleson, 2011). Antecedents pertained to the educational efforts needed to cultivate communication skills (Burleson, 2011). Lastly, the consequences issues were concerned with the effects of skilled communication resulting in different outcomes (Burleson, 2011).

The constructivist approach included activities such as cooperative learning, experiential learning, problem-based learning, and inquiry learning (Hussain, 2012). Persons who conducted the research in the study acquired new knowledge about the topic under study through his or her interactions with the interviewees and through their review of literature. Critical thinking, problem solving, and analytical skills are used in the constructivist approach. New knowledge was acquired by the learner using their previous experience of the learning process (Hussain, 2012). The new knowledge was obtained through observation, reflection, and through the interaction with the surrounding environment. The learner interpreted new knowledge based on an effective learning

process. Effective learning occurred when the learner was personally involved (Hussain, 2012).

### **Procedures**

The number of participants included as the sample for the study were nine. The criteria for selecting the participants were they have earned a PhD in a STEM discipline and were an African American woman. The interviews were conducted over the phone since the interviewees were located throughout the United States. A tape recorder captured each interview through a phone conversation conducted on a speakerphone. Prior to the start of the interview, the Identifier and Segmentation Survey was given to each participant. This survey obtained the age, the length of time since the PhD had been earned, and whether the participant attended an HBCU or a PWI. This information was acquired to determine if there were themes emerging due to these elements. The participant were assigned a pseudonym that was listed on the interview transcript. Once the interview was completed a transcript of the conversation was constructed. The transcript was emailed to the participant for their review to ensure their responses were captured adequately. Once the interview was transcribed, responses to each question was inputted into the AAWQIQLE instrument Coded Themes Spreadsheet. The AAWQIQLW Coded Themes Spreadsheet was an Excel spreadsheet used to analyze the data. After all interviews were completed, the data were grouped into categories from the themes that have emerged using the Excel spreadsheet. Raw data were reduced and organized in preparation of data analysis. Categories were more general and abstract and represent the meaning of similar themes (Evans, 2009). The goal of qualitative research was to make general statements concerning the patterns in the data (Evans, 2009).

## **Data Processing and Analysis**

Qualitative research investigated topics looking at patterns and themes that emerged from the raw data that was presented in textual forms. The data collection used interviews or surveys for data gathering. This study collected data using the interview and survey technique with open-ended interview questions. The analysis of responses from the interviews involved measuring verbal responses in order to find their meaning. There were specific procedures to analyzing qualitative data including organizing or coding data, finding the meaning of the data, and finally displaying the data in graphical or table formats (Evans, 2007). The first step, coding the data, was important to condense the data to see themes and categories of information (Evans, 2007).

Coding in qualitative research operated to organize data (Evans, 2007). The original data kept its integrity through linking codes and retrieving linked codes. In the qualitative analysis process, coding identified the regularities or themes in the data. To code data, sort data by similarities, then group in broad categories. Codes or labels or tags, signified the meaning of the section of data. Codes gave meaning to data, index data, and provide a basis for storage and retrieval of data (Evans, 2007). The initial coding of data led to advanced coding of data and then to a summarization of themes and patterns in the data. The initial coding of data was, therefore, very important to obtaining the meaning of the data and eventually led the path of discovery. The initial coding process required adequate time putting in the structure of the foundation of data meaning (Evans, 2007).

The foundation of the data had two different type of coding elements namely descriptive and inferential codes. The descriptive codes defined or explained the meaning of the data. These were the early coding and should be well thought out before

moving to the inferential codes. The inferential codes were the advanced codes that discuss emerging patterns derived from the descriptive codes. In order to make inferential codes, the ability to see patterns and connections in the data was necessary. Recurring themes and common words that related to the research question should be noted and become part of the inferential codes. Thematic themes should be developed prior to collection of the data. Sorting the data into groups according to the themes developed assisted in finding the meaning of the data found in the groups (Evans, 2007).

Qualitative research massaged data in this manner to form new concepts and refine concepts grounded in the data (Evans, 2007). This is an essential part of the analysis stage and was initiated during the data collection phase. Organizing, grouping and massaging the data for qualitative research meant operationalization. This term, operationalization, described how the data was collected, interpreted, and integrated with emerging themes discovered during the data collection (Evans, 2007).

Another technique that qualitative research used during data analysis is writing memos during the coding process. The coding process sparked new ideas that need a record. Memos record these ideas as they occur. According to Evans (2007), memos were substantive, theoretical or personal (p. 178). Memos that are substantive or are of theoretical content were conceptual.

These types of memos were not just describing data but gave meaning to the data described. When memos were at the conceptual level, codes linked to the development of propositions. Propositions in this context meant patterns or recurrences of themes, or words, or descriptions (Evans, 2007).

The manner in which data was collected depends upon the experiences, intuitions,



creativity and purpose of the person conducting the study. Evans (2007) presented this experience as Kyle's personal subjectivity phenomenon. It is, therefore important to understand how experiences, intuitions, and creativity were shaping the data and the study. Reflexivity was the term explaining the researcher's recognition of his process of collecting and interpreting data. Reflexivity referred to personal and epistemological qualitative research (Evans, 2007). Epistemological reflexivity aimed to determine how the research question defined and restricted the findings. Personal reflexivity reflected on how personal values and experiences shape the study (Evans, 2007). In order to effectively determine the meaning of data, Evans stated Miles and Huberman's 13 tactics for generating developing meaning was appropriate (Evan, 2007).

Table 1 shows Miles and Huberman's techniques.

Table 1

*Miles and Huberman's techniques*

<b>Miles and Huberman 13 Tactics for Generating Meaning</b>	
Seeing what codes/labels go with what	1. Noting patterns and themes
	2. Seeing plausibility
	3. Clustering
Achieve more integration among diverse pieces of data	4. Making metaphors
Seeing what is there	5. Counting
Sharpening understanding	6. Making contrasts and comparisons
Differentiation	7. Partitioning variables
	8. Subsuming particulars into the general
	9. Factoring
Seeing things and their relationships more abstractly	10. Noting relations between variables
	11. Finding intervening variables
Systematically assembling a coherent understanding of the data	12. Building a logical chain of evidence
	13. Making conceptual/theoretical coherence

*Note.* From "Qualitative Data Analysis: An Expanded Sourcebook (2<sup>nd</sup>. Ed.)" by Matthew B. Miles and A. Michael Huberman, American Journal of Evaluation, 20, 1, p159. Copyright 1994 by Sage Publication. Reprinted with permission.

The data collection process follows Chia's diagram. (Chia, 2014 p. 5). This diagram assists the researcher with data collection and data analysis.

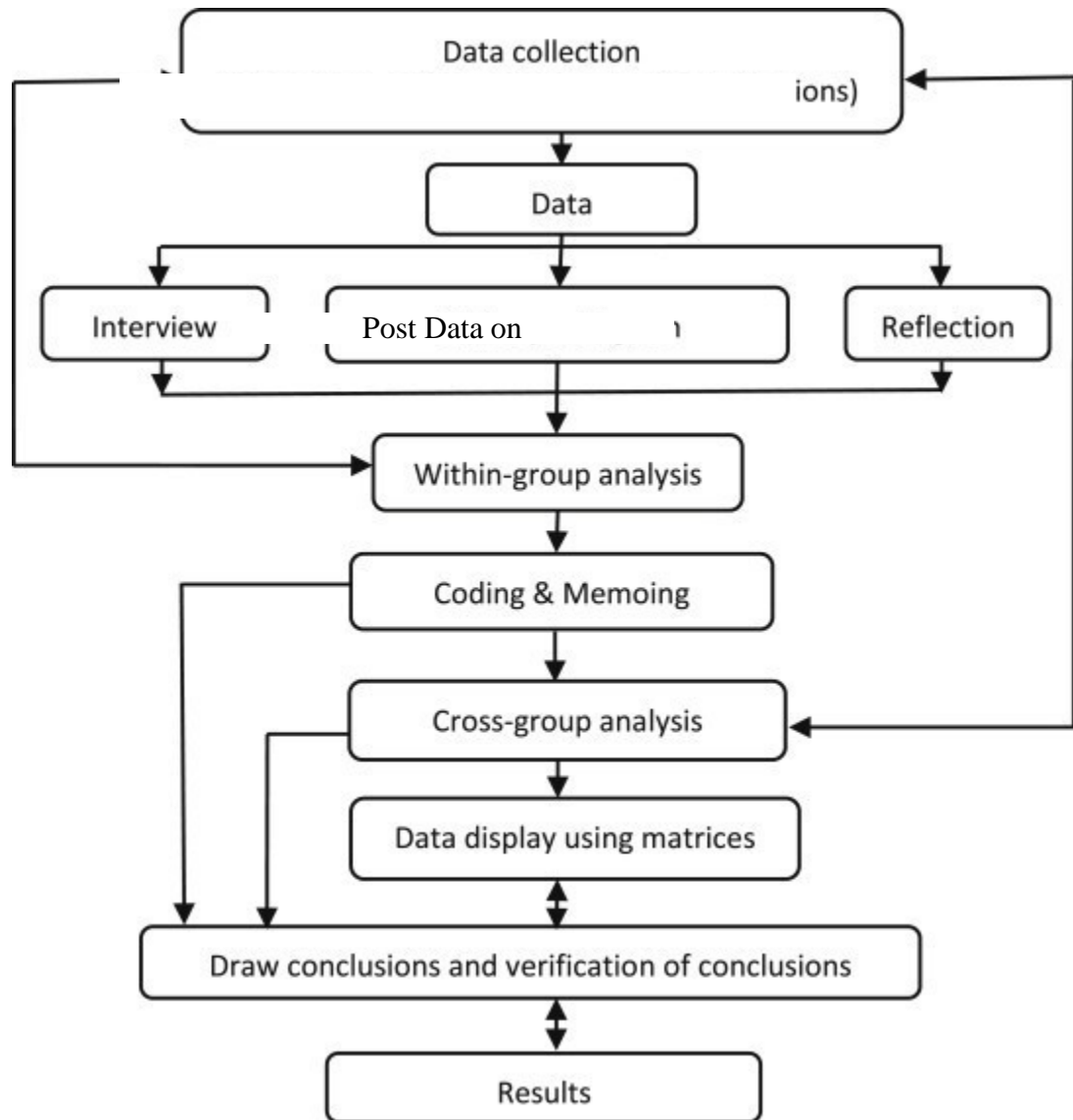


Figure 3. (Chia, 2014)

*Note.* From "Using a virtual learning community (VLC) to facilitate a cross-national science research collaboration between secondary school students," by A.P. Chia, 2014, *Computers and Education*, 5. Copyright 2014 by Elsevier Limited. Reprinted with permission

## Conclusion

This research study was a hermeneutic phenomenological (Frillman, 2011) study of the experiences of African American women who have earned doctorate degrees in a STEM discipline. This type of qualitative study design (hermeneutic phenomenological) unveiled life experiences of the subject through their world experience. The sample for this proposed study were nine African American women who have earned a doctorate degree in a STEM discipline and had entered the workforce in industry or academia using their STEM skills. Universities offering STEM advanced degrees, contacts from existing peer group with PhD STEM degrees and contacts of African American professional network systems were solicited to find eligible participants for the study. In a qualitative study, rigor and trustworthiness determined the validity and reliability of the study. Rigor and trustworthiness occurred through triangulation of the data. Data was collected using the constructivist interview technique and the AAWQIQLE instrument. The data was analyzed using the Miles and Huberman 13 tactics for generating meaning as mentioned in Table 1.

## CHAPTER FOUR: DATA COLLECTION AND ANALYSIS

The purpose of this dissertation was to determine what elements were needed to increase the number of African American women obtaining STEM PhD degrees.

According to Scriven (2013), the most recent information from the National Science Foundation shows African American women and girls are: 6% of the population of the United States, 14% of female students enrolled at four year institutes and 10.4% of female graduate students in STEM. Clarifying the situation, only 6400 African American women with STEM PhD's have associate or full professorships (Scriven). This number represents only 2.1% of the population of associate or full professors (Scriven). Consequently, African American women influence in future endeavors and scientific inventions are limited. This study aimed to determine the type of assistance, decisions, and behavior needed to increase the number of African American women with STEM PhD's and in STEM leadership positions.

The framework for this study was the mega-community model. The mega-community models forms collaborations with three different entities: non-profit groups, government agencies, and businesses (Allen, 2014). The mega-community model handles issues that are too complex for one entity to overcome (Allen, 2014). The type of issues confronted by mega-communities are rebuilding of urban communities, tackling global climate change, supervising the aging population, and inhibiting terrorist attacks (Kelly, M., 2009). For these types of issues, collaboration between non-profit organizations, government, and the private sector are formed to solve the problems. In mega-community formed collaborations, leaders from the three sectors work together to accomplish the common goal. The mega –community initiatives develop plans and

implement strategies (Kelly, M., 2009). The mega community is ongoing and has multiple members of the various organizations (Kelly, M., 2009).

The approach used in this study was hermeneutic phenomenology. This was a credible and rigorous research approach to this study due to the increasing number of African American women in STEM (Ajjawai & Higgs, 2007). Phenomenology studies the meaning, structure, and lived experiences of individuals (Mas, 2011). The investigator gained access to the individuals lived experiences through interviews. The interviewer's analysis was concerned with getting the invariant structures or essence of the experience (Mas, 2011). What did the individual gain from the experience? How did this experience become a change catalyst for the individual? How did it affect the individuals thinking process and decision making process? The information gained from the data gathering method was analyzed by determining themes that emerged from the data showing similarities amongst different individuals.

For the purpose of this specific study, 20 African American women with PhDs in STEM disciplines were interviewed using the AAWQIQLE instrument. The AAWQIQLE is a 17 question interview instrument with specific questions asked about the women's education and career experiences. Each participant agreed to participate in the study by signing a letter of informed consent. This letter explained the process of the study and the participant's involvement in the study. The informed consent form provided contact information of the principal investigator as well as contact information for the Argosy University Online IRB. Finally, the participant was requested to sign the consent form as agreement to their participation. The interviews were recorded by date and by the individual's label assigned to them. Once interviews were completed a

summary by question was transcribed. From this information themes that emerged were inputted into an EXCEL spreadsheet. A written analysis of the interviews and emerging themes is found in Chapter 5.

### **Primary Sources Used**

The primary sources used for this study were African American Women with a PhD or doctorate in a STEM discipline. These accomplished women work in academia in administration, as professors and researchers and as department chairpersons. The women also work in the private sector in leadership roles, as scientists and as researchers. Information obtained from them determined the type of financial, spiritual, and mental support needed to acquire a PhD in a STEM field and have a STEM career as well as to obtain a leadership role in STEM.

Participants come from a wide range of fields. Some are Chemist, Biologist, scientist, some are administrators at universities, some are chairman of departments of STEM fields at universities, and some are engineers. Some women work in the federal government, some in the private sector, and some in the university setting. Some of the participants are post-doctoral fellows. For these positions, participants may still be current temporary employees. The post-doctoral fellows conduct research, write the report of their findings, and seek to have their studies published. One participant is an Industrial Engineer and holds a professional engineering position in the private sector. This is a permanent full time position in industry in which the participant leads and participates in teams to design platforms for new technology and software. Some participants are teaching professors in the University setting as well as provide services to afterschool programs. One participant is a vice provost at a HBCU. Another participant

is the chairman of a STEM department in the university. The table below depicts the titles of participants in the study.

Table 2

***Identifier and Segmentation***

<u>Participant Letter</u>	<u>Age</u>	<u>Position</u>	<u>Length of time degree held</u>	<u>HBCU or PWI</u>
A	37	Industrial Engineering	7	PWI
B	31	Analytical Chemist/Research Chemist	4	HBCU/PWI
C	30	NRC Postdoctoral Fellow - Chemist	3	HBCU/PWI
D	37	Oceanographer	2	HBCU/PWI
E	28	Analytical Chemist	4	
F	52	Environmental Engineer	17	HBCU/PWI
G		Mathematician Applied and Computational Mathematics Division	30	PWI
H		Chairman Industrial Systems Engineering	17	HBCU
I		Information Provost and Vice President for Academic Affairs	45	PWI

### **Analytic Memo**

The purpose of the analytic memo in qualitative research is to document the thoughts of the researcher as he navigates through the data. The investigator describes how themes or concepts link to one another. These memos are written during data gathering but are written separately in this case from the actual interview. The analytic memo keeps track of theoretical thinking about the content of the data and the course of the research. The investigator completes an analytic memo throughout the data collection

process by linking data to literature reviewed, recognizing emerging themes and examining data for patterns (Carr, 2007). An example of an Analytic Memo for this study is as follows:



# Memo

To: Dr. Kim Ards  
From: Lydia Ross  
cc: Dr. Tom Malone  
Date: May 15, 2015  
Re: Analytical Memo

---

- A common theme that is emerging among the participants is their interest in STEM probably came from their parents being professors at universities in Science or Math. In other words since STEM was a common practice while they were growing up, it lead them to become interested in STEM. Also, parents were able to provide homework assistance to participants.
- Another common theme was that people outside of STEM are uninformed about their daily use of Science, Technology, Engineering or Math. By making people aware of their daily use of STEM, it will take the mystery out of the STEM disciplines.
- Classes at HBCU weren't typically as vigorous as PWI. Therefore when these students attended a PWI for their doctorate degrees, they had to play catch up. Also there was a stigma that African Americans coming from HBCU weren't as prepared or weren't as competitive as their White counterparts.
- A theme that was presented many times was the need to have a mentor at the University to bounce your ideas off of and to encourage you during difficult times. It's also just as important to have friends in your program to keep you encouraged to complete the degree.
- Minorities in STEM pursuing PhD's or Master degrees should not have to pay for school. There are many scholarships, grants, fellowships that can be acquired. A student must however keep a B average to be competitive for this funding.

