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Coding while black

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CODING WHILE BLACK

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Doctor of Education in Educational Technology

by

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TABLE OF CONTENTS

Page

Page

LIST OF TABLES

Page

LIST OF FIGURES

Page

DEDICATION

I dedicate this work to my beloved children, Kisa and JohnKai, who have taught me what it means to care more for someone else than I do for myself. May all of your dreams one day come true.

Lovingly, Daddy

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VITA

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ABSTRACT

The focus on the lack of diversity in technology has become a hot topic over the last several years, with technology companies coming under fire for not being more representative of the markets that they serve. Even The White House and President Obama has made this issue of technology diversity and recruiting more women and people of color a topic of discussion hosting several events at The White House aimed at finding solutions to this issue. The issue has become so prevalent in the news recently that technology companies have been asked to publish report cards disclosing the demographic breakdown of their employee workforce. Most of the major technology companies in Silicon Valley have vowed to dedicate themselves to becoming more diverse, and have instituted programs to do such. However, progress has been slow and the results have been disappointing. Although many attempts to fix this problem has occurred for decades there has been no panacea to emerge. Why are there so few minorities pursuing careers in technology? The answer to this question at the moment is unknown. Although many experts have offered theories, there is little in the way of agreement. As the numbers continue to dwindle and more women and people of color continue to pursue careers in other fields or depart from the technology industry, technology companies are challenged to increase the number of underrepresented minorities in their workforce and to come up with solutions that address this issue that has become so important to the future economic growth of the United States.

Qualitative by design, this study examines the perspectives, insights, and understandings of African American software development engineers. Accordingly, participants in this research study provided key insights regarding strategies, best practices, and challenges experienced by African American software development engineers while developing and implementing application programs at American corporations. Participants' perspectives provided an insightful

understanding of the complexities of being an underrepresented minority in an American corporate information technology department.

Keywords: technology, technology diversity, STEM, digital divide, Blacks in STEM

Chapter 1: Introduction

The Importance of Diversity in Today's Workplace

Diversity is not only a celebration of differences among people with regard to sexual orientation, spiritual practice, public assistance status, physical and mental capabilities, race, gender, class and ethnicity, but also includes the acknowledgement, empathizing, welcoming, appreciating, and honoring of differences among people (Esty, Griffin, & Schorr-Hirsh, 1995). The U.S. population is expected to grow by 50% by 2050. People of color are projected to make up approximately half of the population. It is believed that immigration will be responsible for nearly two-thirds of the nation's population growth. 25% of all Americans will be of Hispanic origin. Additionally, nearly one in 10 Americans will be of Pacific Islander or Asian heritage. More people with disabilities as well as more women will become a part of the workforce (U.S. Census Bureau, 2015).

By the year 2020, "more than half of the nation's children are expected to be part of a minority race or ethnic group" (Chappell, 2015, p. 1). It is expected that in 40 years only 36% of all youth will be White as compared with 52% today. It is believed that the population of the United States will also adhere to a similar pattern and by the year 2044 will become a majority-minority country. By the year 2060, the minority population is expected to reach 56%, compared with 38% in 2014 (Chappell, 2015).

The technology sector has recently started to deal with this issue. Some ethnic minority groups such as Hispanics and African Americans are severely underrepresented in the technology sector. Technology companies need to make diversity a priority and cultivate strategies that foster inclusivity, yet for a technology industry that is accustomed to finding creative ways to solve problems solving the diversity issue has proven to be quite the challenge.

The talent pipeline is cited by many as the main culprit. The inference is that technology companies would build a diverse workforce if the talent was available. However, the issue is that are not enough minority students pursuing computer science degrees (Kang & Frankel, 2015).

"A diversity of perspectives enriches science and makes engineering more responsive to a global pool of clients" (Chubin & Malcolm, 2008, p. 1). Corporations that cultivate a diverse workforce also increase their chances of higher and more advantages over their competitors (Kang & Frankel, 2015). Moreover, diversity drives market growth and releases innovation. In companies that lack diversity leadership, females, minorities, and members of the gay community are less likely than White men to have their ideas accepted. This situation may result in companies sacrificing critical market opportunities as a diverse organization is more aware of the wishes of customer segments that are underserved (Hewlett, Marshall, & Sherbin, 2013).

"At a time when STEM fields are increasingly important to the health, security and competitiveness of our nation, we are not supporting the research nor are we generating the diverse supply of talent we need to nourish our future" (Chubin & Malcolm, 2008, p. 1). Although diversity in the workplace is not a new issue, as these changes in the population become more evident, it is even more critical that companies devise strategies to diversify their workforce talent. In 2012, the Manpower Group, published the findings of its seventh annual Talent Shortage Survey. The survey reported that that almost 50% of U.S. companies are having a hard time hiring for critical areas within their organizations. The most difficult positions to fill included engineers and information technology staff.

The findings report further emphasized the most prevalent reasons why employers are struggling to fill these positions. Chief among them is the lack of available applicants. The reports suggests that this mismatch of skills will have an enormous impact on recruitment and

business success around the world (Manpower Group, 2012). The Manpower Group lays out remedies that have been established for closing the talent disparity in their report entitled: *Break the Crisis and Complacency Cycle: Get Ahead of the Global Talent Shortage.* Among these remedies are: creating a workforce plan, using strategic migration, developing malleable work models, researching untapped talent markets, and broadening tapped markets.

Exploration of those untapped markets is where America must search for its next generation of technical talent. It is from those ethnic groups that will comprise 50% of the population of the U.S by the year 2050, those that are the most severely underrepresented in the technology sector today, these are the groups where talent must be harvested in order for America avoid an impending talent shortage (American College Testing [ACT], 2006). Talent is imperative to advancing the bottom line in an increasingly competitive economy. Although formal training plays an important role, by far the most crucial development tools are concentrated one-on-one criticism and mentoring. The global management-consulting firm McKinsey & Co. is a case of a company that truly values its workers, as it exhibits via its dedication to their development. Microsoft Corporation is another example of a company who deems the recruitment of top talent as a corporate priority. The world's leading software company is extremely rigorous in its recruitment process, yearly reviewing all of the 25,000 U.S. computer-science graduates to find the 8,000 in whom it has an interest (Bartlett & Ghoshal, 2002). It has become progressively mandatory in the corporate sector to "hire from a pool of the largest and most diverse set of candidates to thrive in the market" (Kerby & Burns, 2012, p. 1).

The country as well as the workforce are both becoming more diversified (Kerby & Burns, 2012). One of the primary reasons for America's transformation is immigration. Eight out of 10 Americans were White in 1980. In 2016, that ratio has been drastically reduced. Currently

that number has dropped to 63%, and it is forecasted to be below 44% by 2060. Conversely, in 1980 Hispanics were 6%, today they are 17%, and expectations are that they should be approximately 29% by the year 2060. Asians and others were only 2% in 1980 and presently Asians have increased to 8% and by 2060 are expected to be 15% of the population. African Americans, however, should remain steady at 12% to 13% over the time period. Another reason for America's population transformation is that it is getting older. Over time, the age make-up of the American population has changed dramatically, deviating toward an older age structure. For the most part this is a result of the Baby Boom Generation (Teixeira, Frey, & Griffin, 2015).

"The Baby Boom Generation was the largest generation in relation to population size when it emerged" (Teixeira et al., 2015, p. 12). Reductions in fertility rates has decreased generation sizes with respect to population size since that time. In 1980 49% of the populace was below the age of 30, 22% was between the age of 18 to 29, and 27% was under the age of 18. Fifteen percent was between the age of 30 to 39, while 10% was between the ages 40 to 49, 14% was within the ages of 50 to 64, and only 11% was older than 65. Forty percent are under age 30—today with 24% under age 18 and 16% ages 18 to 29. Fourteen percent are, respectively, ages 30 to 39 and ages 40 to 49. Seniors are now up to 15%, and the 50- to 64-year-old age group adds 17%, for a total of 33% who are ages 50 and older period. This compares with 26% in 1980 period (Teixeira et al., 2015). The proportion of people of color in the United States is expanding (Kerby & Burns, 2012); "more women are entering the labor force" (p. 1); and "gay and transgender individuals are making critical contributions to our economy, while being increasingly transparent with regard to their lifestyle" (p. 1).

Immigration also plays a role in the diversification of the workforce. Immigrants represent 16% of the U.S. workforce with an undergraduate degree and constitute 29% of the

growth in this workforce from 1995 to 2008. Migrants also compose the bulk of the net gain in the U.S. labor pool focused in STEM since the mid 90s (Kerr & Lincoln, 2010). Many technology rock stars have emerged as a direct result of immigration (Frier & Burrows, 2014). Therefore, enterprises that embrace diversity have a competitive advantage in the marketplace over those who do not. There are several reasons for this. Companies that have a diverse workforce are able to capture a larger portion of the consumer market. Businesses can more effectively market to consumers across a myriad of racial and economic lines when their employees are from different backgrounds and experiences (Kerby & Burns, 2012).

As technology companies seek to improve diversity there are several trends that can be observed in the industry. For example, many technology companies have come under increasing pressure to release their workforce numbers. Also, several technology companies have created an executive position dedicated to overseeing the initiative of creating more diversity in the company. Moreover, several technology companies have broadened their recruitment process and many of them such as Google have even begun to target Historically Black Colleges and Universities (HBCUs) in their recruitment efforts. Companies are also putting their money where their mouth is by pledging capital towards closing the diversity gap. For example, Microsoft recently pledged 75 million dollars to increasing diversity and Intel pledged $100 million dollars toward recruitment efforts (Vanian, 2015).

Non-profits such as Code.org have also emerged to create more diversity in the tech sector. Code.org has created the Hour of Code. The goal of this program is to introduce computer science to elementary students. *Black Girls Code*, *Code2014,* and *Girls Who Code* are other charities with similar objectives. Universities and college are also getting into the act by partnering with many of these companies as well as developing programs to make computer

science programs more attractive to minority students and also provide the support structure needed to ensure that they complete the degree requirements and graduate. Companies are also creating Employee Resource Groups such as Black Googlers at Google and the Black Employee Network at Amazon (Roberts, 2015).

The Challenges with Diversity in Today's Workplace

In 1983, the U.S. National Commission on Excellence in Education announced its trailblazing report entitled *A Nation at Risk* (National Commission on Excellence in Education, 1983). It stated that America's "once unchallenged preeminence in commerce, industry, science, and technological innovation is being overtaken by competitors throughout the world" and that the "educational foundations of society are presently being eroded by a rising tide of mediocrity that threatens our very future as a Nation and a people." Another report published by the National Academy of Sciences titled *Rising Above the Gathering Storm: Energizing and Employee America for a Brighter Economic Future* in 2005 echoed this sentiment (Augustine, 2005). Thirty years later, America is still at risk, particularly in the disciplines of science, technology, engineering, and mathematics (STEM).

"The country's greatest prospect of preventing this crisis is to look toward our underrepresented groups, namely, women and underrepresented minorities" (Margolis, 2008, p. 26). This suggests that encouraging more African-American students to embrace technology would play a vital role in the economic success of the United States. Managing a diverse workforce comes with its challenges. There is more to it than the simple acceptance of differences in people. Diversity is also about fighting prejudice, promoting inclusiveness, and recognizing the value of those differences (Devoe, 1999). Organizational diversity can be hindered by unfavorable behaviors and attitudes as they can damage relationships among

workers and harm temperament and productivity (Esty et al., 1995). “Negative attitudes and behaviors in the workplace include prejudice, stereotyping, and discrimination, which should never be used by management for hiring, retention, and termination practices” (p. 88).