*Figure 3. Analytic Memo*

### **Analytic Strategies**

Qualitative studies are looking for the meaning of a subject's response, or determine the meaning of a phenomenon (Kolb, 2008). Qualitative data answers the question of why a particular behavior or event is occurring. For the study, the question answered was why are there so few African American women in STEM? Though, it was the interest of the investigator to determine tactics to increase the number of African American Women in STEM. In order to accomplish this task, the investigator used the structured interviews of nine African American women in STEM with a PhD. In other words, expert opinion was used to acquire the data (Kolb, 2008).

The analytic strategy for this study was to conduct interviews with each participant asking 17 predetermined interview questions. The interview was recorded. Once the interview was completed, a summary of each participant's response was written by the principal investigator. The summary of responses were placed in an EXCEL spreadsheet. Themes were derived from reviewing summary responses. Each response was placed in a theme or category by the label of the participant with other participant's summary responses of the same theme. Responses of participants that are the same are reported as major themes (Blum, 2006). Unique responses significant to the purpose and problem statement were reported as outliers (Blum, 2006). A table of the results was included as Appendix C. More important unique information on career planning and achievement of personal goals using proven techniques by the participants was described. Information gained from interviews determined the meaning, structure and essence of the lived experiences of the participants (Mas, 2011). The initial codes developed were the information requesting from the question. For example the initial code for question

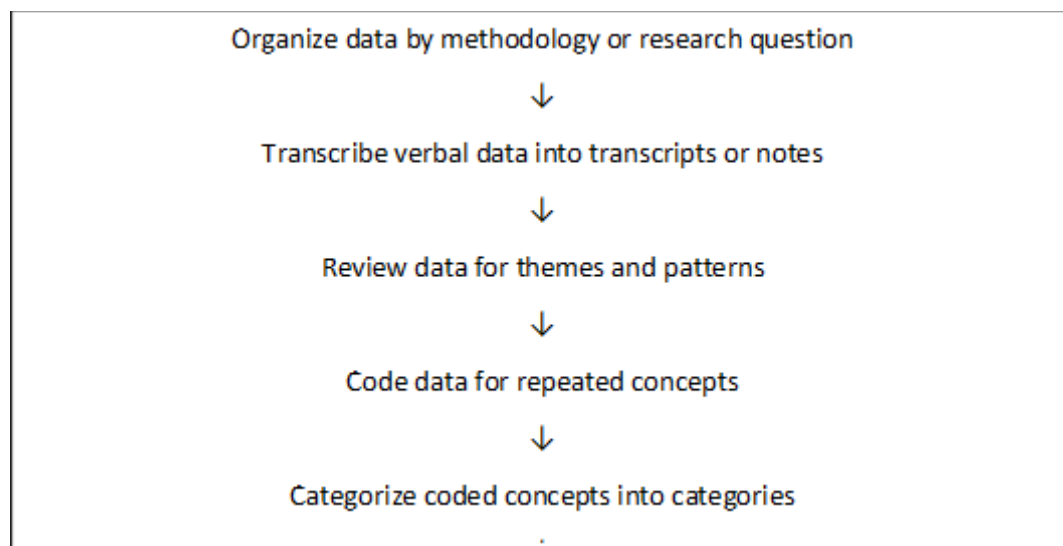
number two was 'positives in education'.

### **Overview of Data Coding**

The data in this study were the interviews conducted by researcher. Data was collected using the telephone and an electronic recorder. The term coding means identifying a repetition of responses for a particular question in this study. For example throughout the data, mentoring was given as a necessary support criteria to successfully complete the PhD degrees as well as to gain meaningful internships. Mentoring then became a support factor for African American women to obtain a PhD in a STEM field and obtain a career in STEM. A coding procedure was needed to categorize patterns that emerged from the data. A theory was developed from the specific data patterns (Auerbach, 2003). A coding process was used to analyze the data.

According to Kolb (2014), a good coding procedure for interview data encompasses seven steps. The first step that was used by the investigator was to summarize all the recorded interviews into written summary data by interview question (Kolb, 2014). The second step used was to organize the interview data by research questions (Kolb, 2014). In this step each question of the interview was placed with the research question it answered. Then all participant's summaries were grouped by interview question with the specific research question. The next step in the coded process was to review data to determine patterns and themes in the summaries (Kolb, 2014). Once patterns and themes were found, the data was coded by repeated concepts (Kolb, 2014). The data was then categorized placed in categories (Kolb, 2014). Next the investigator looked for a relationship between the coded concepts and categories to the research questions (Kolb, 2014). Finally, the investigator interpreted the findings in

order to determine what to do with the information (Kolb, 2014). This final step was used to develop recommendations for future studies (Kolb, 2014). Figure 4 represented, the process of analyzing qualitative data” (Kolb, 2008).



*Note.* From “Marketing Research; A Practical Approach,” by Bonita Kolb, 2009. Reference and Research News, p.233. Copyright 2009 by Copy Right, Inc. Reprinted with Permission.

Finding connections in the data to the research questions is the next step in the coding procedure.

Detecting connections in the data to the research questions is provided by the research framework. In this case the framework is the Mega-Community. In some cases, the participant’s responses do not align with the framework. These responses are reported as outliers and can be used for further research studies. In this study, outliers from experts were important to pursue for further research since these outliers could be important factors to be included in policy changes. But when the data is interpreted, the researcher must support their interpretation with further textual examples in the data (Auerbach, 2003). Determining the relevant text is the next step in the coding procedure.

## **Relevant Text**

Determining the relevant text is to cut the text down to manageable pieces. For our study 17 questions were asked. The participant responses are in manageable portions by the seventeen questions. According to Auerbach, “text that is related to the specific research is called relevant text” (Auerbach, 2003, p. 37). For this study, the summaries of each participant response are relevant and was used. Since our data was separated into specific questions asked, participant’s responses to the same question can be grouped. A review of the responses by question can reveal repeating ideas. These ideas should give clarity to the research concerns and build themes of the data (Auerbach, 2003).

Themes are implied topics that organize or group together repeating ideas. Ideas that are repeated have things in common. In this study, a repeating idea was that in many cases the African American Women that went to an HBCU had some deficits when they entered their PhD programs at a PWI. In every one of these cases that reported, the individual overcome the deficit and still received their PhD. While this was an element to be reported to ensure changes are made at different HBCUs, this deficit was manageable in graduate school and did not stop the success of the individual. Another theme that was brought out in many instances was the fact that academia was more nurturing than industry or the government. The point that was made was that in academia the focus was on the individual’s success whereas in government and industry the focus was on the success of the organization or the company. While some participants discussed deficits, there were aspects of the education experience that were the same, namely nurturing. This aspect discussed how participants were given, attended conferences and were able to have a sounding board for issues that were found in the

education experience. These were all examples of repeating ideas (Auerbach,2003).

These repeating ideas lead to research concerns or theoretical constructs.

### **Theoretical Constructs**

Once the data has been scrutinized by grouping repeating ideas together, themes are then organized into larger abstract ideas. The abstract ideas are called theoretical constructs. The two examples mentioned are grouped into 'Nurturing in Academia. This theoretical construct deals with the conflict of not being adequately prepared for STEM graduate school when coming from an HBCU to the academic having professional development through internships and conferences to ensure success in both HBCU and PWI's. In the STEM fields in both HBCU's and PWI's the participants reported the professional development techniques through internships, seminars, aligning themselves with faculty and through peer networking. All these situations were accomplished through very specific organized programs that was part of their undergraduate and graduate curriculum. Again in all these instances the focus was placed on ensuring the individual's successful completion of the program and obtaining the degree. The environment was nurturing to ensure the success of the student (Auerbach,2003).

Originally, the data was grouped by the research instrument's questions. Each participant responded to the 17 questions. Once the investigator looked over the data and retrieved the relevant text, repeating ideas emerged among the participants. The data was broken down into repeating theses. Each participant response was placed with the repeating ideas by question. The following repeating ideas emerged from the data:

- Respect - For question number one, most participants noticed they received more respect when a person realized they had a PhD in a STEM field. One

participant further explained, if the audience is PhD in STEM who have published papers, experience in acknowledgement and respect in their fields, the respect is not so freely given.

- More opportunities – All participants described having more opportunities by pursuing their PhD in STEM fields.
- Bad attitudes toward gender and race. Many of the participants discussed experiencing some sort of negative or were in the environment of negativity towards women or minorities during their educational experiences.
- Every women interviewed discussed their interest and passion for the STEM fields they choose. Many women explained this passion came at an early age. All women agreed you must have the interest and talent to complete a degree in STEM because it is very difficult.
- New inventions or new innovation. While each woman had a goal of reaching back into their community and increasing the interest of STEM, all women wanted goals included doing new inventions or new innovations.
- Some of the main barriers included going to graduate school and not being properly prepared. Other issues included having experiments or projects that did not work.
- The responses while diverse in the actual experience were repeating that biases do exist in STEM against women and specifically, African American women.
- The support needed according to participants are scholarships, learning centers, science and math tutoring, employment, and mentoring.

- While the women were able to overcome these barriers, they stated barrier to completing is a lack of money, childcare, fear, transportation, and low self-esteem.
- Advice given by these experts for African American women pursuing STEM degrees include learn to manage conflict, grant writing, budget writing, and team building.
- Some of the women had trouble with this question. Many gave responses as skills needed to be a leader.
- Regional attitudes toward STEM were people's perception of STEM.
- The changes that need to occur in industry pertaining to African American women in STEM is to remove the glass ceiling.
- The workforce barriers that African American women face are not being considered due to race and gender. Additionally, if African American women have family issues, they are considered as not reliable or less than their white counterparts.
- The assistance that African American women need to be successful include money, childcare, transportation, housing, internships, career counseling, and mentoring.
- All participants believe that STEM should begin in elementary and also be taught in Middle School and High School.

The description of the essences of the experiences of the experts that were repeating ideas were reported in this phenomenology data (Nova Southeastern University, 2013). Data is now grouped into more abstract ideas.



Once the repeating ideas have been coded, data is grouped into more abstract ideas called theoretical constructs. The data in this study found 9 groups of data. These data groups are described here.

- The first group in this coding process is the Leadership Traits.
- The second theoretical construct is Barriers. These barriers can be described as negotiating school politics, gender biases, and racial biases, obtaining internships, and overcoming deficits.
- The third construct is the Support Elements. The elements of this code are financial, childcare, eldercare, mentoring, resources, family, private sector, government, and non-profits.
- The fourth construct encompasses the Reasons for Choosing STEM.
- The fifth construct embodies Challenges to completing the degree.
- The sixth construct is Exposure to STEM contain responses of overcoming barriers.
- The seventh construct is Choosing a STEM discipline (STEM is difficult need passion to complete and work in it).
- The eighth construct is Overcoming Barriers.
- The ninth construct covers Outliers. Outliers are included to capture any responses that are unique and specific to an individual that is distant from group.

Table 2 depicts the coding themes.

Table 3

<i>Constructs 1 thru 9</i>								
<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>
Leadership traits	Barriers (negotiating school politics, gender biases, racial biases, obtaing interships)	Support Elements (i.e. Financial, childcare, eldercare mentoring, resources, family, private)	Reasons for choosing STEM	Challenges to Completing the Degree	Expoxure to STEM	Choosing a discipline (STEM is difficult- need passion to complete and work in it.)	Overcoming Barriers	Outliers

### Concepts, Codes and Research Questions

Determining whether the study meets the expectations of the study, the relationship between concepts, codes and the research questions needs to be analyzed. The first step is to determine whether the research questions were answered by the study. The research questions were answered with the following responses:

What are the barriers for African American women competing to earn a Master's or STEM degree? The responses answering this question gained from participants were:

- Challenges many. In Grad school for 9 years. Feeling not perfectly prepared to enter some of my classes like not having enough statistics. Perseverance and answering questions. Have to manage workload. Had external fellowship so I had to find my own dissertation and pull together the research. Came up with a topic which was both qualitative and quantitative. Went into urban environment and create my lab in the field. Gaining the trust of the individuals of the community I did not live in.
- Barriers was timing. When it did not have initially it did eventually come to fruition.

- Leaving my undergraduate institution, taking a year off and feeling inadequate.
- Mostly mental barriers. Negative experience in getting my Master's was making me lose my confidence in getting my Doctorate. But getting into the right environment the right mentorship will allow you to be successful. You should never give up on your dreams and goals. Just keep going and develop a good network of friends to keep encouraged.
- Ratio of men to women 5 to 1. Biases more male than females in STEM fields. You hear things that are inappropriate. Women have in the back of their heads children and families. Many times this does not allow women to have a straight shot to gaining the education and career in these fields as men do.
- I did not pass all of my classes the first time. Graduate I passed all my classes. Undergraduate I did not pass all my classes.
- The biggest problem I have had is not having a model to follow. At my agency, when you have a Ph.D. in the mathematical sciences, you basically create your own career. In general, people do not tell you what to do. You have to figure it out on your own. I also noticed that the more successful you are (publishing papers, getting your work acknowledged), the more control you have over your career.
- Bias in funding decisions, bias in peer-review, the minority tax (being overloaded with search committees, admin work, diversity work) and the lack of ethics among various funding agencies.
- I have not encountered barriers to achieving my goals because I have always worked very hard. I always been very motivated. In most cases people

recognized my talent and my work effort. A lot of times I was asked to do things instead of pursuing them myself.

The second research question was “What workforce barriers prevent qualified African American women in STEM from being assigned a decision making role?” This question was combined with three interview questions, namely question numbers 12, 14 and 15 of the AAWQIQLE instrument. Relevant responses from participants included the following comments:

- First thing is know your craft and be good. Master your craft. Your decisions impact your clients and your employees. You have to be skilled at your craft. You have to be proven in the area you want to lead in. Credibility will come with mastery of your craft.
- It is specific to your job but you will always need strong computer skills and know how to do a budget. You would want to know how to handle confrontation in the workplace. You want to attend leadership training where you would learn how to multi-task. Become an expert in my field. Be a grant writer.
- Advertising, a lot of times I have to go out and seek things. Things need to be more transparent.
- Present research everywhere. Have many collaborations with other scientist. Run a committee and build up your performance report. Depends on what upper management sees in you. Could be tapped out at your level. Leaders are on a leadership track. Some people don't want leadership positions. Other people want to move up and out of the laboratory. You have to want to be leading.

- You always have to build your network and be a part of your professional organization. Continue to get leadership training like they do in the government. Take advantage of the opportunities for developing your leadership skills in your organization.
- How to deal with the inevitable prejudices you will encounter for being a minority and a woman. You are put in these situations because of other people's preconceived notions. You can't respond in a typical African American woman's behavior. You have to understand how to be yourself without being obnoxious, without being rude. (Training on professional behavior).
- In STEM in corporate or academia or the government, you need to have all your degrees to the PhD level. In STEM to be promoted you are best served with degrees in your field. If you want to be president of a University, your best degree to have is the PhD in your field.
- Before working for the federal government I worked for a private government contractor. There, you advanced by going up the management ladder. Many felt that an undergraduate STEM degree was sufficient, followed by a professional degree such as an MBA.
- Almost all people who succeed rapidly will tell you that there were many mentors and others who supported them. An African American woman may have to work harder to find mentors and people who offer encouragement. Rather than look for one mentor it may be necessary to get information from whomever and wherever you can. The key is not to stay at your desk, isolated from your colleagues. Talk to your colleagues, get to know them, ask them questions. Take advantage of

conferences that offer opportunities for receiving advice about succeeding in your field. In mathematics, there's the Infinite Possibilities Conference that offers advice, support, and encouragement to minority women either thinking about or already in careers requiring a Ph.D. in the mathematical or statistical sciences. Places like the IMA (Institute for Mathematics and its Applications) at the University of Minnesota often offer workshops to help minorities succeed in careers in the mathematical sciences. Hopefully, your place of employment provides some funding for you to present papers and attend the major conferences in your field to make contacts and form collaborations.

- Go beyond your degree; get a certification of some sort.
- Know more than others. Move in the right networks.
- Don't let them leave you out of anything. Be there, be present, show up, and be vocal but vocal only when you have something significant and intelligent to say.
- Stop worrying so much about looks. Stop being all form and no substance. Show your substance. Invest in expanding your knowledge and skills, and not your hair and wardrobe.
- This is a hard question to answer. Opportunities are there. The problem is organizational culture and climate. If that does not change, we will not advance.
- Those at the top need to increase cultural competence and need more training in implicit biases.

- Congress needs to closely scrutinize funding agencies that demonstrate biases in funding.
- There must be women to promote. There must be more females in the leadership positions. NSF tries to get more women in the pipeline and teaches them to consider more flexible schedules for women due to family needs. We do need scholarships for childcare and elder or family care.
- It's time to balance personal and professional lives. NSF helps women navigate their professional degrees.

The final research question for this study is, "What are the lived experiences of African American women working in a STEM industry? Responses to this question were obtained from question one of the interview instrument. The relevant responses pertaining to this research question is as follows:

- When other minorities see me, they also tend to get very inspired. I often have people ask me how did I get here or what made me go into chemistry or science? Most people don't expect African American women to hold a Doctorate degree in STEM. However, most people see someone doing good for themselves, embrace it and want to learn more.
- Minority Fellowships (Native American, African American, and Puerto Rican) allowed me to focus on school and have an easier time. Therefore my lab did not have to pay for me. Another fellowship allowed me to do a guest research assistant at another institution.
- Opportunities for jobs that come with having the degree and teaching in an undergraduate institute. In terms of perception at home a lot of people know I

have the degree and look at it with pride and younger people believe they can do it also.

- Depends on who I'm conversing with. Outside of the field, no one ever thinks I have the credentials that I have. I've been treated strangely. A particular instance as a professor from a different college, I was treated poorly by one security. Security gave apologies the next day once learning who I was. If someone in your field based on your level of experience the credibility makes them not as respected. They don't treat you with as much respect. I am an analytical chemist. Analytical Chemistry.
- People always assumed I was from another country because their preconceived notion was that Black people of this nation would not be here. They even asked my mother if she was Sudanese. My mother just explained to him that we are educated people. Then he went on to say he doesn't know why this country and specifically African American don't give more credit to what the white man has done for them. Like made it possible for them to even be in school and acquire an education. He said African American were absolutely less qualified. He was on my dissertation committee. I did not ask him what he thought of me because I felt he believed I was part of the group he was speaking about. He was an older man who came up in another era.
- For me, obtaining a doctorate in applied mathematics was the best decision I could have made. With my research work I get to experience the joy of creating new ideas, new codes, and through my project leadership I get to inspire others to do work that they enjoy. I published my work in conference proceedings or



refereed journals and present it at conferences throughout the U.S. and abroad. I have traveled to conferences in locations like Vancouver, Canada, Oslo, Norway, Madrid, Spain, and Paris, France that I would never have thought I would ever see as a child. My biggest complaint is that sometimes I am so busy that I do not have time to do everything I would like to do. I spend a lot of time doing outreach work – tutoring at-risk students, giving presentations on my work to middle school, high school or college students. I also try to live a balanced life—enjoying family and friends, being active in my church, playing tennis.

- I have an interdisciplinary engineering and science degree that required courses in 2 different departments (one in engineering and one in science), so I have been able to experience two different “cultures.” In terms of the lived experience, it has been fraught with highs and lows. Most of all, the implicit and explicit biases against women and ethnic minorities have been a day-to-day struggle. I cannot think of a workday where I experienced ZERO micro-aggressions. Every workday is full of micro-aggressions associated with biases based on gender and/or ethnicity. The Ivory Tower is essentially a “Tower of Babel.” Few are capable of functioning authentically in a diverse and inclusive culture; few are culturally competent to build such a culture; and no one wants to have a real dialogue about any of it. In my lived experience, we as scholars have failed to deal with diversity and inclusiveness; thus we cannot possibly prepare our students adequately.
- Most of my math classes I was the only female and the only African American. During my Master’s degree one of the male students would say inappropriate

things and then say, “Whoops I forgot a lady is present”. There were some issues but I was determined I was going to finish. Even though there were some negative experiences, I was going to finish regardless.

Once all the research questions have been answered, it is important to ensure the summaries transcribed by the researcher are reviewed by participants.

### **Rigor**

Rigor is established in a qualitative study through member checks, expert opinions, audit trails, and triangulation. A participant’s review of their interview summary is termed member checking. This member checking is one way to ensure rigor in a study. “Member checks is one of the most beneficial methods for assuring credibility in a qualitative study” (McBrien, 2008). Member checks allows the participants to determine the honesty and integrity of the summaries (McBrien, 2008). Since the investigator wrote summaries of the interviews, member check ensure the accuracy of the summary. Another way rigor is established is through credibility.

Credibility for this study was established by interviewing experts in the STEM field. Initially the investigator considered interviewing community African American girls and women to determine their needs to enter a STEM field and ensure the completion of the degree. Yet, to use African American women in STEM who have obtained the highest degree in their field, the information obtained from experts in the field assures the accuracy of the assumptions as well as the accuracy of the opinions (Kolb, 2008). Only African American women with a STEM PhD were interviewed for this study. The audit trail of the steps to collect the data, will allow the study to be repeated by others.

An indicator of trustworthiness is the ability to establish an audit trail that relates to the theoretical, methodological, and analytical choices of the study (McBrien, 2008). Once the research questions were established, the AAWQIQLE instrument was developed. The researcher developed the question by considering information needed to fully answer the research questions and provide information to establish a process for pursuing STEM degrees. The next step was to find African American women with PhD STEM degrees who would participate in the study. The step was accomplished by contacting the provost, former professors, mentors, and the Black Science Network. Each of these organizations were sent a letter introducing the investigator, the purpose of the study, a request for permission and a request for participation. Once participants agreed to be interviewed, the logistics of the interview, more detailed information about the study and a consent form was sent to the participants. Interviews were conducted by phone and recorded. Each interview was transcribed and a summary of the interview was written by question. The interviews were coded into themes and patterns and lastly constructs. Finally, the rigor process was concluded by verifying triangulation was accomplished. Triangulation in the study refers to the completeness and conformability of the findings.

The triangulation of the data implies that information acquired in this study was gained from three unique sources. For this study, the first form of triangulation was to conduct interviews using the same interview question. The next form of triangulation was to acquire participants from the industry, academia, and the government. The next form of triangulation was to acquire expert opinions from experts with several different types of STEM degrees. The next form of triangulation was to acquire African American

women with STEM degrees at different point in their careers. Some of the woman were seasoned STEM PhD's, some were in the mid-range of their careers and some have recently obtained their PhD's. For our purpose, triangulation has been achieved in this study (Decrop, 1999).

## **Study of Participants**

### **Profiles of Participants**

**Profile of A.** Participant A has an Industrial Engineering PhD. She is a 37 year old African American women who works as an Engineer in the Industry. In her position she is responsible for sitting on teams that develop new technological designs. She also volunteers at an after-school program teaching youth to develop webpages and understanding the platforms that web pages are created.

**Profile of B.** Participant B has her PhD in Analytical Chemistry. The 31 year old participant received her PhD in 2011. She is currently working for the government as a Research Chemist. Her major goal at this time is to get more minorities and more women excited about science. She recently worked in South Africa where her job was to promote STEM education for 3 months. She held outreach programs for people who could not afford certain chemicals or who didn't understand how to use certain chemicals to show them how to use the chemicals.

**Profile of C.** Participant C received her PhD in Chemistry. She is a 30 year old and has had her PhD for 3 years. She currently works for the federal government as a post-doctoral fellow. Her short term goal is to land a permanent position at her current place of employment. To accomplish this goal she is conducting research, presenting her research, and working to get the report of her research published. Her ongoing goals are

to encourage youth to go into math and science and to develop mentorships with youth.

**Profile of D.** Participant D received her PhD in Oceanography. She is 37 years old and has had her doctorate for 2 years. She is a post-doctoral fellow for the federal government working as a research scientist. Her long term goals are to develop chemistry curriculum that is applied and more in line with everyday life. Some of her research includes developing methods to determine how gas impacts the ocean.

**Profile of E.** Participant E received her PhD in Analytical Chemistry. She is 28 years old and working as a post-doctoral fellow for the federal government. Her short term goal is to become a full time employee once her fellowship has been completed. Long term she would like to give back to the community and build programs to develop youth in STEM.

**Profile of F.** Participant F received her PhD in Environmental Engineering. She is a 52 year old who has had her doctorate for 17 years. Currently she works as an Assist Provost in an HBCU. She always saw herself helping people lead better lives by building systems of sanitation or developing drinking water systems in Africa. While she is not doing those things now she is still changing the lives of young people.

**Profile of G.** Participant G has a PhD in Computational and Applied Mathematics. She has had her doctorate for 30 years and is currently a Research Mathematician for the federal government. Her goals are to continue her research and present her work in the US and abroad. She would also like to publish more papers in referred journals. Finally, her outreach to the community is tutoring at-risk students in middle and high school.

**Profile of H.** Participant H has her PhD in Psychology/Ergonomics. She is

currently the Chair of her department at a University. She is achieving her goals as a faculty member and an administrator. She plans to continue to design and evaluate complex systems. She also will continue to identify instructions of inclusion that teaches STEM that is beneficial to all worldviews.

**Profile of I.** Participant I has had a PhD in Mathematics since 1977. She is currently the Information Provost and Vice President of Academic Affairs. She was also a leader in the Girl Scouts organization where she pushed STEM and even had a STEM badge created for the girl scouts. She has dedicated her life to empowering students particularly women in the areas of STEM. During her time as Dean of the School of Engineering, she worked and changed the School of Engineering to the College of Engineering.

### **Conclusion**

This study determined the elements needed for an African American women to acquire a STEM degree. The process uncovered elements that were currently present to increase the number of African American women in STEM. The framework the study used was the Mega-Community Model. This model formed collaborations between the government, the private sector, and non-profits. The study acquired expert opinions from African American women with PhD STEM degrees. The study was a hermeneutic phenomenology qualitative study. Participants were interviewed and recorded using a pre-designed interview instruments. Responses from the participants were summarized and analyzed to gain the meaning of their experience. Patterns in responses were placed into specific codes. Finally, the study evaluated the degree of rigor of the study through member checks, expert opinions, audit trails, and triangulation.

## **CHAPTER 5: CONCLUSIONS, DISCUSSION AND SUGGESTIONS FOR FUTURE RESEARCH**

This chapter reveals the qualitative meanings of nine African American women with PhD degrees in STEM. The investigator conducted a hermeneutic phenomenological study concerned with the experience of African American women that have obtained a PhD in a STEM discipline. A hermeneutic phenomenological study is concerned with human life experience or lived experiences (Laverty, 2003). The study examined the lived experiences of African American women in STEM, their choice of the discipline they pursued, their education experience, and their experience in the work world as a PhD with a STEM degree. The focus of the study was to illuminate details within their experience that would obtain an understanding of what elements are necessary for an African American woman to achieve a PhD in a STEM discipline. This information could be used to develop programs that would increase the number of African American women in STEM.

The framework for this study was the mega-community model. In this framework a problem existed that could not be solved by an organization or entity alone. So, a collaboration should be formed between three sectors: the government, the private sector, and non-profits. The problem this study examined was the low percentage of African American in STEM in academia, the government, and in Industry. Its aim was to gain expert opinions from African American women in STEM to determine what elements were needed to increase the number of African American women in STEM. The mega-community framework deals with problems that cross tri-sectors which is the first element of its five components (Heine, 2008). The mega-community has five components (Heine, 2008). The first component was the tri-sector. In this study, the low

percentage of African American women in STEM was an issue for the government, the private sector and non-profits. The three sectors missed the rich culture, influence, intelligence, integrity, inventions, and platform design brought by the African American women (Gilmer, 2014, p. 178). This caused a lack in the robustness of the leadership of the American global market presentation (Gilmer, 2014). The next component of the mega-community was overlapping.

The overlapping component of the mega-community described the issue that was of interest individually to each member of the collaboration (Heine 2008). For the industry, African American women were needed in leadership to drive processes. African American women are needed to design, innovate and produce products and services. African American women are needed in industry to be change agents and design and invent products that other individuals don't have the live experiences to consider. An example of an outlier in this study was described by Participant I. Participant I was the chairperson of the local girl-scout organization. Her platform was STEM. When she was going out of office the STEM badge was developed for her organization. The girl-scouts of her local chapter can now earn STEM badges. Since STEM is a concern, this badge will probably go national. The inspiration for this badge is an African American woman in STEM. She is an innovator.

Academia needs tenured professors, provost, department chairs, and deans who are African American women (National et al., 2013). These women provide inspiration to African American young women interested in STEM. African American women in these leadership roles can provide mentoring and act as role models. African American women in these leadership roles can make policy decisions that enable more African



American women into the STEM pipeline. They can conduct recruitment of African American women and girls reaching them at very young ages. They can use innovative activities and develop curriculum and fairs that provide a unique interest to the African American community. They can address the African American community from an African American viewpoint with the achievement of being a leader in STEM at a college or university.

African American communities are represented throughout the United States of America (Church, 2008). African American women, therefore, should be represented in the government, the private sector, and the non-profit sector. African American women in STEM are needed to develop systems, build networks, create inventions, and conduct research that includes African Americans in the decision making of policies and procedures of this nation. The United States needs African American women in leadership roles who have an understanding and knowledge of the technological advances of the world and to create more technological advances. Society needs African American women to be part of the growth of the United States in the global marketplace. The United States also needs to produce African American women in STEM to ensure their presence in the innovations of the global marketplace. The United States needs African American women who are scientist, know and design technology, engineers and mathematician to ensure the environment is safe and that we are living efficiently (Malveaux, 2013). The country needs African American women to ensure the country is healthy and using its resources to produce the best outcome and to produce better living (Malveaux, 2013). Thus, the government as well as industry and academia needed to have skilled African American women in STEM. The next three components of the

Mega-Community model are convergence, structure, and adaptability.

Convergence in the mega-community model ensures members of the collaboration work together for the common good. No entity or person in the collaboration operates to undermine or disrupt the effort of the collaboration. Structure defines the procedures and policies that must exist to guarantee the committee of the three collaborative parties for resolution of the issue. The adaptability component of the mega-community allows the member flexibility to function efficiently and effectively. Adaptability is the component that works towards resolution of the problem overall. It also works to ensure the individual needs of the participants are met. The collaboration network is therefore measurable and malleable (Heine, 2008).

### **Summary**

The STEM stakeholders are very concerned with increasing diversity in the STEM pipeline for the current workforce and for the future. This study was conducted to assist with increasing African American women in the STEM pipeline. African American women with PhD degrees were interviewed using the AAWQIQLE instrument of 17 questions. The interviews were conducted over the phone and recorded using an electronic recorder. Each question on the instrument gained information to answer the three research questions of the study namely:

- What are the barriers for African American women competing to earn a Master's or STEM degree?
- What workforce barriers prevent qualified African American women in STEM from being assigned a decision making role?
- What are the lived experiences of AA women working in a STEM industry?

An analysis of the interview data revealed themes and patterns emerging from the data. The interview questions gained expert opinions from African American women with PhD degrees in STEM. The interviews revealed issues the African American women encountered related to pursuing their degrees. The interviews also revealed how the women maneuvered through the issues and accomplished their goals.

### **Results vs Literature Review**

**Contributions.** According to the literature review African Americans have made several contributions to the STEM fields in the past and more recently. All the women interviewed were making contributions to the STEM fields. One of our participants was the first African American and first woman to receive a PhD in Computational and Applied Mathematics (Participant – G, personal communication, May 5, 2015). She was also the principal developer of graphics for the National Institute of Standards and Technology of Mathematical Functions (Career Cornerstone Center, 2014). Because of the innovations of another participant in this study the School of Science and Technology of a University became the College of Science, Engineering, and Technology. She was also the principal investigator and co-principal investigator for major grants including STARS, STARS Plus, Graduation Academy and Science and Technology for Outreach for the State of Virginia. Another participant who is the chairman of an Industrial and Systems Engineering department designs and evaluates complex systems. She also encourages others to pursue STEM degrees. Her aim is to take the mystery out of STEM and make it obtainable.

**HBCU.** According to the literature review, HBCUs are able to assist minority students in developing self-esteem and confidence to order to successfully compete in the

global marketplace. Four of the participants went to HBCU during their undergraduate studies. One participant said she got an application from her undergraduate HBCU to do a special program at Lincoln University. This was prior to being enrolled in the school. The program was nurturing in that it gave the students a head start on study habits and doing well in math, chemistry, and biology. According to the literature review, some studies suggest students who participate in Pre-Freshman Academic Program aimed at improving the academic success of students at the University of Maryland have higher retention rates in STEM degrees than those who don't (Perna, 2009). The college also spoke with parents about their children attending graduate school while they were still in high school. Another participant commented that she was blessed. She stated she had a lot of support from her family and the university. Also, while in school she did have school loans but she had received a lot of scholarships from school. Both cases depict a sense of nurturing to ensure students completed their education.

The Literature Review stated, it is imperative that schools, parents, and the community provide the means to increase children's science and math intellect through after-school programs, tutoring programs, and homework assistance. Several of the participants discussed areas in which they assisted HBCU or were from HBCUs to increase children's K-12 awareness of STEM. One of the participant (Participant-A, personal communication, May 20, 2015) who currently works in industry stated one of her goals was to go back to an HBCU and give back. She is also involved with after-school programs teaching girls to build web pages and training them on the platforms they are using. One participant (Participant - H, personal communication, May 25, 2015) who is the chairman of a STEM department at an HBCU conducts experiments to

enhance performance for visually impaired students, as well as designs learning systems for Appalachian children. In terms of her goals she commented,

I will continue to identify pedagogies of inclusion that teach STEM in a way that is meaningful to all worldviews. There is an illusion of difficulty that is just not true. For instance, there are very difficult concepts in the humanities and fine arts that are just as complex as concepts in electrical engineering or chemistry and math. So the idea of “difficulty” makes no sense

Another participant who is the Provost for Academic Affairs at an HBCU stated her commitment to children and STEM as a college administrator. She stated,

This is what has been a passion for me for most of my career. We do a lot of outreach to elementary school. We do science fairs where we do math bees instead of spelling bees. This type of exposure made me make the decision to go to college and get a math degree in the 7<sup>th</sup> grade. My institution sponsors STEM activities starting at the elementary school. To start thinking about STEM in High School it is too late.