Today’s Technology Workforce Landscape

Silicon Valley is the popular name given to the southern region of the San Francisco Bay Area located in Northern California. The name stems from the fact microprocessors are made from silicon and that most of the world’s largest technology enterprises are located in this area.

The lack of diversity in Silicon Valley has received much media attention lately, however, this issue of diversity is not unique to the technology sector. Technological innovation is the driving force of the American economy. As such, new industries are appearing every day and conventional industries are being disrupted entirely via the application of advanced technology. In order for the United States to maintain a position of leadership, we must develop an economic foundation of enterprise that steadily innovates, improves the use of problem solving capacity, competitive advantage and innovation can all be enhanced as a result of a diverse workforce (Sarkissian, n.d.).

Diversity improves creativity. It fosters the seeking for new information and viewpoints, leading to improved decision making and problem solving (Dezso & Ross, 2012). Companies today are dealing with an international global consumer base. Domestic companies are also facing a consumer base whose demographics are shifting. As a result, customer expectations with regard to how companies should work are also diverse. The best way to foster acceptance of customers is to mirror the diversity of your customers. Problem solving can be enhanced in corporations by eradicating groupthink. Diversity and inclusion can help to defend against the dangers of groupthink by proffering fresh ideas and alternative solutions (Sarkissian, n.d.).

Although it has been reported that diverse companies perform better as it relates to earnings and decision making, minority tech-employment and entrepreneurship in the United States does not mirror population levels. Women, Latinos, and African Americans are not part of the innovation economy (Bagley, 2014). There are many examples of success startups in the Silicon Valley including DropBox, Airbnb and Slack. Companies with more diverse board of directors enjoy a 95% higher return on equity than those whose executive leadership is alike (Barta, Kleiner, & Neumann, 2012) and companies whose workforce is more varied tend to perform at a higher level fiscally (Hunt, Layton, & Prince, 2015). Another study conducted by Tufts University suggests that diversity also improves the decision making of groups (Sommers, 2006).

Technology companies such as Google are committed to recruiting talented and diverse people in order to improve the racial and gender make up of their work forces and corporate boards (Kavilanz, 2015). Several technology companies have released recent data in their yearly diversity reports. These reports corroborate what diversity advocates and minority technologist intimated for years: Employees at technology companies, and specifically those in technical positions are overwhelmingly White and Asian men (Jones & Trop, 2015). The evidence is more disturbing when studying technical workers. In positions that require technical knowledge there are less women and even fewer Latinos or African-Americans (Jones & Trop, 2015; Ricker, 2015). Technology company executives should examine this data. Many studies report that that are comprised of different ethnic groups rank higher in creativity, which results in better profitability (Richard, McMillan, Chadwick, & Dwyer, 2003). This improved creativity helps them design services and products that are attractive to a diverse, global consumer (Dezso & Ross, 2012).

Technology companies are taking steps to tackle the issue of diversity in their industry. For example, in an effort to ensure that managers don't give unwarranted lower performance reviews to women, Google is providing training to managers to make them more conscious of their hidden prejudices (Manjoo, 2014). Facebook has introduced *TechPrep*, a new Web resource designed to attract people of color and women to computer science (Elahi, 2015). Moreover, Facebook is collaborating with professional groups and other charity organizations to boost the number of young people of color and girls interested in technology careers (Bercovivi, 2014). Pinterest is also attempting to move the needle. In the summer of 2014, the social media company established instruction in unconscious gender and racial bias, proselytized at events for women, Hispanic and African American engineers, and coached female computer science students (Vara, 2015). The small percentage of women studying computer science is also a huge challenge for the technology industry. Although over the past couple of decades there has been an increase in women who are learning disciplines such as chemistry and biology has risen, the percentage of those majoring in computer science has dropped (Henn, 2014). Technology companies such as Facebook, Google and Apple are known for their innovation. However, they have struggled when it comes to finding a solution to workplace diversity. Recently, technology companies have started to disclose transparency reports that illustrate demographic data in response to the criticism of their hiring practices. These transparency reports corroborate what has been surmised for years, that the industry is predominately comprised of Asian and White males, while other groups such as Hispanics, women, and Blacks are barely visible (Mangalindan, 2014).

The Underrepresentation of Minorities in the Technology Workforce

According a 2014 article in *USA Today*, "Tech jobs: Minorities Have Degrees, But Don't Get Hired" (Weise & Guynn, 2014), the technology workforce in America has improved with regard to diversity, however there is still room for further improvement. The National Science Board's (2014) annual *Science and Engineering Indicators* report asserts that while progress has been made with regard to attracting diverse groups to STEM occupations, participation varies considerably across different ethnic groups. For example, Asians, which only make up 5% of the general population, composed 19% of engineers and scientists in the United States. This eclipses their percentage of the populace (Tai, Liu, Maltese, & Fan, 2006).

Conversely, American Indians, Alaska Natives, African Americans, Hispanics, racial and ethnic minorities that have been disproportionately represented in the STEM fields, only represented 10% of the country's employees in engineering and science in 2010. This illustrated a modest increase as in 1993 the Figure was 7% which is still well below their percentage of the general populace of 26%. Females were underrepresented as well in the STEM labor pool. Although half of the degreed workers in the U.S. are women only 28% of them are STEM workers (Tai et al., 2006). Recent research suggests that a fall in the number of women filling computer-oriented positions is contributing to their underrepresentation in STEM jobs.