**Community.** According to the Literature Review, youth should be influenced to enter STEM fields before they go to college (DiLisi, 2011). Consequently, programs have been developed for children from K-12 that are focused on STEM education. These programs develop self-efficacy in children and provide them with early exposure to STEM based careers. One participant (Participant –A, May 20, 2015) commented African Americans in the past were not allowed to be educated. We are still forging our way. Children should therefore be exposed to STEM at an early age. They should use STEM in elementary and high school when their minds are like sponges and will retain the knowledge. Another participant (Participant –B, personal communication, April 9, 2015) who works for the federal government’s National Institute of Standards and Technology (NIST) commented,

I really enjoy teaching chemistry well. I like dealing with young people and teaching them chemistry. Seeing that light bulb go off in their head once they gotten a concept is great. I love that aha moment. To me that is the most

rewarding thing.

This participant also spent time in Africa teaching chemistry. According to her,“

While in Africa we gave science to all ages. Children who did not have prior experience with science thought it was stupid until we did an experiment. Once they saw some really cool stuff, they got excited about it. If you get them earlier the better and then keep them engaged. Then you can build on what you did.

One of the participants (Participant – C, personal communication, April 17, 2015) who also works for the NIST says pertaining to learning STEM at an early age,

Start at High School and even elementary level. If you understand the equation you will understand the chemistry. Always do the work because some of it is correct. Put things together and make it a reality. You have to have an imagination. No one every stopped me from believing

Another point of the Literature Review was programs that provide informal education to STEM increase children’s awareness of career opportunities and influence their decision to pursue STEM degrees in college. One of the participants (Participant– A, personal communication, May 20, 2015) commented,

We need to have an understanding the creation of the game not just the user of the game. Therefore, we need to create communities around being designers as well as consumers of technologies. It is great to have a basic understanding of how things are made.

Another participant (Participant –B, personal communication, April 9, 2015) commented we must preconditioned youth to believe they need STEM. According to her,

We don’t see black people in the field. If we google scientist, we see a white male with glasses. It’s hard for people who don’t look like to believe they will be accepted into those fields. So some areas thrive on it and need it. Other areas people have been preconditioned to think they don’t need it. Although some of our best scientist are black they are not put into the forefront.

Another important point about children in today’s learning environment. Many public school systems are concerned with children passing state standardized test. An emphasis is placed on teaching the students information to do well on the exams. Many

times science is not prioritized as a necessary subject for students to learn. Consequently, in the absence of exposure to science, children don't have the tools to imagine being scientist or engineers. One participant's (Participant –D, personal communication, April 26, 2015) comments on this issue were

We have to start as early as possible. The standardized testing makes STEM take a back seat but we need it at an earlier age. In High School students should definitely have STEM like computer programmer, communication, data analysis and excel. Having more shop classes and electronic classes are needed and should be taken by all. These classes would have helped me as a Scientist. I have to weld sometimes”.

Participant-E (Participant –E, personal communication, April 29, 2015) felt that we should assist African American and all women in the work-world by providing onsite childcare for their children. This childcare should not only be making sure their children are well cared for and fed but should also provide them with STEM programming.

According to her

The employer can contribute to the childcare program by providing some type of STEM education. There are several STEM program works going on in middle school and elementary school. We teach them cool chemistry. High School absolutely should have STEM. If we give the students sound experiences they can make sound choices in college.

Participant-G commented on pertaining to children getting a good early education and getting a good education in STEM were,

As far as academics, the US really needs an overhaul of its view of education. This is the only country I know where adults are not ashamed to admit that they don't understand mathematics. I run a sizable tutoring program of 15 to 20 students for my sorority. Even my best male students (3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup> graders) list their career goals as playing in the NFL, the NBA, or some other sports league. I see students passed from one grade to another with deficient reading and math skills. The elementary school education forms the foundation for the rest of a student's education. The skills introduced in the early years must be mastered if the child is going to have any chance of being successful in a STEM field.

The exposure to STEM at an early age and throughout the formal education

experience is pertinent. It makes STEM apart of girl's lifestyle and decreases their fears and uncertainty about STEM. It also provides a good, positive and productive way for them to express themselves. They also are building a foundation to be designers and innovators in STEM. A passion for STEM is established in young minds. "It is important to have a passion for the goals you want to accomplish," according to Participant-I (Participant – I, personal communication, June 3, 2015). According to her,

Mathematics is what has been a passion for me for most of my career and I've been very successful in the field. For the local chapter of girl scouts we have a STEM badge. When I completed my tenure as chairman of the board of the local girl scouts they created a STEM badge because my platform was STEM, STEM, and STEM. It is so critical to expose our girls to STEM. It transforms their lives.

### **Relevant Conclusions**

The relevant conclusions of this study are the elements needed to increase the number of African American women in STEM fields. It is of interest also what is required to increase the number of African American women obtaining a PhD in a STEM discipline. Further, the investigator was interested in how to overcome barriers that hinder African American women from obtaining leadership roles in STEM. Finally, the investigator was concerned with the lived experiences of African American women in STEM. Relevant conclusions from this study describe important elements to be used in strategies to increase African American women in STEM.

#### *Research question 1*

The first ingredient needed to increase African American women in STEM begins with the exposure and study of STEM disciplines through science, technology and mathematics in the K-12 education experience. The research question that should be answered is, "what are the barriers for African American women competing to earn a



Master's or PhD STEM degree? One barrier discussed by participants was not being properly prepared to compete in graduate school. Some participants felt that after going to an HBCU for undergraduate they were not as prepared as their White peers in PWI graduate schools. HBCU should be aware of this and produce graduates who can compete in parity to students who have attended a PWI. This response was somewhat surprising since most African Americans have experienced having to be twice as good to just get their foot in the door in most work environments. The expectation is that a HBCU will work extra hard to ensure their students are overly prepared for the work world and graduate school. According to Butler, African American students are more likely to obtain the master or PhD in science, engineering and business at an HBCU than at a PWI (Butler, 2009). Further, many African American students problem with unpreparedness begins with not having the higher level math and science courses during their High School years (Butler, 2009). Finally, while many times students are under prepared academically, "an HBCU generally takes a students from where they are to where they need to be" (Butler, 2009, p. 20). HBCU's routinely graduate highly successful professionals (Butler, 2009).

Another type of barrier expressed by a participant (Participant – D, personal communication, April 26, 2015) was mental barriers. STEM disciplines are very difficult and require an individual to spend time studying the information. Sometimes an individual can lose their confidence because of the difficulty of the material or subject matter. Barriers from peers who want to hinder your progress in order to get ahead. Getting into the correct environment accomplish higher degrees in STEM and never giving up on your dreams help to overcome these barriers. Also, having a good support

system keeps one encouraged during difficult times. According to Jenkins, “student’s persistence in master and PhD degrees in STEM would be boosted by an overall positive climate for success” (Jenkins, 2012, p13).

The barrier of the actual scientific work has sometime caused people to give up. Yet, in STEM, projects or experiments sometime fail. The nature of science is to keep trying taking alternative approaches until you are successful. You always have to have a plan A and a plan B. For some participants, they had to change the course of their dissertation which was discouraging. Another participant had trouble with inspiration and time when writing her dissertation. Another participant had trouble with the difficulty of the classes and always having to present their research. In order to maintain in these difficulties participant’s explained, ‘you must keep your eye on the goal’. One participant’s comments on barriers she dealt with were biases in funding decision, biases in peer-review, being overloaded with search committees, administrative work, diversity work and the lack of ethics among various funding agencies (Participant –H, personal communication, May 25, 2015). Funding is the largest barrier for African American women to pursue a PhD or Master STEM degree. Many of the younger participants of the study did not have to pay for their education because there were many scholarships, fellowships, and grants available. According to Holmes, “Latasha, a participant in her study stated, “Funding her education was a concern, so the availability of scholarships for students in STEM was an added bonus or option for a physics major. Latasha felt supported in her STEM courses at her undergraduate institution and felt well prepared for her graduated studies” (Holmes, 2013, p. 15). Nevertheless, information dissemination is one of the issues concerning African American Women knowing where to find funding

opportunities. For this reason, “STEM stakeholders have called for increased research, funding, and other initiatives to support and sustain individuals who study and work in these disciplines (Holmes, 2013, p.15). Universities providing STEM education therefore can provide African American women with funding to go to school as well as stipends to live on while in school. Increasing African American women in STEM is important according to Holmes because “STEM is linked to national security, innovation, sustainability, health care, and maintaining vital infrastructures on a national and local level”(Holmes, 2013, p.15).

Finally, the gender and racial biases were experienced by many of the participants. One participant who attended a PWI dealt with bias in funding decisions, bias in peer-review, dealt with being overloaded with search committee, administration work, diversity work and the lack of ethics among funding agencies. This participant (Participant – H, May 25, 2015) personal communication, was mature and had her PhD since 1998. Her responses probably came from her school and work experience. While her PhD was obtained at an HBCU, her undergraduate and master degree was from a PWI. Also, she was a professor at a PWI during her work experience and now is the chairman of an Industrial and Systems Engineering at an HBCU. While obtaining her education and in the workplace and through her social organizational leadership and membership, she stated the racial and gender biases she experienced were:

- Having my capabilities underestimated.
- Not being invited into study groups in graduate school.
- Not being given inside information or not being in strong networks.
- Incompetence of academic administrators, leadership: many are not trained at all in inclusive excellence.

- Refusing to take on the “look and feel” of a minority. I will not be silent at meetings and I refuse to straighten my hair. I am also not soft and nor do I take on submissive behaviors. This upsets White people on a sub-conscious level. It is hard for them to deal with such a personality – one that comes in with no apologies and who takes just as much privilege as they.

Reviewing the comments of this participant encompasses many of the experiences of African American women now and in the future. In professional situations, many universities and colleges still feel having women in STEM fields are an anomaly especially for African American women. There is a preconceived notion that African American women should only be in some type of “Mama” role and not in a role where they are able to lead technological advances and innovation. The truth is, African American women have had to run households and still hold very important positions as well as having to be better than their White counterparts to even be in their mist. A lot of times particularly in PWI’s, African Americans have had to find their own way. Either you have to be in the minority position of being needy or be loud and stereo typical hard and harsh to be accepted in the White majority networks. This makes you a thing and not an equal person competing on an equal basis, with the capability and intelligence to be part of the group. One participant (Participant –F, personal communication, May 2, 2015) commented that her professors and peers in her STEM doctoral program thought she was Caribbean. Generally, African American women have been treated as less than or not as equipped as their international counterparts. While international students have their gifts and talents and educations, African Americans have endured and excelled the racial and gender prejudices of the United States of America. A lot of times is the faculty and staff are not trained in the inclusive excellence. According to Rudman et. al.,

training led by an African American professor may have positive effects on both implicit and explicit prejudice and stereotypes (Rudman et al., 2001, p. 364).

*Research question 2*

The next research question to discuss is, “What workforce barriers prevent qualified African American women in STEM from being assigned a decision making role?” Participants reported many different reasons qualified African Americans are not assigned to decision making roles. Some reasons included not knowing the position was available or if known a White or other minorities have already been slated for the position. African American women believed the status quo majority feels entitled to the leadership positions and are therefore blocked from being considered for the position.

One participant (Participant – F, personal communication, May 2, 2015) commented,

A sense of entitlement and privilege exist within the leadership. This belongs to white men first and then the white women or black men. If you are a Black woman it's a much larger barrier. If you don't have European looks even as a Black woman the standards are not the same.

One example of a different standard is a case in which an African American woman who is a president of a university. This woman is single. A clause in her contract is that she cannot have overnight male guests in the Presidential house. That's a ridiculous clause. The clause probably would not exist in the contract if the president of the university were male and single.

Another participant (Participant – E, personal communication, May 28, 2015) commented that those making the hiring decisions don't believe the African American women are not smart enough or capable of being in leadership decision making roles. African Americans in general are perceived as infiltration. While the mind of the decision maker is not known, the result is the African American woman not obtaining the

leadership position. This participant felt there was an element of fear operating. Basically, the decision makers are trying to protect their own roles. It is very difficult to overcome someone trying to protect their position. Sometimes sabotage is experienced and blatant disrespect. Other times, an African American can go through the hiring process but is not considered for the role. The law has been met but there is a reason given that depicts her lack in some area from not obtaining the role.

Working in corporate America many years ago, I experienced people who did not have the qualifications I had but did have networking opportunities that I was not invited to participate. My counterparts spoke the same cultural language of the decision makers that gave them the edge. In order to overcome this phenomenon, one participant stated, you need to have mentors who support you. An African American may have to work harder to find a mentor and therefore must ask questions of her counterparts or get the information wherever she can. Also, participate in training opportunities and conferences that give information about succeeding in your field. According to Galloway, “studies on women of color in STEM have identified major obstacles to success. Additionally, studies suggest that isolation inhibits success academically (Galloway, 2012, p39).

Isolation also negatively affects African American women in STEM in their careers. Isolating oneself from the group is deemed to be not a team player. According to Gilmer, “Isolation is a major factor that impacts the success of women STEM faculty. Compared to their male colleagues, women STEM faculty feel isolated, lonely, and mistreated, and they feel they do not fit in or belong to their department “ (Gilmer, 2014, p. 99). One participant advised women interested in PhD’s in mathematics or statistical sciences should attend possibility conferences. These conferences give guidance to

minority women pertaining to these fields and on gaining the PhD in these fields.

Conferences given by the IMA (Institute for Mathematics and its Applications) located at the University of Minnesota offer such programs to assist minorities to succeed in the mathematical sciences. Employers generally provide funding for their PhD's to present papers and to attend the major conferences in their field. Participant I (Participant –I, personal communication, June 3, 2015) explained, this will require having a balanced personal and professional life. The NSF (National Science Foundation) gives assistance in these areas and helps women to navigate their professional degrees.

### *Research question 3*

The final research question to be discussed is, “What are the lived experiences of African American women in STEM?” The experiences of the participants were all unique. One expected experience given by Participant-B was that minorities tend to get inspired (Participant –B, personal communication, April 9, 2015). According to her, someone sees the success of an African American woman in STEM with a PhD and believes they can also obtain that success. Participant is also very inspiring because she because she is only 31 and has had her PhD for 4 years. She explained having the PhD has given her the opportunity to speak about chemistry and science to young people. The dialogue begins with what made me choose chemistry. I am able to speak about my interest but also to get them interested in chemistry and science. This turns out to be an unofficial recruitment into STEM. This same participant gave the testimony that during her graduate school education one of her professors said he would let her sign up for his class. But he also told her she wouldn't do well because she came from HBCU. She turned the negative into a positive and ended up getting the highest grade in the class.

Her comments about herself are, “I’m the type of person that can show you better than I can tell you”. It is imperative that African American women going into STEM have the support of family, their church, their community and supportive mentors. These degrees are difficult requiring talent, perseverance, confidence, and encouragement. According to Hrobowski, “mothers of these women have sent an important message to their daughters: that obstacles and challenges are inevitable, but that individuals have the power to overcome the odds and succeed through hard work, self-discipline, and perseverance” (Hrobowski, 2002).

Another participant explained the great opportunities she acquired because of PhD in mathematics (Participant – G, personal communication, May 15, 2015). According to her obtaining this terminal degree was the best decision of her life. She has accomplished innovative research and have enjoyed creating new ideas, new codes while inspiring others. She has had the opportunity to publish her works and present them at conferences throughout the world including Canada, Oslo, Norway, Madrid, Spain and Paris, France. Her only complaint is not having enough time to accomplish everything she would like to do. She spends a lot of time with at-risk youth, tutoring, and giving presentations to middle school, high school and college students. While being an innovator, this participant makes sure the youth are exposed to higher levels of math and new mathematical technologies.

Being an African American women in STEM people tend to automatically believe you are an international Black women from another country. One participant (Participant – F, personal communication, May 1, 2015) discussed some events that made an impression on her. The first was in her doctoral studies as an environmental engineer



attending a PWI, people had preconceived notion that Black people of this nation would not be studying or obtaining PhDs in STEM fields. One person even asked her mother if she were Sudanese. This same participant had a professor on her defense committee who stated publicly African Americans were less qualified than their White counterparts. This is an example of institutional racism. This type of racism operates in the educational experience as well as the work experience for African American women. In STEM it is more defined because there is also the gender discrimination for women. For African American women, it's a double edge sword. According to Rattansi,

“Institutional racism relies on the active and pervasive operation of anti-black attitudes and practices. A sense of superior group position prevails: whites are “better” than blacks . . . This is a racist attitude and it permeates the society, on both the individual and institutional level, covertly and overtly.” (Rattansi, 2007, p. 132)

Another participant who is the chairman of an Industrial and Systems Engineering department at an HBCU experiences this phenomenon even at her level of leadership, decision making and success. According to her,

The implicit and explicit biases against women and ethnic minorities have been a day-to-day struggle. I cannot think of a workday where I experienced ZERO micro-aggressions. Every workday is full of micro-aggressions associated with biases based on gender and/or ethnicity. The Ivory Tower is essentially a “Tower of Babel.

Few are capable of functioning authentically in a diverse and inclusive culture; few are culturally competent to build such a culture; and no one wants to have a real dialogue about any of it. In my lived experience, we as scholars have failed to deal with diversity and inclusiveness; thus we can't possibly prepare our students adequately” (Participant – H, personal communication, May 25, 2015).