The U.S. Census Bureau (2011) reported in 2011 that women's employment in STEM positions has fallen due to their declining share in computer vocations. According to the reports, in 2011, women held 27% of STEM occupations, after plateauing at 34% in 1990. There were a total of 7.2 STEM employees in 2011, representing 6% of the U.S. workforce. That is an increase from 4% since 1970. Additionally, the study asserts that even though women compose approximately 50% of the total labor pool, they only accounted for 25% of the STEM workforce

in 2011. One of the reasons offered for the low percentage of women in STEM careers is that pursuing a degree in a STEM-related discipline does not always translates to pursuing a career in STEM. Furthermore, the research suggests that in addition to women, Hispanics and Blacks are severely underrepresented in STEM positions. Six percent of STEM employees were Black in 2011. Over the last 40 years this number has only increased by four percentage points. The growth has been just as slow for Hispanics whose share of STEM jobs has only gone from 2% to 7% since 1970 (Landivar, 2013).

President Obama supposes that economic advancement of America relies on a robust STEM labor pool. As a result, his administration has made STEM education a priority (Strauss, 2011). Disparities in educational opportunities is largely the reason for the underrepresentation of African Americans and Hispanics in U.S. STEM jobs over the last decade (Beede et al., 2011). The report also found that,

> regardless of race and origin, higher college graduation rates are associated with higher shares of workers with STEM jobs. However non-Hispanic Whites and Asians are much more likely to have earned a bachelor's degree, which factors into their having a larger share of STEM jobs. (Beede et al., 2011, p. 3)

Additionally, the report asserts that demographic disproportions within the STEM workforce would be virtually eradicated by providing equality in educational attainment (Beede et al., 2011).

Other experts on STEM education agree. "Because it has been spuriously assumed that the intellect to master the subject, many students have been precluded from studying science and math which is a major glitch in the education system" (Drew, 2011, p. 2). By installing routinely high expectations in these areas, we can release a surplus of hidden genius in the United States.

Presumptions regarding pre-determined abilities and aptitude are wrong. Every student, including students of color, women, and indigent students, can become proficient in science and math and can be developed now for America's future global economic challenges (Drew, 2011).

The National Academies report *Expanding Underrepresented Minority Participation: American Science and Technology Talent at the Crossroads* recognizes that "the need has never been greater for the nation to develop a coherent approach to producing new scientists and engineers from diverse backgrounds" (Bianchini, 2013, p. 163). Fewer than 6% of 24-year-olds in the United States obtained undergraduate degrees in these classes, which ranks the U.S. 20th in a list of 24 countries. Underrepresented minority groups, Alaska Natives, Native Americans, and African Americans, are expanding faster than any other segment of the population (Bianchini 2013).

According to Boundaoui (2011),

> America needs to strengthen its approach take much more seriously this challenge of harnessing talent from a broad pool of citizens if the nation is to continue having the strong science, technology, engineering, and mathematics (STEM) workforce needed to remain competitive in the marketplace. (p. 1)

According to a *San Jose Mercury News* review of federal data, "there were fewer African American and Latino technology workers in the Silicon Valley in 2008 than there were in 2000, even as their share grew across the nation" (Swift, 2010a, p. 1).

The Lack of African American Software Development Engineers

"Top universities such as Stanford and Ohio State University produce Hispanic and Black computer engineering and computer science graduates at twice the rate that leading technology companies hire them" (Weise & Guynn, 2014, p. 1). For example, about 1% of engineers at

Facebook Inc., Google and Twitter Inc. are Black engineers. There are seven Blacks on Pinterest's 450-person payroll (Frier & Burrows, 2014). African Americans make up only 2%, on average, of technology workers at seven Silicon Valley companies that have published staffing reports (Weise & Guynn, 2014). "Hispanic and Black computer science graduates are invisible to these companies" (Weise & Guynn, 2014, p. 1). In the same technical roles such as programmers and software developers, Asian Americans earn $8,146 less than their White counterparts and Blacks $3,656 less than Whites (Guynn, 2014).

Even when Blacks and secure positions in technology fields, they are regularly overlooked for promotions and pay increases (Guynn, 2014). There is a dearth of African American software developers. However an arrival of African American software developers could shift the technology industry (Austin, 2014). There are many opportunities for solving problems in the Black community as well as providing diversity in areas where it is lacking. For example, game development could benefit from diversity on their teams. Such diversity would help in creating characters of color that "are respectful as opposed to racist caricatures like the trash-digging informant Letitia in Deus Ex: Human Revolution. Creativity can drive this influx" (p. 1).

African Americans must be made aware of the opportunity to generate wealth that is available to those who can develop innovative ideas. For example, an application called *Rap Genius* was created by two White men. The startup raised over $15 million and it was not founded by a creative contingent of African American software development engineers. This is an example of African American culture generating wealth that does not benefit the African Americans. The creativity to birth this idea is crucial, but it is essential to possess the skills required once the idea has been cultivated. The price of admission into startup fame today, which

can generate untold wealth, is idea generation. In a culture where good ideas and creativity are the barriers to entry seem ludicrously easy and advantageous for impoverished communities (Austin, 2014).

"The skills that needed to nurture such as proficiency in math, science, and computer programming, are few and far between in the black community" (Austin, 2014, para. 3). African-Americans comprise of a very low percentage of workers at the most prominent technology firms in the San Francisco Bay Area (Mangalindan, 2014). The situation worsens when considering San Francisco proper. There are approximately 1,000 African-American technology workers out of 47,000 total technology workers. In the southern states of Alabama and Louisiana the percentages are much better. African-Americans make up 20% of the technology workforce. It is becoming increasingly much harder to employ local talent as many African-Americans are fleeing the area due to the high living costs (Priceonomics, 2015). Expanding the hiring pool alone is not enough to remedy the obstacles faced daily by members of racial or ethnic minorities and women once they secure these positions (Diallo, 2015).