In this era of cultural diversity, America has become a melting pot with all kinds of people from all nations. The new racism is concerned with not being racist against other cultures. In this new racism the unique issues of African Americans takes a back

seat to cultural diversity and becomes irrelevant to the masses. Consequently, our educational systems in our children's formative years remains inferior to other communities. Thus, less of African American children go to college. Those that do go to college face minorities of other cultures with higher levels of math and science courses and thus cannot compete on parity levels. According to Littlefield,

as educators, we have to address the pedagogy of how people define the continuing effects of racism and understand the extent the racism and cultural diversity as part of our social structure permeates and controls the minds of the oppressed, namely African Americans. (Littlefield, 2008, p.682)

In regards to this same issue one participant, an academic provost, said "the barriers in the workforce are racism and sexism . . . attitudes must change, and this will occur with a new generation" (Participant – H, personal communication, May 25, 2015). We have to develop systems that overcome these societal pitfalls.

### **Limitations of Data Collection**

During the actual data gathering process several issues occurred pertaining to recording the interviews and obtaining the interviews. Approximately 75 letters were sent out to the Black Science Network, National Institute of Standards and Technology, various HBCUs, mentors, friends, and relatives who had contacts with African American women with PhDs in science, technology, engineering or math. The investigator was interested in acquiring 20 interviews. But only nine interviews were acquired through the data gathering process.

Setting up interviews became somewhat difficult for the investigator and

participants due to the participants very busy schedules. Several interviews had to be rescheduled due to changes in participant's schedule. In the case of two participant's, their schedule didn't allow them to spend an hour interview. For these participant's the AAWQIQLE instrument was emailed to them. These participants filled out the interview instrument and returned it to the investigator by email. Each interview was sent out to participants for member checking to ensure the summary of the interview was correct. One participant returned a response that was updated by the investigator. During the taping of an interview, the participant's voice was very soft. For this summary, the investigator had to turn the recorder to the highest volume to ensure all information was adequately gained.

## **Discussion**

Originally, I anticipated African American women have had biases due to race and gender. I did find instances of this occurrence. Actually, it was a common occurrence African American women can relate to across all disciplines (Benard, 2006). But, in STEM the difficulty of disciplines is so stressful and intimidating. The intensity of the STEM programs, family pressures, the politics of graduate school coupled with gender and race biases causes some women to quit. Yet, for those champions that cross the finish line and enter the winner's circle, the reward is worth the journey. Also, the strength of accomplishment, the respect of the degree and the opportunities and exposures gained from this accomplishment is an ongoing catalyst for innovations and new creations.

Another common theme was the wisdom of the women and humility whether they had their doctorate a few years or many years. All the participants had an interest and a goal of improving their communities and ensuring African American women and girls were in the STEM pipeline. All participants had a compassion for people and a desire to make STEM understood and to make science, technology, engineering, and math obtainable and interesting to those coming after them. All the women spoke of staying focused, keeping your eyes on the goal, and remember the light at the end of the tunnel. Many women had the concern of being viewed as not anomalies but people who had achieved and therefore those coming behind them could achieve these degrees and positions also. A few participants did not personally experience racism and sexism but was in the presence of it occurring to another individual. One thing the African American community must do is to celebrate our achievements as African American women and girls (Boyle, 2015). We also must overcome the mentality of cutting down one another. The African American community needs to instead lift up one another. The African American community needs to see that each person is important in their own gifts and talents and not only embrace a few and ignore others. African American girls and women need to be nurtured, protected, encouraged and celebrated. Finally, an outlier spoken by one participant was could we just have an even playing field so that we don't need minority special scholarships in order to be a part of the innovation of the present and future.

In terms of who should review this report, since the theoretical framework of the study is the mega-community model, the government, the private sector, and non-profits should review this study. From the study, each entity should come together in a

collaboration and develop a strategy that specifically increases African American women in STEM.

### **Suggestions for Future Studies**

The people who should begin the conversation are non-profits. Non-profits for this endeavor should include colleges, universities, community organizations, K-12 school systems, and churches. These organizations should contact local governments and gain cooperation and begin a dialogue. From this collaboration the corporate social responsibilities of various companies should be contacted to join the collaboration. This mega-community collaboration build the strategy, recruit participants into what they have built, and implement the strategy. An evaluation agency needs to be part of this collaboration that determines how successful it is. Success can be measured by the number of participants recruited, the number of participants that went to college and completed a STEM degree, and the number of participants that obtained a STEM job.

Another study that could be done is a study on the participants of collaborations formed to increase African American women in STEM. An interview using the AAWQIQLE instrument to compare the results of those interviews with the results of this study could be conducted. From the information gathered, STEM programs could be developed and presented to the government, the private sector, and non-profits to form new collaborations. A study that forms non-profits programs developed from the needs given by the women in this study could be examined. These needs should include funding, counsel on where to find funding, scholarship for childcare and eldercare, stipends to live on so the individual can dedicate themselves to their study, mentoring, internships, and then career placement after graduation. Young people who are at-risk also need

assistance in preparing college applications and a seminar on what to expect once they get to college.

From the results of this study, I will develop a STEM non-profit that prepares girls and women for college and in preparation for higher learning graduate studies. This non-profit will have STEM training and tutoring to prepare the African American girls to produce at parity levels with their White counterparts.

A future study could include arts in their STEM programs. This new programming would be called science, technology, engineering, arts and math (STEAM). A non-profit program that conducted math tutoring, science tutoring, reading tutoring, and homework assistance also had instrument training to build an orchestra, theatre, and dance. While this program was not able to continue due to funding, the orchestra was successful and all the children in the program got better grades due to the tutoring they received. The tutoring was conducted by retired school teachers. This was a church non-profit program. The program also conducted two large theatrical events for Easter and Christmas. The program was conducted long before the acronym STEAM was coined. A future study describing a program of this magnitude could be done as a proposal for a dissertation. A future study could plan the event as well as secure the funding and actual implement the study giving the results of the program that churches, the community non-profits, schools, higher education, the government, and the private sector could use to form a collaboration. Lastly, future studies should study companies that have special programs as part of their diversity human resource efforts to increase African American women in their corporations.

As African American women in STEM, having all the valuable information, what

should the thrust be? The findings of this study should be presented to the STEM coalition to institute programs to accomplish these goals to ensure African American women have an active leadership role in STEM. This study included putting the support elements results into the community, the middle to high school education systems and institutions of higher learning. African American women begun to view themselves as an entity that is growing and moving forward. In order to be successful African American women must ensure the pipe line from K-12, through college up to the PhD is filled with the younger sisters who are equipped and able to work on parity levels with their counterparts. African American women have to go to their communities and choose young women to mentor, and redirect them in order to hand off their batons to them to keep running the course, keep innovating, keep developing, keep strategizing, keep planning and implementing. African American women have to know their craft, be the best at what they do and train their younger sisters coming behind them to do the same. African American women have to wrap their arms around their young people, their neighborhoods and small children. African American women have to raise the next generation up in STEM. Science, technology, engineering and math has to become a natural part of life. African American women have to become the inventors, the designers, and the creators not just the users. Once African American women have obtained a leadership position, they have to make sure to train other African American women to follow them. African American women have to raise the standards of their children, their people, and operate at that standard.

One of the participants (Participant – G, personal communication, May 5, 2015) who works for the National Institute of Standards and Technology (NIST) stated one problem she has encountered in her career is that she does not have a model to follow.

According to her, when you have a Ph.D. in the mathematical sciences, you basically create your own career. In general, people don't tell you what to do. You have to figure it out on your own. I also noticed that the more successful you are (publishing papers, getting your work acknowledged), the more control you have over your career.

Nowadays most people are not hired right after receiving their Ph.D. They usually come to my agency because they have been awarded a post-doctoral position or they have research experience either from another post-doctoral position or another job. Although it can extend the time it takes to obtain a permanent position, a postdoc can provide you with a valuable mentor and give you some time to build up your research credentials. To keep growing in your career, however, it will be necessary to continue learning and making new contacts to build collaborations that expand the influence of your work.

This example talks about being innovating. You have to set your own stage. Build your own model. Develop your own career. Do your work, get it published and present it to your peers. Keep learning, keep developing, and don't ever be stagnant or complacent. These are goals for African American women as a whole. But for African American women in STEM it is the road to success.



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**APPENDIX A**  
**PARTICIPANT SUMMARIES**

## PARTICIPANT SUMMARIES

Participant - A

African American Women Qualitative Interview Questions of Lived Experiences

(AAWQIQLE)

1. What are the lived experiences of African American women in STEM with a doctorate degree (Goes, 2011)?

*Unique Experiences as AA women – I don't have specific scenarios or experiences that are significantly different. Have not felt some level of discrimination being in the working world due to being an AA women in STEM. Applied to a number of places like Indiana, Georgia and several other places. I was offered some of these positions but I felt I would not have the quality of life I wanted.*

2. What are your positive experiences pertaining to getting your STEM education?

*In general, STEM programs as an Engineer has helped me in life in general. Specifically as Industrial Engineer, Input – Process –Output. We have to do some level of science and mathematics. Basic concepts useful in life. Learned about some aspects of Civil Engineering, Electrical Engineering and Chemistry. Social Media using web-based platforms. Basic concepts and ways of thinking. Allows you to know how social media is processing, how it was created, how designed. No longer just a user but also understanding that we are an information society. Learned this useful information. I may not be an expert in the field of apps but I know something about the design and processing of the App or software like Facebook or Webpages. Exposure to digital technologies. Doctorate degree because that's what I enjoy. Having a PhD in STEM gives me opportunity to share and encourage others to do the*

*same. Volunteer at middle school to build mobile apps. Exposure to logic in programming for children.*

3. What are your negative experiences in getting your STEM education?

*Not negative because of race or gender. Graduate school in STEM is very challenging. One incident in undergraduate where a young man was not please that my GPA was stronger than his. Some people were jealous with my level of achievement. That is there and there is some challenge with the male, female in STEM. Did not personally encounter other incidents of it but my friends did. Just have to work through it and focus on your goals to the best of your ability.*

4. Why did you pursue an education in STEM?

*Strengths and Interest were in STEM. Design and using mathematics in problem solving. Design something that others can use.*

5. What are the goals you plan to achieve using your STEM education?

*Ultimately academia is my goal and all that it brings, teaching, service and inventions.*

6. What barriers, if any, have you encountered to achieving your goals?

*Challenges many. In Grad school for nine years. Feeling not perfectly prepared to enter some of my classes like not having enough statistics. Perseverance and answering questions. Have to manage workload. Had external fellowship so I had to find my own dissertation and pull together the research. Came up with a topic which was both qualitative and quantitative. Went into urban environment and create my lab in the field. Gaining the trust of the individuals of the community I didn't live in.*



7. What racial or gender biases did you encounter in your pursuit of your education in STEM?

*Did not have these problems. Professors were progressive and were male and female. Others did but I personally did not.*

8. What type of support did you receive to get your education in STEM (i.e. grants, scholarships, mentoring...)? From family? From the government? From the private sector? Please explain if the support was adequate or if some other type of support was needed. *I had a tremendous amount of support. \$100K scholarship to support me to acquire PhD in STEM. Goal for me to go back to an HBCU or other program and give back. Went to school and receive additional funding toward tuition and fees. Got 2 additional fellowships and received an additional \$20 thousand. Go another \$20 from the Ford foundation. Support for development as a researcher. Administrators and professors sent me to conferences across the world. Went to New Zealand and Italy with the NSF. Conference was for people who would be negatively impacted by digital divide. Belong to the Black Engineers that we fellowshiped. Familial support and Black Administrators and professors encourage us and feed us. All the support was absolutely necessary. Support was very rich, financial, professional support, emotionally support and academic support.*

9. Were there any barriers you encountered to completing your master degree or doctorate degree in STEM? How did you overcome these barriers? *Had a lot of mentoring and peer support. You really need to stay focus on your goals and look for the light at the end of the tunnel. You should not spend time worry about those who don't like you or why. You have to stay true to yourself.*

10. What advice would you give to an African American woman desiring to obtain a Master or Doctorate degree in terms of choosing the degree to pursue? What advice would you give in terms of career goals (i.e. certifications, companies to pursue)? *Be true to yourself. People look at numbers and potential earning. Stay true to yourself, do what you love to do, do what you love learning about, what will get you to where you want to go. In terms of a career being professional.*
11. How would you define leadership decision-making roles? *My motto for leadership is that it starts with respect. Going to be working with people who need to have your respect of them. Known to be respectful of their abilities, limitations, goals and desires. People will work hard as a team member if they know you respect them. For decision making, the very basic thing is a backbone and justify your decision. Fortitude.*
12. What type of career training does an African American woman need to be promoted to a decision making leadership role in STEM careers and regions (i.e. Silicon Valley)? *First thing is know your craft and be good. Master your craft. Your decisions impact your clients and your employees. You have to be skilled at your craft. You have to be proven in the area you want to lead in. Credibility will come with mastery of your craft.*
13. What are the different types of attitudes toward STEM are found in different regions across the United States? For example, Silicon Valley is very interested in STEM. However, in other regions what are the attitudes toward STEM? *Do not have sources but came make a conjecture. Nationally STEM has come to the forefront because the President has made it a priority. It is geographic and economic. Areas that are*

- disadvantaged don't have opportunities to explore. Silicon Valley and Universities have the financial backing to provide STEM opportunities. Understanding the creation of the game not just the user of the game. Creating communities around being consumers of technologies. Great to have a basic understanding of how things are made.*
14. What changes need to occur in the industry to open more opportunities to African American women? What changes need to occur in academia to open more opportunities to African American women? *Need to be more focused on giving away information. Individuals will pick careers that they know about. Willing to teach what we are doing and let them be involved in it.*
15. What workforce barriers need to be overcome that prevent qualified African American women from acquiring leadership decision making roles in STEM? *Don't think my role professionally has given me knowledge. Generally engineers have the same goals. Requirements gatherer for a concept management system. Set up another concept management system is new to the end user when transferring data to enhance to the end-users experience. End-users sometime is difficult. Convincing the end-user.*
16. What assistance is needed for African American women who are enrolled in Master or higher STEM degree programs? *Financial support, mentor support, academic support to help you navigate through your program. Need professional development support, teaching tone in your emails and word choices in your emails. Need assistance in child-care. Depends of what going on in your life.*

17. Would STEM education be beneficial in elementary school? *Yes!* Would STEM education be beneficial in high school? *Yes. Exposures to the information and because their minds are like sponges. Take ownership. AA won't allow to be college educated. Still forging our way. What can I do to change the situation?*

Participant - B

African American Women Qualitative Interview Questions of Lived Experiences  
(AAWQIQLE)

1. What are the lived experiences of African American women in STEM with a doctorate degree (Goes, 2011)? *When other minorities see me, they also tend to get very inspired. I often have people ask me how did I get here or what made me go into chemistry or science? Most people don't expect African American women to hold a Doctorate degree in STEM. However, most people see someone doing good for themselves, embrace it and want to learn more.*
2. What are your positive experiences pertaining to getting your STEM education? *Obviously getting my degree and doing something to make my parents happy. I really enjoy teaching chemistry well. I like dealing with young people and teaching them chemistry. Seeing that light bulb go off in their head once they gotten a concept is great. I love that aha moment. To me that is the most rewarding thing.*
3. What are your negative experiences in getting your STEM education? *When I went to graduate school one of my professors said he was going to sign me up for the class but I wouldn't do well in the class. He was basing that opinion off the fact that I was coming from an HBCU. He was basically looking at how I looked.*

- I was actually able to turn that negative into a positive by getting the highest grade in that class. I'm the type of person that can show you better than I can tell you.*
4. *Why did you pursue an education in STEM? I always liked science. I was a child that asked her parents for a microscope. My parents were both science majors as well. They both have their degrees in Physics and went on to get their Masters in Engineering. Science and Math were heavily used in my household. When I was having trouble with my homework my parents were always willing to help. Like even now, my Dad teaches math. What really solidified me becoming a Chemist was in the 10<sup>th</sup> grade, I took my first chemistry class with Mr. Sackerledge. I loved the class because it was a combination between Math and Science. I was having trouble in the class. Mr. Sackerledge pulled me to the side and showed me the number of A's and B's in the class. He told me the last A was me. He said you technically have a B percentage wise but I know you can do better. He saw something in me and from that moment on I busted my butt so that I didn't let him down for giving me that little push. (These are innate characteristics formed in those who are pursuing higher paths in life. For me, I pushed my son but always was able to help him in math and science. I was not looking at it as something special. I just automatically did it.) From that day on I made straight A's in that class for all the remainder of the 3-9 week semester. And since mentorship was formed between us, Mr. Sackerledge allows me to come back and teach some of his labs.*
5. *What are the goals you plan to achieve using your STEM education? My major goal right now is to get more minorities and more women excited about science. I just got back from South Africa. My job was to promote STEM education for 3 months.*

*Had outreach programs and developed programs for people who not be able to afford certain chemicals or may not have a teacher who knows the science of the chemical. Take labs to people who cannot afford a certain household items and show them how to use them and where they can find such items anywhere. I am veryvery passionate about having quality education. I want to make the learning experience easy for the teachers as well as the learners. I try to convert the hard subject into an easy subject. Science and Math are universal languages across the world. Yet the US tends to lack and women and minorities tend to lack in their mastery of it.*

6. What barriers, if any, have you encountered to achieving your goals? *I really have not had major barriers because especially as it pertains to my career, things that I set my mind to come to fruition. Like the position I have now they really didn't have space for me when I interviewed. While I was unable to take the job when it was offered immediately because of obligations to another job taken in the interim, I was eventually placed in this job. Barriers was timing. When it didn't have initially it did eventually come to fruition.*
7. What racial or gender biases did you encounter in your pursuit of your education in STEM?
- Racial, I'm not going to get it is because I was the Black girl in the group. I didn't deal with any sabotage in the lab or anything, but I did deal with a lot of things.*
8. What type of support did you receive to get your education in STEM (i.e. grants, scholarships, mentoring...)? From family? From the government? From the private sector? Please explain if the support was adequate or if some other type of support was needed. *Scholarship from church. Became part of the SHIP program. Had*

*my full tuition covered the 3<sup>rd</sup> and 4<sup>th</sup> year. Lincoln scholarship in grad school. Had many scholarships. Going to any STEM programs should not pay for their education at all as long as you have a 3.0 average. Align yourself to people who know about scholarships.*

9. Were there any barriers you encountered to completing your master degree or doctorate degree in STEM? How did you overcome these barriers? *Research is a big barrier because 65 to 70% of the time your research is not going to work. Your friends become your savior because they are going through it too and encourage you. I don't to fail.*
10. What advice would you give to an African American woman desiring to obtain a Master or Doctorate degree in terms of choosing the degree to pursue? What advice would you give in terms of career goals (i.e. certifications, companies to pursue)? *My biggest advice I would give not just for a science field, but any field is to do an internship. In my experience just because it looks cool on TV you might actually hate it when you get there. If you want to be a doctor shadow a doctor, if you want to be a pharmacist, shadow a pharmacist. Even though the money is good when you get to the job you might actually hate your job. Other scenarios is that you love the job but the pay for it, you can't live on. So it's all about experimental. I did many internships outside my field. I'm an analytical chemist but I did internships in bio chemistry, inorganic research, etc. so I know I don't want to do those things. It is important to go around getting hands-on experience.*
11. How would you define leadership decision-making roles? *Leadership abilities go along with your personality. Some people are natural born leaders and some people*

- learn it. Sometimes you have to work with people you don't like or don't know but you have to get the job done. Therefore you need your leadership abilities. You need to be able to work in a team and allow people to voice their concerns but you still have to keep everyone focused on the overall goals. In order to advance your career and show that you can dictate to people what needs to be done and accomplish the goal, it will be very hard to advance in your career.*
12. What type of career training does an African American woman need to be promoted to a decision making leadership role in STEM careers and regions (i.e. Silicon Valley)? *It is specific to your job but you will always need strong computer skills and know how to do a budget. You would want to know how to handle confrontation in the workplace. You want to attend leadership training where you would learn how to multi-task. Become an expert in my field. Be a grant writer.*
13. What are the different types of attitudes toward STEM are found in different regions across the United States? For example, Silicon Valley is very interested in STEM. However, in other regions what are the attitudes toward STEM? *Most people always say I don't need science I don't need math. They don't realize the reason they walk and breathe and talk is because of science and math. While people want to say they don't need it, they use it every day. Like for example the cell phone. I think most people are scared of it because it's been told black people are not good in math and science. Preconditioning. We don't see black people in the field. If we google scientist, we see a white male with glasses. It's hard for people who don't look like to believe they will be accepted into those fields. So some areas thrive on it and need*



- it. Other areas people have been preconditioned to think they don't need it.*
- Although some of our best scientist are black they are not put into the forefront.*
14. What changes need to occur in the industry to open more opportunities to African American women? What changes need to occur in academia to open more opportunities to African American women? *Most establishments try to bring in X amount of black people or minorities if to only have the quota. The problem is the information is not being put out there. Most people don't know where to find it. It needs to be advertised and promoted more. It needs to be pushed more. The black organizations in chemistry only has their conference once a year. Therefore people don't really know what's going on.*
15. What workforce barriers need to be overcome that prevent qualified African American women from acquiring leadership decision making roles in STEM? *Advertising, a lot of times I have to go out and seek things. Things need to be more transparent.*
16. What assistance is needed for African American women who are enrolled in Master or higher STEM degree programs? *It always good to have a mentor in that time of your life. You need someone close to your age to give you positive reinforcement. African American women had children and family issues while I was in school. I had my own issues. Assistance for child care, elder care, and transportation is needed across the board not just for African American women.*
17. Would STEM education be beneficial in elementary school? Would STEM education be beneficial in high school? *Absolutely and younger if possible. While in Africa we gave science to all ages. Children who did not have prior experience*

*with science thought it was stupid until we did an experiment. Once they saw some really cool stuff, they got excited about it. If you get them earlier the better and then keep them engaged. Then you can build on what you did.*

Participant - C

African American Women Qualitative Interview Questions of Lived Experiences

(AAWQIQLE)

1. What are the lived experiences of African American women in STEM with a doctorate degree (Goes, 2011)?  
*Minority Fellowships (Native American, African American and Puerto Rican) allowed me to focus on school and have an easier time. Therefore my lab did not have to pay for me. Another fellowship allowed me to do a guess research assistant at another institution.*
2. What are your positive experiences pertaining to getting your STEM education? *Able to teach an upward bound chemistry courses alongside high school teachers. Able to be a mentor for a lot of students who have come after me in the graduate program. They look up to me as a big sister. I was able to give them good advice so they wouldn't make the mistakes I made.*
3. What are your negative experiences in getting your STEM education? *Coming from an HBCU the level of education in Chemistry didn't prepare me completely to come to graduate school and do well. I struggled the first two years. But, once I got my bearings I did well. Some of the students coming from PWI had an edge over me. I took an organic chemistry class but I don't know what I learned. I received an A. But later on I paid for it.*

4. Why did you pursue an education in STEM? *As a kid my sister and I watched the files. I wanted to be a forensic biologist. It's hard to get in. Things on TV are not like real life. I had a passion for teaching, a high school chemistry teacher. Greatest thing about university I wanted to do chemistry. I got an application about going into chemistry and do a special program at Lincoln. They gave us a head start on study habits and doing going in math or chemistry or biology. They told our parents about grad school while we were still in high school. They have programs like that now.*
5. What are the goals you plan to achieve using your STEM education? *I would like to be permanently hired. I have to write a publication and presenting it at a seminar. I want to continue to be a scientist in lab as I'm doing now and moving up the ranks. Talk about research, go to each other practices and encourage one another. I want to encourage youth to be more interested in math and science. Mentor for a young African American gentleman. This is a good job and I'm a learning mode all the time.*
6. What barriers, if any, have you encountered to achieving your goals? *Leaving my undergraduate institution, taking a year off and feeling inadequate. International students are very intelligent. We do presentation better than the international students but their grades were better. Being humble went a long way also. Had a great advisor who was like a father to me. Meeting with him was like a therapy session. Taught his research labs.*
7. What racial or gender biases did you encounter in your pursuit of your education in STEM? *I thought it was interesting. I could pick my own lab because I had my*

*own money. The males in our labs were resistant to the 5 women in the labs. Tried to make us join a different lab. Now it's more wide open for women as opposed to maybe 15 years ago. Have not had too many biases gender or racial. I've seen a white female who wanted me to join her lab because I had my own money. We went on a tour at University of Mass from Lincoln University. The first time I saw her she said I was sleeping in her lab as an undergraduate school. She gets away with strange comments and superiority over folks. If you part of someone's lab they have to come up with the money for you to be in school. Either work study or they pay you out right. But I came with my own money. If they want you in their lab they have to pay for you. I had my own funding so I could choose my lab. You have health insurance and benefits. Just like having a job. \$21,000 a year. Graduate students teach the labs.*

8. What type of support did you receive to get your education in STEM (i.e. grants, scholarships, mentoring...)? From family? From the government? From the private sector? Please explain if the support was adequate or if some other type of support was needed. *Support was adequate. You have to keep a 3.5. By summer I had a 3.4 and lost the scholarship. Chemistry tutor. Lots of fellowships and grants. Support from scholarships, mentors at Lincoln, great advisors from University of Mass. University of Mass sent us to great internships, chance to work in labs and research. Exposed us to what we like and what we didn't like. I was able to go to University of Miami. I was able to go to France.*
9. Were there any barriers you encountered to completing your master degree or doctorate degree in STEM? How did you overcome these barriers? *My first project*

*failed. Had to come up with another lab. Had trouble writing. I was inspired going to the office. Time crunch in writing dissertation. First year the level of how difficult the classes were and always had to present. Went from Bachelors to doctorate. So at Univ of Mass you go straight through. If you get a Master's you have to pay for it. You should receive the doctorate or it send a negativemessage.*

10. What advice would you give to an African American woman desiring to obtain a Master or Doctorate degree in terms of choosing the degree to pursue? What advice would you give in terms of career goals (i.e. certifications, companies to pursue)?
- You have to start early and stay on top of your grades. Get research experience even if it is volunteer. There are high school students who have worked in research laboratories already. Build your resume, read your textbook, read research paper, know your professors research and flatter people by being interested in their work. Find a mentor to help you through the field. I am being a mentor.*
11. How would you define leadership decision-making roles? *Work for the government. Sometimes leadership is in the way but sometimes it gets you away from the lab and research. The qualities needed are.*
12. What type of career training does an African American woman need to be promoted to a decision making leadership role in STEM careers and regions (i.e. Silicon Valley)? *National Institute of Standards and Technology in DC in the government a region where the STEM degree is mandatory. You have to have STEM in Silicon Valley. STEM is so precise. Outstanding research and publications. Present research everywhere. Have many collaborations with other scientist. Run a committee and build up your performance report. Depends on what upper*

- management sees in you. Could be tapped out at your level. Leaders are on a leadership tract. Some people don't want leadership positions. Other people want to move up and out of the laboratory. You have to want to be leading.*
13. What are the different types of attitudes toward STEM are found in different regions across the United States? For example, Silicon Valley is very interested in STEM. However, in other regions what are the attitudes toward STEM? *People feel a sense of pride but also a sense of intimidation. People run away from science in math. I get accolades but people really don't relate to us. People look at it as if it's impossible to achieve this. I'm from Brooklyn and the people think I represent them. I still listen to my music. Completely relatable. I'm not giving up myself but increasing myself.*
14. What changes need to occur in the industry to open more opportunities to African American women? *Start at High School and even elementary level. If you understand the equation you will understand the chemistry. Always do the work because some of it is correct. Put things together and make it a reality. You have to have an imagination. No one every stop me from believing. Family gave me advice on life. We need to support one another.*
15. What workforce barriers need to be overcome that prevent qualified African American women from acquiring leadership decision making roles in STEM? *Know how to behave and your attitude. People would not be intimidated by my White girlfriend. But they are intimidated by me because my hair isn't straight and how I present myself. Are we supposed to be taken care of at work, or are we supposed to*

- take care of work? I got many opportunities because I was black. You just have to do the work.*
16. What assistance is needed for African American women who are enrolled in Master or higher STEM degree programs? *It would be great if we didn't need assistance. We need an even playing field. Trying to get an alternative work schedule – White women. She said I'm going to get this work schedule and you are going to work it out. She got it.*
17. Would STEM education be beneficial in elementary school? Would STEM education be beneficial in high school? *Yes STEM would be beneficial in elementary to become the top doctors and scientist. Yes more beneficial in high school. Make STEM education a part of life. If you paid a police officer, a teacher, a fireman what you paid LeBron James you would have more in it.*

Participant - D

African American Women Qualitative Interview Questions of Lived Experiences

(AAWQIQLE)

1. What are the lived experiences of African American women in STEM with a doctorate degree (Goes, 2011)? *Opportunities for jobs that come with having the degree and teaching in an undergraduate institute. In terms of perception at home a lot of people know I have the degree and look at it with pride and younger people believe they can do it also.*
2. What are your positive experiences pertaining to getting your STEM education? *Full scholarship undergraduate, Tanzania internship, university of Chicago*

*internship, Hawaii and Africa opportunities due to my degree and research while still in school.*

3. What are your negative experiences in getting your STEM education? *I have a Master degree also and my undergraduate courses did not prepare me adequately in the Master Program. But many professors treated me like I didn't belong in school due to my deficiencies. The second school for my Doctorate was really nurturing and really developed me professionally.*
4. Why did you pursue an education in STEM? *Summer programs in math and science. I was really interested in Environmental science. I got my degree in Oceanography.*
5. What are the goals you plan to achieve using your STEM education? *I am really feel passionate about chemistry. Chemist by trade. Develop a curriculum that makes chemistry application based more into everyday life. Develop method to determine how gas impacts the ocean. Organic Chemistry Master, Oceanography Chemist Doctorate. Improving technologies and methods how we look at the environment and water treatment. Like how burning gas affects the ocean.*
6. What barriers, if any, have you encountered to achieving your goals? *Mostly mental barriers. Negative experience in getting my Master's was making me lose my confidence in getting my Doctorate. But getting into the right environment the right mentorship will allow you to be successful. You should never give up on your dreams and goals. Just keep going and develop a good network of friends to keep encouraged.*



7. What racial or gender biases did you encounter in your pursuit of your education in STEM? *Subtle messages. Worked as a reporter at a conference and the advisor was shocked to realize I could really write and that an HBCU had produced me.*
8. What type of support did you receive to get your education in STEM (i.e. grants, scholarships, mentoring...)? From family? From the government? From the private sector? Please explain if the support was adequate or if some other type of support was needed. *Level of support I had was blessed. Government funded scholarship for all 4 years undergraduate. 3 summers tuition and board. Mentored to go to graduate school, GRE practice and application assistance. University support for Master for tuition and stipends. Mentorship was not as direct. Doctorate paid for conference and trip to DC and establish mentorship. Funded by private foundation, government for 2 years, research grant, department fellowships for one semester. Seek scholarship money you will find it. Tap into programs that work well and get support. Pursue after these programs we can help students acquire the support.*
9. Were there any barriers you encountered to completing your master degree or doctorate degree in STEM? How did you overcome these barriers? *Scientific research does not only work. Need a plan A and a plan B. Advisor suggested I changed the course of my dissertation. It was still rewarding but I was discouraged. You have to keep your eye on the goal.*
10. What advice would you give to an African American woman desiring to obtain a Master or Doctorate degree in terms of choosing the degree to pursue? What advice would you give in terms of career goals (i.e. certifications, companies to pursue)? *Science teachers need to actually work on real experiments. If you want to work in*

- industry it's important to go there ASAP. But in the government and Academia you need to go for the Doctorate.*
11. How would you define leadership decision-making roles? If you are going to manage a system you need to understand what the people below you are doing. As a scientist we need to learn how to move the business processes forward. Scientist need more business courses at the graduate level.
12. What type of career training does an African American woman need to be promoted to a decision making leadership role in STEM careers and regions (i.e. Silicon Valley)? *You always have to build your network and be a part of your professional organization. Continue to get leadership training like they do in the government. Take advantage of the opportunities for developing your leadership skills in your organization.*
13. What are the different types of attitudes toward STEM are found in different regions across the United States? For example, Silicon Valley is very interested in STEM. However, in other regions what are the attitudes toward STEM? *Across the board people think it is important. There is a focus on getting people into the work but not letting people understand what the work looks like. My sister went into public health education with her chemistry degree. Apply your STEM research but you can go into other fields in business and education with those degrees.*
14. What changes need to occur in the industry to open more opportunities to African American women? What changes need to occur in academia to open more opportunities to African American women? *Need more AA women in academia. It's very bleak. More AA women would bring more students to these fields.*

15. What workforce barriers need to be overcome that prevent qualified African American women from acquiring leadership decision making roles in STEM? *There are people try to block your way but mostly I've felt people have been more supportive than detrimental.*
16. What assistance is needed for African American women who are enrolled in Master or higher STEM degree programs? *A lot of people choose not to get the doctorate because of family responsibilities such as children, elder care etc. Benefits aren't that great. Need better health benefits among graduate students and earning retirement earlier. One student had to leave the program because of inadequate health benefits.*
17. Would STEM education be beneficial in elementary school? Would STEM education be beneficial in high school? *Have to start as early as possible. The testing make STEM take a back seat but we need it at an earlier age. High School definitely like computer programmer, communication, data analysis and excel. Having more shop classes and electronic classes. These classes would have helped me a Scientist. I have to weld sometimes in my experiments.*

Participant - E

African American Women Qualitative Interview Questions of Lived Experiences

(AAWQIQLE)

1. What are the lived experiences of African American women in STEM with a doctorate degree (Goes, 2011)? *Depends on who I'm conversing with. Outside of the field, no one ever thinks I have the credentials that I have. I've been treated strangely. A particular instance as a professor from a different college, I was treated*

*poorly by one security. Security gave apologies the next day once learning who I was. If someone in your field based on your level of experience the credibility makes them not as respected. They don't treat you with as much respect. I am an analytical chemist. Analytical Chemistry.*

2. What are your positive experiences pertaining to getting your STEM education?

*There are several programs in undergraduate and graduate programs for minorities. NBR Slice program. Mellon, Rise. A lot of programs that assisted us and made us very well guided through our career. Got to attend several national conferences. Support is very necessary for STEM participants especially women in STEM. I now learned to grab people who can help me and I can help.*

3. What are your negative experiences in getting your STEM education? *Field that is*

*becoming so inundated with PhD graduates. Therefore jobs are very difficult to come by. You have to network and be open to things that you might now have considered.*

4. Why did you pursue an education in STEM? *Always good at math and science in*

*school. Went to research based on an experience in an internship at a hospital. I shadowed a physician and did research. I found I liked the research and didn't really care for the physician's work.*

5. What are the goals you plan to achieve using your STEM education? *Immediate*

*goals and long term goals. The ultimate goal is to land a job once I complete my fellowship. Grooming myself. Long term I would like to extend this type of information you are doing. I like to give back to encourage people to assist people to obtain these goals and have a STEM career.*