> The need for a culture shift at technology companies seems obvious if any of these diversity initiatives are to be successful. One of the reasons there is a need for a cultural shift is because without a supportive work environment for underrepresented employees, people may feel isolated.. . . It can often be difficult getting leadership to acknowledge internal culture as a problem. In the fast-paced and high-pressure tech environment, no one wants to be perceived as the complainer who spends time monitoring co-workers' behavior instead of shipping product which helps companies to meet their profit goals. (Diallo, 2015, p. 1)

Moreover oftentimes there is no time to restructure policies and procedures to adapt to an increasingly diverse workforce.

> Black and Latino men are faced with a hiring disparities significantly wider than even the gender gap — one that places additional pressure on those who do get hired to perform well. The challenges for companies that genuinely value diversity are that creating it doesn't happen on its own and sustaining it requires buy-in from all employees. (Diallo, 2015, p. 1)

"Efforts to close the gap include plans to offer more computer classes to younger students, improve national access to computer coding, and address *head-on* the stigma that's sometimes attached to the computer profession" (Mason, 2014, p. 1).

Students often see distorted portrayals of people who work in the tech industry, and they are sometimes shown to be unkempt, lonely, and uninspired, a vision that invariably has been known to repel many women. Television series such as *Silicon Valley* have been known to discourage young women and minorities from viewing because of these inaccurate portrayals of *tech geeks* (Mason, 2014). However, open source software development has been shown to serve as a gateway for developers of color to enter the industry. The requirements to obtain such a job is not as stringent as other technical positions, as is articulated in the fact that almost anyone can get started in the field by "jumping in and writing some code" (Demby, 2013, p. 1).

The Current Population Survey (CPS) report, authored by Ebenstein, Harrison, McMillan, and Phillips (2014), reported that more than eight in 10 software developers in 2012 were White. Although White developers were overrepresented, Asian Americans were overrepresented as well. These statistics show that although people of color are employed as software developers, Latinos and Blacks are extremely underrepresented. There are bigger social

considerations that contribute to the *Whiteness* of the image of the technology world, more broadly. Latinos and Blacks are more likely to attend technology-poor schools, they're underrepresented in science and math fields at every level of higher education, and are less likely, than Whites to have access to the Internet access outside of their home. Open-source software can be a huge asset to those of lower-economic status, an ample number of whom are Black and Latino. Open-source frameworks such as JQuery and Backbone.js make it easier for novice developers to utilize some of the splashy techniques of more veteran developers. But for all the budding advantages that these frameworks might provide to Latinos and Blacks, it does not appear that a roadmap to a career in software development is usually among them (Demby, 2013).

The lack of African-Americans in software development can possibly have racist implications. Photo-sharing services Google Photos and Flick, for example, have come under fire recently for software that tags photos of Black people as gorillas or apes, dredging up racist attitudes from the Colonial era. But in this case, instead of humans seeing through a racially charged perception, the distortion is perceived through their software (W. Lee, 2015). To be sure, the problem with Google Photos might have happened regardless of who designed it; but theoretically, if more Black staffers were plugging their own pictures into the service, someone would most likely have caught the mistake. The problem is likely twofold, experts say. "Not enough photos of African Americans were fed into the program so that it could recognize a Black person, and there probably weren't enough Black people involved in testing the program to flag the issue before it was released" (p. 1).

As noted by Thomas (2014),

> Many executives and pundits have argued that the educational pipeline remains one of the chief impediments to hiring a more diverse workforce, and that as long as universities aren't recruiting a broader mix of students for STEM degrees, the corporate landscape will suffer accordingly. (p. 1)

Computing job portal Dice reported that

> Black IT entrepreneurs and professionals believe that the problem goes much deeper than simply widening the pipeline; they argue that racial bias, along with lingering impressions of what a *techie* should look like, loom much larger than any pipeline issue. (Thomas, 2014, p. 1)

The National Black Information Technology Leadership Organization, whose focus is to develop the next generation of African-American technology leadership, report that only 40% of African Americans who hold degrees in computing or related disciplines are able to secure positions in the field although the industry insists that there are not enough qualified workers to satisfy the number of open positions (Thomas, 2014).

The American Institute for Economic Research (AIER) conducted a study of H-1B visas and also reports that African Americans workers in information technology on average, earned $3,656 less than White workers. H-1B visas are visas for non-immigrants that allow U.S. companies to hire foreign talent in specialized occupations that need technical expertise in specialized fields such as in medicine, mathematics, architecture, science, and engineering. One of the lead investigators of the study concluded that as it pertains to compensation in the technology sector, "Race does still matter" (Thomas, 2014, p. 1). The AIER study took into consideration variables such as geography, age, and education level. The discrepancy in pay is consistent all levels in the industry ranging from entry level positions to roles in leadership

(Thomas, 2014). According to founder and President of Microsoft Bill Gates, “the lack of Black tech professionals hurts the United States” (McDougall, 2007, p. 1). According to Gates, Blacks are “particularly underrepresented in the tech industry because high school dropout rates in the Black community exceed 50%” (p. 1). Less than 13% of computing degrees were awarded to African Americans in 2004.

The lack of technology skills among African Americans is due, to some degree, to the dearth of people of color being attracted to STEM (McDougall, 2007). Ebony McGee, a researcher who has spent more than ten years studying the lives and experiences of Black STEM high school students, reports that “Black males who consistently outperform their peers in mathematics are also victims of covert racial stereotypes and racial microaggressions” (McGee, 2015, p. 1). McGee goes on to report that “Black males are presumed to lack intelligence when it comes to academics, particularly mathematics” (p. 1).

“There are thousands of young Black men in urban cities across the country who are STEM high-achievers and have the potential to succeed as STEM professionals” (McGee, 2015, p. 1). Nonetheless, these men are always hearing negative commentary regarding their continued successes in technology. These messages from counselors and/or teachers diminish their mathematics capabilities. “The low expectations from this large demographic serves to further discourage these often talented individuals from pursuing STEM fields such as software engineering“ (p. 1).