6. What barriers, if any, have you encountered to achieving your goals? *Ratio of mento women 5 to 1. Biases more male than females in STEM fields. You hear things that are inappropriate. Women have in the back of their heads children and families. Many times this doesn't allow women to have a straight shot to gaining the education and career in these fields as men do.*
7. What racial or gender biases did you encounter in your pursuit of your education in STEM?
8. What type of support did you receive to get your education in STEM (i.e. grants, scholarships, mentoring...)? From family? From the government? From the private sector? Please explain if the support was adequate or if some other type of support was needed. *Family was extremely supported. My mom was generally catering to me. I would need long periods of just doing the work. In addition to being part of the minority research programs, I had academic scholarships. I had more time to study and didn't have to work. Undergraduate then to Doctorate. This may be institution specific. They*
9. Were there any barriers you encountered to completing your master degree or doctorate degree in STEM? How did you overcome these barriers? *Barriers came from peers. People do a lot of things that allow them to shine and hinder your progress. If you have a great support system you keep your eye on the prize. (Very wise)*
10. What advice would you give to an African American woman desiring to obtain a Master or Doctorate degree in terms of choosing the degree to pursue? What would you give in terms of career goals (i.e. certifications, companies to pursue)? *If this*

- something you can use and can it provide you with a living. Significant investment so it makes sense to choose something where you get a very good return on your investments. Do your research. Don't have to necessarily be in love with it. We are really working to survive.*
11. How would you define leadership decision-making roles? *That depends on the type of institution you are in. Originally I was in academia now in government. In academia is more nurturing because they're trying to get you to your field to accomplish the degree and career. In the industry or government, your supervisor are placed in the position for the best interest of the company. They may or may not be things you want to do or will contribute to your advancement. You have to understand your surroundings.*
12. What type of career training does an African American woman need to be promoted to a decision making leadership role in STEM careers and regions (i.e. Silicon Valley)? *How to deal with the inevitable prejudices you will encounter for being a minority and a women. You are put in these situations because of other people's preconceived notions. You can't respond in a typical African American women behavior. You have to understand how to be yourself without being obnoxious without being rude. (Training on professional behavior).*
13. What are the different types of attitudes toward STEM are found in different regions across the United States? For example, Silicon Valley is very interested in STEM. However, in other regions what are the attitudes toward STEM? *Specific to the department now sure about regional. STM is very popular. Politics and policy*

- determine how things are viewed in the DC area. Can't really give a good assessment.*
14. What changes need to occur in the industry to open more opportunities to African American women? What changes need to occur in academia to open more opportunities to African American women? *I really don't know what can be changed because I don't have enough experience. I never felt exclusion or isolation.*  
*Note: (Jackson Hospital)*
15. What workforce barriers need to be overcome that prevent qualified African American women from acquiring leadership decision making roles in STEM?  
*Believe that we are capable of obtaining these kinds of roles like we are not smart enough. Not capable of handling these kinds of dynamic roles. We really don't know what is in the minds of the decision makers. AA men and women are perceived as infiltration. Blatant prejudice opinion. AA women have to try and understand that the people are generally trying to protect their roles.*
16. What assistance is needed for African American women who are enrolled in Master or higher STEM degree programs? *Having access to opportunities to converse with or attend panels or forums are enrolled in these programs. Important in the pursuit of my degree. (Oh, I can see myself doing that). Having support in family's children and parents because women are caretakers. Like in graduate school someone said don't accidentally get pregnant.*
17. Would STEM education be beneficial in elementary school? Would STEM education be beneficial in high school? *Yes a childcare center onsite. Wait list for that center is over 2 years. Contribute to the childcare program in which we do*

*some STEM education while they're in childcare and elementary school. There are several work going on in middle school and elementary schools. We teach them cool chemistry. High School absolutely. If we give the students still experience they can make still choices in college.*

Participant - F

1. What are the lived experiences of African American women in STEM with a doctorate degree (Goes, 2011)? *People always assumed I was from another country because their preconceived notion was that Black people of this nation would not be here. They even asked my mother if she was Sudanese. My mother just explained to him that we are educated people. Then he went on to say he doesn't know why this country and specifically AA don't give more credit to what the white man has done for them. Like made it possible for them to even be in school and acquire an education. He said AA were absolutely less qualified. He was on my dissertation committee. I did not ask him what he thought of me because I felt him believed I was part of the group he was speaking about. He was an older man who came up in another era.*
2. What are your positive experiences pertaining to getting your STEM education? *I was blessed. I had a lot of family support and support from the university. I received scholarships for graduate school but I did have school loans.*
3. What are your negative experiences in getting your STEM education? *Having a dissertation committee member say AA are less qualified. The message was negative but I had to negotiate him being on my committee.*



4. Why did you pursue an education in STEM? *I wanted to do something that would make the people have better lives. I was STEM in undergraduate. I was a Chemistry major.*

5. What are the goals you plan to achieve using your STEM education?

*That's a difficult question for me. I'm not where I thought I would be but I am where I supposed to be. At different times in my life I would have thought I was in Africa designing systems that would help people eat better or have better sanitation and drinking water. Now I'm a university administration but I'm still changing lives. I am doing some research and have pulled things from my engineering background.*

6. What barriers, if any, have you encountered to achieving your goals? *I have been extraordinary blessed. I had to work as an undergrad. I didn't have major difficulties. I didn't pass all my classes the first time. Graduate I passed all my classes. Undergraduate I didn't pass all my classes. My father told me you don't learn the first time you get information, you are just exposed to it.*

7. What racial or gender biases did you encounter in your pursuit of your education in STEM? *Usual advice you might not be successful however, in the educational process, I was quite blessed.*

8. What type of support did you receive to get your education in STEM (i.e. grants, scholarships, mentoring...)? From family? From the government? From the private sector? Please explain if the support was adequate or if some other type of support was needed. *Got scholarships, student loans, support from my parents financial and emotional. I had support from some of my professors, especially in graduate. Some*

*of my advisors are still my mentors today. I told one of them about the conversation with the committee member he said don't worry about, it's not going to make a difference. Had a great peer support group in graduate school. Everyone did not finish their schooling but we all gave support where we could.*

9. Were there any barriers you encountered to completing your master degree or doctorate degree in STEM? How did you overcome these barriers? *No barriers, I don't have a Master's degree only have a Bachelors and PhD. I had been working and did not want to go back to the workforce. It took me 6 years.*
10. What advice would you give to an African American woman desiring to obtain a Master or Doctorate degree in terms of choosing the degree to pursue? What advice would you give in terms of career goals (i.e. certifications, companies to pursue)? *Go for what you love, if you don't like it you shouldn't be doing. You spend a lot of time doing it.*
11. How would you define leadership decision-making roles? *You have to be self-progressive, generous, courageous and compassionate. That cuts across race gender or anything specific human segregation. These attributes should be in all leaders. Really important for AA women in STEM to put your ego aside. Make decision on what's best for the organization. AA women in STEM have to not be vengeful and work with people we don't like. Just because someone has done something to you or you don't like them for some reason, you still have to work with them. It's really important for us to put ourselves in the other person's position and think about how they feel.*

12. What type of career training does an African American woman need to be promoted to a decision making leadership role in STEM careers and regions (i.e. Silicon Valley)? *In STEM in corporate or academia or the government, you need to have all your degrees to the PhD level. In STEM to be promoted you are best served with degrees in your field. If you want to be president of a University, your best degree to have is the PhD in your field.*
13. What are the different types of attitudes toward STEM are found in different regions across the United States? For example, Silicon Valley is very interested in STEM. *However, in other regions what are the attitudes toward STEM? We have a governor who says people don't need a degree in anything but STEM. He was talking about computer technology. In the next breathe he doesn't believe there is a global warming problem to support which is also STEM. This is in Florida. The governor does not have a degree in STEM. He should not be the one explaining. A lot of people don't have an appreciation for STEM. People are embracing part of STEM but not all of STEM.*
14. What changes need to occur in the industry to open more opportunities to African American women? What changes need to occur in academia to open more opportunities to African American women? *Improvements in elementary and secondary education.*
15. What workforce barriers need to be overcome that prevent qualified African American women from acquiring leadership decision making roles in STEM? *Sense of entitlement and privilege. This belongs to white men first and then the white women or black men. If you are a Black women it's a much larger barrier. If you*

*don't have European looks even as a Black women the standards. A women who is a president of a university and is single, has a clause in her contract that she cannot have overnight male guest in the Presidential house. That's a ridiculous clause.*

16. What assistance is needed for African American women who are enrolled in Master or higher STEM degree programs? *Sometimes they are financial, sometimes relationship support, childcare etc.*

17. Would STEM education be beneficial in elementary school? Would STEM education be beneficial in high school? *Yes it should be in both places. Should be part of the curriculum.*

#### Participant - G

1. What are the lived experiences of African American women in STEM with a doctorate degree (Goes, 2011)?

*For me, obtaining a doctorate in applied mathematics was the best decision I could have made. With my research work I get to experience the joy of creating new ideas, new codes, and through my project leadership I get to inspire others to do work that they enjoy. I published my work in conference proceedings or refereed journals and present it at conferences throughout the U.S. and abroad. I've traveled to conferences in locations like Vancouver, Canada, Oslo, Norway, Madrid, Spain, and Paris, France that I would never have thought I would ever see as a child. My biggest complaint is that sometimes I'm so busy that I don't have time to do everything I would like to do. I spend a lot of time doing outreach work – tutoring at-risk students, giving presentations on my work to middle school, high school or college*

*students. I also try to live a balanced life – enjoying family and friends, being active in my church, playing tennis.*

2. What are your positive experiences pertaining to getting your STEM education?

*I think the best thing about my undergraduate education was that my degree required that I take a lot of subjects in non-STEM fields like philosophy, psychology, sociology, world history in addition to the mathematics and science courses. It helped me develop an appreciation and excitement about learning many different things. The school was difficult enough to bring me back down to earth after graduating first in my class in high school, but I admit I did feel pretty good when I did well in a course.*

3. What are your negative experiences in getting your STEM education?

*Graduate school was much more challenging than I expected. I think it would have helped if I had actually talked to someone who had been in graduate school in mathematics beforehand. I was working on a Master's degree in pure (theoretical) mathematics and I was the only African American in the program. It appeared that the faculty expected less from the female students than the male. I completed the Master's degree and left to teach at an HBCU. At the same time I applied for a graduate program being started in computational and applied mathematics at a nearby university because I was interested in doing work that involved both mathematics and computer science. This was the first place that I was actually encouraged by faculty members. I had intended to just get a master's degree in computational and applied math, but my second year there, the graduate program director put me in the doctoral program without telling me. After I received a letter in the mail welcoming me into the Ph.D. program, I went to the program director to*

*ask for an explanation. He had a sly smile on his face and he told me, "Oh, we put all our promising students into the Ph.D. program." So I thought, I'm in it, so I guess I'll stay in it! It was a new program, so I ended up being the first woman and first African American to graduate with a Ph.D. in computational and applied mathematics from that school.*

4. Why did you pursue an education in STEM?

*I did well in all my classes so I could have gone into a lot of different fields, but I liked the challenge of solving mathematical problems. I originally wanted to be a high school math teacher, but after completing student teaching I decided to go on to graduate school for a bigger challenge instead of taking the hometown teaching position I was offered.*

5. What are the goals you plan to achieve using your STEM education?

*I have a good stable job as a research mathematician at a federal government agency. My goals are to continue my research and continue to lead projects involving work that is useful to my agency, but also interesting to me. I would like to continue presenting my work at conferences in the US and abroad, but publish more papers in refereed journals. I would also like to continue my outreach work, tutoring at-risk students and giving presentations on my career at various venues such as middle schools, high schools, career fairs.*

6. What barriers, if any, have you encountered to achieving your goals?

*The biggest problem I've had is not having a model to follow. At my agency, when you have a Ph.D. in the mathematical sciences, you basically create your own career. In general, people don't tell you what to do. You have to figure it out on your own. I*

*also noticed that the more successful you are (publishing papers, getting your work acknowledged,...) , the more control you have over your career. Nowadays most people are not hired right after receiving their Ph.D. They usually come to my agency because they have been awarded a post-doctoral position or they have research experience either from another post-doctoral position or another job.*

*Although it can extend the time it takes to obtain a permanent position, a postdoc can provide you with a valuable mentor and give you some time to build up your research credentials. To keep growing in your career, however, it will be necessary to continue learning and making new contacts to build collaborations that expand the influence of your work. A lot of hard work and a bit of luck will help.*

7. What racial or gender biases did you encounter in your pursuit of your education in STEM?

*I didn't experience much racial or gender bias. What I remember, however, is a sense of isolation. Once I got into the higher level math classes, I was often the only African American in my class.*

8. What type of support did you receive to get your education in STEM (i.e. grants, scholarships, mentoring...)? From family? From the government? From the private sector? Please explain if the support was adequate or if some other type of support was needed.

*I received my Ph.D. in the mid-1980s. During that time many schools were looking for promising black students to show that they supported Affirmative Action goals. I received several scholarships funded by my college through private donors and the state, and a sorority scholarship, as well as grants and a small loan from the federal*

*government. There was some family funding when I was an undergraduate, but my father was a blue collar worker (boilermaker helper at the shipyard) with little savings for the college education of his three children. I was the youngest.*

9. Were there any barriers you encountered to completing your master degree or doctorate degree in STEM? How did you overcome these barriers?

*There were no serious barriers to completing my master's or doctorate degree in mathematics. However, it would have been nice to receive more advice and pep talks from mentors along the way. I have never had an 'official' mentor, but there have been people who have influenced me. Ironically, most of the advice came only after I entered graduate school for a second masters (which turned into a Ph.D. in computational applied mathematics). I know we have lost many students, especially women and minorities, who might have considered a career in mathematics if someone had encouraged them. One of my most talented summer students was a female who ended up studying for a Ph.D. in a non-STEM field. She received virtually no encouragement from her advisor and the professors in the mathematics department of the highly prestigious university where she attended.*

10. What advice would you give to an African American woman desiring to obtain a Master or Doctorate degree in terms of choosing the degree to pursue? What advice would you give in terms of career goals (i.e. certifications, companies to pursue)?

*During their undergraduate years students should try to get as much information as possible. Talk to your college professors and advisors. Search websites of government labs and private companies for internships. Internships are great because they give you an inside look at what it's like to work in a particular*



*field. Try to excel in all your classes. These days there are plenty of internship opportunities for good students. Whatever career a student chooses, she should make sure that she is comfortable working with computers. A computer programming class would probably be a good idea for any STEM field.*

11. How would you define leadership decision-making roles?

*It depends on the type of job. At my agency there are managers and division chiefs who make a lot of the decisions concerning promotions and salaries, but most of the day-to-day decisions about individual research are made by the researcher himself. Also, in my case I lead several projects as part of my job even though I don't hold the position of manager. This becomes very important when you want to be promoted. You can be promoted to a senior research position without becoming a manager. The work in my laboratory is meant for people who enjoy doing mathematical or scientific research. Even those who are promoted to supervisor or division chief usually get those roles more because of the quality of their research and standing in the research community rather than because of their experience as leaders. Other places, for example, companies in private industry may be more interested in your leadership skills.*

12. What type of career training does an African American woman need to be promoted to a decision making leadership role in STEM careers and regions (i.e. Silicon Valley)?

*Before working for the federal government I worked for a private government contractor. There, you advanced by going up the management ladder. Many felt that*

*an undergraduate STEM degree was sufficient, followed by a professional degree such as an MBA.*

13. What are the different types of attitudes toward STEM are found in different regions across the United States? For example, Silicon Valley is very interested in STEM. However, in other regions what are the attitudes toward STEM?

*I can't speak about all areas of the US, but it's hard to imagine an area where STEM graduates would not be needed. The Washington, D.C. metropolitan area is an excellent place for all types of STEM graduates. There are universities (Howard University, George Mason, Univ. of MD, Johns Hopkins..), private contractors, and government research labs (DOE, NIST, NIH hires both Ph.D.s and M.D.s, NSA, NOAA, Census Bureau...)*

14. What changes need to occur in the industry to open more opportunities to African American women? What changes need to occur in academia to open more opportunities to African American women?

*It would be wonderful to see more government labs and private companies devote more money to long term research and development work. So many jobs are geared to getting a quick answer rather than looking at the long term goal of supporting the research that would lead to a better product. Also, rather than encourage more American students to go into STEM fields, US colleges and universities are depending on getting students from foreign companies. This is fine to a certain extent, but in many cases, rather than stay in this country to work, many are going back to their own countries for jobs.*

*As far as academics, the US really needs an overhaul of its view of education.*

*This is the only country I know where adults are not ashamed to admit that they don't understand mathematics. I run a sizable tutoring program of 15 to 20 students from my sorority. Even my best male students (3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup> graders) list their career goals as playing in the NFL, the NBA, or some other sports league. I see students passed from one grade to another with deficient reading and math skills. The elementary school education forms the foundation for the rest of a student's education. The skills introduced in the early years must be mastered if the child is going to have any chance of being successful in a STEM field.*

15. What workforce barriers need to be overcome that prevent qualified African American women from acquiring leadership decision making roles in STEM?

*Almost all people who succeed rapidly will tell you that there were many mentors and others who supported them. An African American woman may have to work harder to find mentors and people who offer encouragement. Rather than look for one mentor it may be necessary to get information from whomever and wherever you can. The key is not to stay at your desk, isolated from your colleagues. Talk to your colleagues, get to know them, ask them questions. Take advantage of conferences that offer opportunities for receiving advice about succeeding in your field. In mathematics, there's the Infinite Possibilities Conference that offers advice, support and encouragement to minority women either thinking about or already in careers requiring a Ph.D. in the mathematical or statistical sciences. Places like the IMA (Institute for Mathematics and its Applications) at the University of Minnesota often offer workshops to help minorities succeed in careers in the mathematical sciences. Hopefully, your place of employment provides some funding for you to*

*present papers and attend the major conferences in your field to make contacts and form collaborations.*

16. What assistance is needed for African American women who are enrolled in Master or higher STEM degree programs?

*Much of the response in the previous question also applies here. Once you are admitted to a graduate program, your advisor may have funding and grants available through a variety of sources such as the National Science Foundation, some government labs. The more important question is how to get into the STEM degree programs in the first place. A solid education and excellent grades are the key. See response to next question.*

17. Would STEM education be beneficial in elementary school? Would STEM education be beneficial in high school?

*The most important thing is that a child receives a high quality education at the elementary school level. The likelihood of success in a STEM career depends on a student attaining excellence in the basic courses – math, science, reading, writing that are already part of an elementary school education. Some exposure to computers would be good, but nothing replaces mastery of these core courses.*

*In high school, students still need a solid foundation in the basic courses, but some early exposure to computer programming languages like python, java, or c++ would put students way ahead of the pack.*

Participant - H

1. What are the lived experiences of African American women in STEM with a doctorate degree (Goes, 2011)? *I have an interdisciplinary engineering and science degree that required courses in 2 different departments (one in engineering and one in science), so I have been able to experience two different “cultures.” In terms of the lived experience, it has been fraught with highs and lows. Most of all, the implicit and explicit biases against women and ethnic minorities have been a day-to-day struggle. I cannot think of a workday where I experienced ZERO micro-aggressions. Every workday is full of micro-aggressions associated with biases based on gender and/or ethnicity. The Ivory Tower is essentially a “Tower of Babel.” Few are capable of functioning authentically in a diverse and inclusive culture; few are culturally competent to build such a culture; and no one wants to have a real dialogue about any of it. In my lived experience, we as scholars have failed to deal with diversity and inclusiveness; thus we can’t possibly prepare our students adequately.*
2. What are your positive experiences pertaining to getting your STEM education? *I have had many positive experiences with faculty who ARE culturally competent. I was actually mentored most effectively by “three white men”, all of whom really respected my capabilities and intellect and gave me very important advice on how to navigate various pitfalls in academia.*
3. What are your negative experiences in getting your STEM education? *The most negative is to be questioned or under-estimated by faculty and students. I can stop it quickly with students – by the 3<sup>rd</sup> class meeting they get it....I know a lot more than they do. Because scholars have such limited cultural competence and because many have come from privileged backgrounds where they have lived in socially segregated*

*worlds, they bring juvenile assumptions to the table. One experience involved a colleague who expressed surprise that I had written a grant proposal so well. Another colleague tried to “show me” how to use URLs on my first day of work. What an idiot. Did he think I did not know what a URL was? Granted this was in 1999, but gee, why wouldn’t I know what a URL was? Weird. The most upsetting experiences have occurred on grant review panels for both NSF and NIH. I have seen moderators/program directors who are entirely ineffective at making sure all voices are heard when discussing a proposal. Many moderators allow white males to dominate discussions, giving more credence to what they have to say. This leads to white male privilege in terms of getting proposals scored high. Females and minorities are shut down unless they fight their way in and insist. When I fight my way in and refuse to be quiet, I am perceived as dominant and pushy, but this is the only way to make sure peer review is done fairly. NSF and NIH have program directors who simply fund their own friends – many of whom look like them – white males or white females. This is the elephant in the room and explains why the funding evidence looks the way it looks. I have also seen a lot of institutional privilege on these panels. One white male panelist chose to overlook a major flaw in an NSF proposal by saying “Well, the PI is from Harvard.” NSF and NIH have FAILED to address these types of biases and continue to perpetuate structural biases by getting the same types of people to be program directors of extramural funding programs. I also had an experience with a department chair who showed extensive positive bias toward white male faculty, one of whom was a close friend of his. This department*

- head pretended to understand diversity but his actions said otherwise. His department to this day is still a very bad reflection of both gender and domestic ethnic diversity.*
4. *Why did you pursue an education in STEM? My strengths were in STEM and I knew the job prospects would be better. I was also encouraged by two undergrad professors (white males). Although I took many African-American studies courses as electives at my undergrad alma mater, not one African-American professor ever encouraged me in spite of my A+ performance and trying very hard to engage them during office hours and in class. I am very prideful of my heritage as an African-American to the point of being described as militant (which I consider a complement) but ironically, those who have encouraged and helped me the most in STEM have been three white males (much older than I) and who were always authentic. I also thought I could bring a new perspective to STEM that would attract students. You can be a scholar activist who values inclusion and thinks about it every day while also being successful in a STEM discipline from a technical and scientific perspective. You do not have to lose your culture by pursuing STEM.*
5. *What are the goals you plan to achieve using your STEM education? I am achieving my goal as a faculty member and administrator. I have served in industry and government as well and it was wonderful. I plan to continue to design and evaluate complex systems and encourage others to pursue STEM degrees by taking them away from it. I will continue to identify pedagogies of inclusion that teach STEM in a way that is meaningful to all worldviews. There is an illusion of difficulty that is just not true. For instance, there are very difficult concepts in the humanities and fine arts that are just as complex as concepts in electrical engineering or chemistry and math.*

*So the idea of “difficulty” makes no sense. What makes STEM difficult is that we have terrible teachers who have no idea what pedagogies work and what pedagogies should be cast aside. In the humanities, what works has been tested and refined over many decades. In STEM, we are far behind and we are not motivated to find the best ways to convey knowledge.*

6. *What barriers, if any, have you encountered to achieving your goals? Bias in funding decisions, bias in peer-review, the minority tax (being overloaded with search committees, admin work, diversity work) and the lack of ethics among various funding agencies.*
7. *What racial or gender biases did you encounter in your pursuit of your education in STEM?*
  - a. *Having my capabilities underestimated.*
  - b. *Not being invited into study groups in graduate school.*
  - c. *Not being given inside information or not being in strong networks.*
  - d. *Incompetence of academic administrators, leadership: many are not trained at all in inclusive excellence.*
  - e. *Refusing to take on the “look and feel” of a minority. I will not be silent at meetings and I refuse to straighten my hair. I am also not soft and nor do I take on submissive behaviors. This upsets White people on a sub-conscious level. It is hard for them to deal with such a personality – one that comes in with no apologies and who takes just as much privilege as they.*



8. What type of support did you receive to get your education in STEM (i.e. grants, scholarships, mentoring...)? From family? From the government? From the private sector? Please explain if the support was adequate or if some other type of support was needed.
- a. *Full scholarship as an undergrad. However, even with a full academic scholarship, I still worked to send money home.*
  - b. *A small monthly fellowship that covered tuition and a small stipend when I was working on my MS degree. I still worked part time.*
  - c. *No support during my doctoral degree. Despite a 3.83 GPA and excellent research and publications, I did not get an assistantship and had to work full time while going to school full time. Had two kids.*
  - d. *My family was unable to help.*
  - e. *No government funding.*
  - f. *None of the support was adequate.*
9. Were there any barriers you encountered to completing your master degree or doctorate degree in STEM? How did you overcome these barriers?
- a. *Funding was a barrier.*
  - b. *Having kids and a spouse/family was difficult but I simply went without sleep. I learned to function on 4 hours of sleep on weekdays and would catch up on sleep on weekends. Not healthy but necessary for survival.*
  - c. *I overcame the barrier of underestimation by always over-delivering. Eventually, those who worked with me consistently finally realized I knew what I was doing.*

10. What advice would you give to an African American woman desiring to obtain a Master or Doctorate degree in terms of choosing the degree to pursue? What advice would you give in terms of career goals (i.e. certifications, companies to pursue)?
- a. *It will not be easy. But, nothing worth having is easy.*
  - b. *Do not be silent and do not be intimidated. You are just as smart as everyone else. Do not allow stereotype threat to make you lose confidence and doubt yourself. White and Asian students perform well only because they are led to believe that they are smarter. If you believe you will be smarter, you indeed will perform well. So, remember that....it's all about confidence and knowing you are capable. Sit in the front, master the material, and don't apologize for being smarter than everyone else. Ignore the doubters, even if the doubter is your own advisor.*
  - c. *You MUST put in the effort and really know what you are doing. Do not slack off and do not give things a superficial review. READ, KNOW, DO...don't rely on others to tell you. Figure it out and do it at such a level that they have no other option but to respect your intellect.*
  - d. *Be vocal about unfairness. Be vocal about bias. Yes, whether you like it or not, it IS your obligation to call it out when it happens.*
11. How would you define leadership decision-making roles? ... *I don't understand this question.*
12. What type of career training does an African American woman need to be promoted to a decision making leadership role in STEM careers and regions (i.e. Silicon Valley)?

- a. *Go beyond your degree; get a certification of some sort.*
- b. *Know more than others. Move in the right networks.*
- c. *Don't let them leave you out of anything. Be there, be present, show up, and be vocal but vocal only when you have something significant and intelligent to say.*
- d. *Stop worrying so much about looks. Stop being all form and no substance. Show your substance. Invest in expanding your knowledge and skills and not your hair and wardrobe.*

13. What are the different types of attitudes toward STEM are found in different regions across the United States? For example, Silicon Valley is very interested in STEM. However, in other regions what are the attitudes toward STEM?

- a. *Silicon Valley is interested in STEM but not STEM that includes under-represented minorities. Their STEM only extends to Whites and Asians.*
- b. *STEM seems to be appreciated everywhere else, but the South is still slow in valuing the necessity of STEM.*

14. What changes need to occur in the industry to open more opportunities to African American women? What changes need to occur in academia to open more opportunities to African American women?

- a. *This is a hard question to answer. Opportunities are there. The problem is organizational culture and climate. If that does not change, we will not advance.*
- b. *Those at the top need to increase cultural competence and need more training in implicit biases.*

- c. *Congress needs to closely scrutinize funding agencies that demonstrate biases in funding.*

15. What workforce barriers need to be overcome that prevent qualified African American women from acquiring leadership decision making roles in STEM?

- a. *This is a hard question to answer. Opportunities are there. The problem is organizational culture and climate. If that does not change, we will not advance.*
- b. *Those at the top need to increase cultural competence and need more training in implicit biases.*
- c. *Congress needs to closely scrutinize funding agencies that demonstrate biases in funding.*

16. What assistance is needed for African American women who are enrolled in Master or higher STEM degree programs?

- a. *Full funding – stipend, tuition.*
- b. *Culturally competent advising.*

17. Would STEM education be beneficial in elementary school? Would STEM education be beneficial in high school?

- a. *STEM education should begin at the age of 18 months and continue through the life span.*

Participant - I

1. What are the lived experiences of African American women in STEM with a doctorate degree (Goes, 2011)? *Most of my math classes I was the only female and the only African American. During my Master's degree one of the male students*

- would say inappropriate things and then say, "Whoops I forgot a lady is present". There were some issues but I was determined I was going to finish. Even though there were some negative experiences, I was going to finish regardless.*
2. What are your positive experiences pertaining to getting your STEM education? *I had big role models. I was self-confident. No one ever told me I couldn't do everything growing up of course. I had role models in undergraduate that said "you can do whatever you want to do". Even in graduate school I had some professors that were very supportive. They all were not. While in Indiana one of my advisors was the chair of the math department. He was leaving to go on sabbatical and had me stay in his home while he was gone and look after his cats for free my last semester in school. I would not have to rent an apartment for a portion of the year. He was very supportive and his wife was going to be leaving with him. I thought that was phenomenal that they trusted me to do that.*
3. What are your negative experiences in getting your STEM education? *I guess I can't think of any particular ones except people taking digs at you. But again I was self-confident and I did have good support. Nothing deterred me. I do remember when I got ready to take my qualifying exams there was one professor who said "You can't be ready to do that yet". And I said oh but I am. I had finished all my coursework and was ready to get started on taking the exam. The professor was surprised that I had gotten through everything. I guess most of my experiences were positive instead of negative. Since it was so long ago, I guess I have blocked out the negative experiences.*

4. Why did you pursue an education in STEM? *In the seventh grade I had a math teacher who was wonderful. In the seventh grade I decided I wanted to go to college and major in Math. I love math. I like doing problems and got very good grades. That's how I got started in the seventh grade.*
5. What are the goals you plan to achieve using your STEM education? *Again, I've been out so long I have realized all of my goals. I started out as an Assistant Professor. I was promoted to a full professor. I became a department chair. I became a dean and now I am the provost of Academic Affairs. I never thought I would do all these things they just happened along the course of my career.*
6. What barriers, if any, have you encountered to achieving your goals? *I have not encountered barriers to achieving my goals because I've always worked very hard. I always been very motivated. In most cases people recognized my talent and my work effort. A lot of times I was asked to do things instead of seeking them out.*
7. What racial or gender biases did you encounter in your pursuit of your education in STEM? *I did experience gender biases because people didn't expect women to be in the area I was in. People had perceptions of what you could and could not do. A lot of times I was the only woman and the only Black in the class. In most instances I had to prove them wrong. I just did not let those things deter me. My PhD is in Mathematics.*
8. What type of support did you receive to get your education in STEM (i.e. grants, scholarships, mentoring...)? From family? From the government? From the private sector? Please explain if the support was adequate or if some other type of support was needed. *I received a lot of support. I didn't pay a thing for graduate school. I*

*got fellowships and worked as a teacher assistant. Because of my work ethic I was sent to conferences. I had very good support while in school. I had support from fellow students once they found I knew what I was doing. They did not mind working with me. It is true if you are a minority there is a lot of financial support in terms of scholarships and grants for STEM fields.*

9. Were there any barriers you encountered to completing your master degree or doctorate degree in STEM? How did you overcome these barriers? *People did take digs at me. If you were shy you could have been hindered. My confidence did not allow those barriers to deter me.*
  
10. What advice would you give to an African American woman desiring to obtain a Master or Doctorate degree in terms of choosing the degree to pursue? What advice would you give in terms of career goals (i.e. certifications, companies to pursue)? *First of all, it has to be something that you want to do. This is not something to do because you say this is the career I want. You must have a passion. I love math. But since that time I have gone back and gotten a graduate degree in computer science. Math was my passion and I decided I was going to get a graduate degree in math. Pick something you like and have a talent in it. It has to be something you really want. If you want it you will have the passion and drive and enthusiasm to see it through. It's very hard work and you are devoting years of your life to obtain the degree. The workload is substantial. You can't be faint of heart. You have to really want to do this and you must have the talent in the area of STEM you are going into.*
  
11. How would you define leadership decision-making roles? *I follow what my father told me as a child. You can't make grown people do what you want them to do. In*

*order to get people to follow you, you have to motivate them and get them enthusiastic about what you want them to do. It's all about getting people to buy into what you would like for them to do. You just can't make them do it. Therefore to be a good leader, you have to have some good plans and thoughts and you have to listen to others advice. Let them be part of the decision making. In order to get people to follow you they have to want to do that.*

12. What type of career training does an African American woman need to be promoted to a decision making leadership role in STEM careers and regions (i.e. Silicon Valley)?

13. What are the different types of attitudes toward STEM are found in different regions across the United States? For example, Silicon Valley is very interested in STEM. However, in other regions what are the attitudes toward STEM? *I can relate it to gender bias used to be chair of the board of the local chapter. I was in a team building meeting with the girl scouts. Some of the council members from the rural areas said their girls were not interested in stuff like that (STEM). I was appalled. I found that chilling. I thought you should not put barriers in front of girls. Girls can do whatever they want to do. I do know in some areas people don't look favorably on girls selecting certain degrees. At Howard one of my female friends who was an engineer stated the professor told her on the first day of school, "she was just occupying a seat a man should have". She went on to get her PhD in chemistry at Georgia Tech.*

14. What changes need to occur in the industry to open more opportunities to African American women? What changes need to occur in academia to open more



- opportunities to African American women? *Things have changed. There must be women to promote. There must be more females in the leadership positions. NSF tries to get more women in the pipeline and teaches them to consider more flexible schedules for women due to family needs. We do need scholarships for childcare and elder or family care.*
15. What workforce barriers need to be overcome that prevent qualified African American women from acquiring leadership decision making roles in STEM? *It's time to balance personal and professional lives. NSF helps women navigate their professional degrees.*
16. What assistance is needed for African American women who are enrolled in Master or higher STEM degree programs? *Need financial support that's a Biggy. You also need the support to work on your dissertation. You need extra help. You sometimes go back to work and don't finish. My professor advised me to not leave until I finished my degree. You need a flexible work schedule.*
17. Would STEM education be beneficial in elementary school? Would STEM education be beneficial in high school? *This is what has been a passion for me for most of my career. We do a lot of outreach to elementary school. We do science fairs where we do math bees instead of spelling bees. This type of exposure made me make the decision to go to college and get a math degree in the 7<sup>th</sup> grade. My institution sponsors STEM activities starting at the elementary school. To start thinking about STEM in High School it is too late. We do have agencies and enrichment programs in STEM in elementary school. For the local chapter of girl scouts we have a STEM badge. When I completed my tenure as chairman of the*

*board of the local girl scouts they created a STEM badge because my platform was STEM, STEM, and STEM. It is so critical to expose our girls to STEM. It is key and we have evidence in exposure for girls in STEM. It transforms their lives.*