Statement of the Problem

Diversity is critical in the field of software development engineering. According to research conducted by Antonio et al. (2004), “a diversity of views improves science and allows engineering to be more agile in terms of responding to a global supply of clients” (p. 508).

Antonio et al. also found that "students working in a diverse group setting were influenced by the different perspectives of minority participants and demonstrated enhanced complex thinking processes as a result" (p. 512). The current demographic makeup of the technology workforce is predominately male and overwhelmingly White or Asian. By increasing the demographic make-up organizations are more likely to foster innovation and create better products that better serve their diverse customer base.

"At a time when STEM fields are increasingly important to the health, security, and competitiveness of our nation, many technology companies are not supporting the research, nor are they generating the diverse supply of talent needed for the future" (Chubin & Malcolm, 2008, p. 1). There is a scarcity of research regarding the lack of African Americans pursuing careers in software development. The reason for this study is to determine what challenges are faced by African-American software development engineers, what strategies and practices are employed by African-American software development engineers, how African American software development engineers measure success, and recommendations made by African-American software development engineers. The main research question for this study focuses upon determining the key factors that contribute to the under representation of African-Americans pursuing careers as software development engineers.

Purpose of the Study

The purpose of this study is to determine what strategies and practices are employed by African American software development engineers, to determine what challenges are faced by African American software development engineers, to determine how African American software development engineers measure success, and what recommendations would African

American software development engineers make for future African American software development engineers.

Research Questions

To explore the factors that contribute to discouraging African-Americans from pursuing a career in computer science, the following questions are addressed through this study:

1. What strategies and practices are employed by African-American software development engineers to overcome the challenges of being part of an underrepresented group in the technology sector?
2. What challenges are faced by African-American software development engineers in implementing the strategies and practices to overcome being part of an underrepresented group in the technology sector?
3. How do African-American software development engineers measure success in overcoming the challenges of being part of an underrepresented group in the technology sector?
4. What recommendations would African-American software development engineers make for future African-American software development engineers to be successful as part of an underrepresented group in the technology sector?

Significance of the Study

Antonio (2004) suggests that "a diversity of perspectives enriches science and makes engineering more responsive to a global pool of clients" (p. 507). According to Antonio, "students working in a more diverse group setting were influenced by the different perspectives of minority participants and demonstrated enhanced complex thought processes as a result" (p. 516). A study that examines the strategies and practices employed by African American

software development engineers, challenges being faced by African American software development engineers, measures of success as well as recommendations would African American software development engineers make for future African American software development engineers can be of value on several fronts.

First, understanding the strategies and practices that are employed by African American software development engineers can help corporations and organizations adjust recruitment and hiring strategies. Second, it can help colleges and universities modify their curriculum in ways that will attract more African Americans to careers in software development. Third, researchers have studied the need to have more minorities represented in the computing fields, but there is not much focus in the literature as to why African Americans are so underrepresented in computing in academia and in the workplace.

Limitations of the Study

- Researcher assumes that the participants will be cooperative and available
- The impact of the researcher's age, gender, and personality to the study is unknown.

Definitions

In order to avoid ambiguity, the terms listed below will be defined as follows for the purposes of this dissertation:

STEM: Refers to the acronym Science, Technology, Engineering and Math ("Science, Technology, Engineering, and Mathematics," 2017).

Software Development Engineer: A software engineer is a person who applies the principles of software engineering to the design, development, maintenance, testing, and evaluation of the software and systems that make computers or anything containing software work ("Software Developer," 2017).

African American: African American, also referred to as Black American or Afro American, is an ethnic group of Americans (citizens or residents of the United States) with total or partial ancestry from any of the native populations of Sub-Saharan Africa ("African Americans," 2017).

Workforce Diversity: Refers to similarities and differences among employees in terms of age, cultural background, physical abilities and disabilities, race, religion, sex and sexual orientation. In this paper, diversity refers to workforce diversity ("Workforce Diversity," 2015).

Summary of Chapter 1

African American software development engineers are critical in the effort for American to answer the call to provide adequate technology workers to meet the needs of the global innovation economy of the 21st century. As such, the country's greatest prospect of thwarting the economic dangers of not having enough skilled technology workers to meet the needs of the job market is to look toward our underrepresented groups, namely, women and underrepresented minorities (Margolis, 2008). The illumination of the practices and strategies that encourage African Americans to not only pursue careers in software development but also to help them to navigate the challenges and obstacles that have been faced by their progenitors is imperative. Providing answers to why so few African Americans are pursuing careers as software development engineers will ensure the production of the next generation of African American software development engineers.

Chapter 1 provided an outline of this research study, described the background of the problem, and highlighted the purpose of this study. Four research questions were proposed and the significance of the study was indicated. An outline of the limitations and assumptions were

provided and the key terms related to the study were defined. Chapter 2 will produce a review of relevant literature that will provide a foundational framework for the research.

Chapter 2: Literature Review

This chapter presents a review of the literature related to the lack of African American software development engineers, including a historical overview of early American attitudes towards African Americans and technology, deficiencies in educational opportunities for African Americans and other minorities, workplace diversity challenges, the current state of diversity at technology companies, women in technology, and what can be done to attract more African Americans to choose careers as software development engineers.

Historical Overview of African Americans and Technology

This section of the literature review will focus on the early experiences of African Americans and how these experiences have influenced the attitudes of latter generations of African Americans and their overall cultural connection to the world of modern technology. This portion of the paper will address the conditions, educational disparities, and intimidation toward intellectual development for many years.

History of African Americans and Technical Education in America

Oppression and injustice have been part of the African experience in America since the first arrived in Jamestown, Virginia. The disparities in educational opportunities, the lack of access to pursue more lucrative occupations, the inability to participate in the voting process, and other similar forms of racial bigotry are all indicative of policies anchored in American philosophy and tradition. The ramifications of these practices are observable now (Sinclair, 2004).

Race and Technology in Early America

Among the many reasons why the connection between innovation and race in the United States has been rejected for centuries, chief among them is White supremacy. Even one of the

founding fathers, Thomas Jefferson, believed that Blacks were intellectually inferior to Europeans. This idea that Blacks were less intelligent than Whites became the foundation for their enslavement as well a host of other indignities suffered by Blacks even after slavery became illegal. Plantation owners used this logic as a justification for enslavement (Bedini, 2004). The implication being that those who did menial labor possessed only minimal intellectual prowess. Furthermore, many of the an abundance of the literary works of the eighteenth-century made derogatory comparisons of African and other Eastern societies with regard to their relative inventive weaknesses in technology and science (Sinclair, 2004).

This characterization provided an advantage for Americans and Europeans to discredit or dismiss any notion of innovative talent among other ethnic groups (Adas, 1990). For generations high-tech knowledge and skillfulness in America has been associated with ancestral lineage. The preeminent idea in colonial America was that the notion of democracy would triumph as the imagination of its population were freed. Technological competencies and *Whiteness* were often viewed as integral components of each other, and as crucial facets of masculinity. However, this notion was constructed in terms of race from its inception. Whether Africans were enslaved or enfranchised was of no consequence; they were never thought to be by their European-American contemporaries to be able of technical creativity--and they enveloped this *difference* into a pronounced point of contrast (Sinclair, 2006).

During this time an examination of the literature reveals that there are many examples that expose the belief of the day. However the following example epitomized in the acerbity of a Massachusetts attorney while disputing a patent case when he stated: "I never knew a negro to invent anything but lies" (Sinclair, 2004, p. 5). Although colonial newspapers cited hundreds of notices chronically the substantial technical aptitude of fugitive slaves, slave masters asserted

that African slaves destroyed or abused their tools as they could not fathom how to utilize them, not as purposeful acts of counteraction (Berlin, 2009). As time went on the notion that scientific aptitude and race intersect became more acceptable. Although Philadelphia was considered a relatively *progressive* city, when the Franklin Institute was established in 1824 with the charter of strengthening the advancement of the mechanical arts, it did not stop them from barring Black from attending. Historically, African-Americans historically have been denied access to technical education (Sinclair, 2004).

Technical Education and Blacks

Since the inception of America, Blacks have been convinced that they lack inventiveness. As America matured and the possibility of the abolition of slavery loomed, those in power had challenges solving the problem of what to do with free Africans (Sinclair, 2004)? That problem, more accurately articulated, brought into question the ways that former slave owners would deal with these newly freed individuals who still provided labor that contributed to their wealth. Education became a tool of oppression. The designers of *Black education* appreciated that education could be utilized to both liberate and oppress. Early American education was crafted to rule, placate, and indoctrinate subjected people (Watkins, 2001; Wharton, 1992; Woodson, 1990).

Education has been the primary method of manipulating African-Americans. There has always been a strategy to how African-Americans are educated. It has never been simply a matter of literacy. How African-Americans have been educated has always had economic and political ramifications. How African-Americans were educated played a major role in race relations for the entire 20th century and beyond. Charity by other races had become one of the primary methods of creating policy. Race benefaction served the purposes of those whose aim

was to control African Americans through education. This technique made it much easier to avoid the slow and deliberative system of law making and provided the control needed to shape the education as was deemed fit for their purposes. The school system that was created via charities was an effective method for conditioning the minds of African-Americans and people of color (Watkins, 2001).

The benefit of this arrangement is that all aspects of education could be controlled by corporate entities. African-Americans have been denied educational opportunities since the establishment of slavery and even after the abolishment of slavery, Blacks were still dependent on Whites for their educational nourishment. Slaves were not allowed to receive credit for their inventions and as a result generations of aspiring African-American technologists have been denied the impact of having a powerful role model to use as inspiration (Wharton, 1992).

The historical experiences of African-Americans with technology in America provides insight into why so few of them pursue careers in technology. There is evidence that the attitudes and beliefs regarding computing that have been forged for generations can be seen in African-American students today. While studying why African-American high school students choose not to participate in technology classes even when the opportunity to take the classes was available to them, Margolis (2008) found that the conditioning persists. African-Americans did not take computer science classes and it was not a result of the classes not being available. The study suggest that although the opportunity to take these classes was there it did not affect the attitudes of the students regarding computing:

> We came to realize through this research that while interest and choice are ordinarily framed as individual and personal actions, this is not an adequate understanding. Instead, the ways in which students make their decisions are, again, largely determined by

> structural factors and widely held beliefs, even in a school where opportunities abound. And all of these issues are still very much intertwined with the larger ones of race, class, and gender. (Margolis, 2008, p. 73)

African-American and Latino students have historically been subjected to systematic inequities that played a role in their being viewed as being intellectually inferior. As a result, more of them, than their White counterparts, are placed in remedial classes where they won't be afforded the same learning opportunities (Margolis, 2008). Moreover, in 2010 *The San Jose Mercury News* published an article, "Blacks, Latinos and Women Lose Ground at Silicon Valley Tech Companies," Swift (2010b) indicates that not only is the variety of the population in the region not reflected in its technology workforce, but also that the disparity is progressing.

As recently as 2010 it has been documented that African-Americans are underrepresented in the technology workforce in Silicon Valley (Swift, 2010a). Moreover, not only is the diversity of the area not reflected in the workforce but also the underrepresentation of women, Latinos and African-Americans is growing. Between the years 2000 and 2008 the number of Hispanic and Black technology workers in Silicon Valley has decreased although nationwide their numbers have grown (Swift, 2010a). African-Americans have been denied access to the type of education needed to be successful in the technology fields. Moreover, African-Americans have not had the benefit of being aware of their ancestors who were science exemplars and contributors to the technological advancements in this country primarily because these stories have been hidden and this has served to stifle interest among African-Americans in the sciences (Wharton, 1992). It is important that Blacks receive the same learning opportunities as other groups to meet the global challenges America faces today, and into the future.

Educational Pipeline Issues: Social Implications of K-12 Education

The quality of the educational opportunities in computing made available to African-Americans will play a major role in the success of attracting more of them to the field. A report in 2008, prepared by the WGBH Educational Foundation and The Association for Computing Machinery entitled *The New Image for Computing* (ACM, 2008) found that there was interest in computing among Hispanic and African-American males yet these two groups are still severely underrepresented whether it be on university campuses or in the technology workforce. The study suggests that how students view a career in computing may not necessarily be the issue. The implication is that further research may be needed to determine why it is that the attraction that was observed while students are in school is not present once they embark upon their careers.

However, the number of underrepresented students who are majoring in computer science is improving according to the most recent Taulbee Survey. Although the situation has improved more students are still needed to study computer science in order to fill the number of available jobs. The report also highlights that the lack of diversity persists in computer science programs (Zweden, 2009). For some reason African-American and Hispanic males do not maintain their interest in computing once they leave high school. Although more students are pursuing degrees in STEM, this has not alleviated the low STEM graduation rate among the underrepresented groups (Higher Education Research Institute, 2010).

This finding suggests that perhaps something else is happening while students are in college that is contributing to their not persisting to graduation. One such study is the 2010 Bayer Facts of Science Education, which found that minority students are being discouraged from

completing their STEM degrees by university professors (Bayer, 2010). The leading workplace barriers identified for the women and minority scientists include:

- Managerial bias (40%), company/organizational/institutional bias (38%)
- A lack of professional development (36%)
- No/little access to networking opportunities (35%; Bayer, 2010).

This research indicates that leaders in higher education would be wise to consider each student as individuals that consist of varied lived experiences, backgrounds, and histories (Bayer, 2010). Furthermore, it suggests that the curriculum should include be inclusive of all cultures as well as provide interventions that contribute to the success of minority students (Laffey, Espinosa, Moore, & Lodree, 2003). The narrative is that these students simply do not have the ability to succeed in these fields and that is promulgated as the reason why they are underrepresented as opposed to recognizing the effects of long standing institutional inequities (Kao, 2000). African-Americans and Latinos earn below 10% of the both the undergraduate and advanced degrees in computer science (Zweben, 2006).

The disparity between educational opportunities in computing are often exacerbated by schools. Students who are the most accomplished with computers tend to be given the most challenging projects, while students who only possess a basic understanding of computers continue to receive the most elementary coursework. Therefore, computing in schools can be a space where prejudices are being cultivated as opposed to being a mechanism for improving educational and life opportunities (Margolis, 2008). The result of African Americans and Latinos being subjected to poor educational environments is that it increases their chances of being placed in remedial programs, which further restricts their educational opportunities (Higher Education Research Institute, 2010).

The effectiveness of technology access is dependent on much more than simply the providence of computer equipment. There is a complex interconnected array of factors that must be taken into consideration in order for meaningful technological access to take place. These factors include personal factors, electronic factors as well as human and societal assets. The idea that some groups have less access to technology, commonly referred to as the *digital divide,* implies that those who do not have access to technology will have their opportunities limited. However, the corollary is also true, and that is that underrepresented groups will also have less opportunities to utilize technology (Warschauer, 2003). The goal of providing underrepresented groups with technology should be more about the evolution of these communities and less about closing the digital divide (Jarboe, 2001).

There is more to social inclusion than having access to technology (Askonas & Stewart, 2000). The essence of social inclusion in today's society is measured by the ability to consume and create new knowledge (Warschauer, 2003). Students are constantly being bombarded by marketing messages on television. Debell and Chapman (2006) found that how students use computers is based on several factors and that race and socioeconomic status plays an important role on the effect that these factors have on student computer use.

Income is a determining factor as it relates to computer usage in the home. Less than 40% of families whose household income is less than $20,000 use computers at home while nearly 90% of those whose household income exceeds $75,000 have access to computers in their homes. The study also suggests that there may be a connection between computer use in the home and race. European American students are more likely to have access to computers in the home compared to those who hail from minority ethnic groups to include Latino Americans, African Americans, and Native Americans. Moreover, the study reported that having access to

computers in the school was critical for those groups whose access to computers in the home was less likely. African American, American Indian, Spanish-speaking only, and students whose family incomes were less than $40,000 rely more heavily on being able to access the Internet from school than from anywhere else (Debell & Chapman, 2006).

Even if the problems of access are resolved, African American students still face an array of social obstacles. There is a belief among African American students that others view them as intellectually inferior (Perry, Steele, & Hilliard, 2003). These attitudes when combined with institutional experiences makes it very difficult for students from underrepresented groups to perform (Solorzano, Ceja, & Yosso, 2000). The most important aspect of teaching underrepresented students is the formation of a respectful connection between student and teacher (Steele, 1992). Middle class students benefit from support groups that provide them with connections and information that is crucial to advantage and opportunity. However, these kinds of networks are largely not available to minority students and as a result they are left to navigate the pitfalls and obstacles on their own (Stanton-Salazar, 1997).

Advanced Placement (AP) classes are college-level courses that students can take advantage of to receive credit while attending high school ("Advanced Placement," 2017). Exposing students to the college level standard and thereby increasing college preparedness is the major aim of the program. Historically Latino and Black students as well as low-income students have been prevented from taking AP courses by actions such as lack of teacher recommendations, entry exams, and grade requirements (Kohli, 2015). This situation has been recognized by the College Board. The College Board is a mission-driven not-for-profit organization that connects students to college success and opportunity ("The College Board", n.d.)

The College Board was created to broaden the path to higher education ("The College Board", n.d.). In California, Long Beach and Los Angeles unified school districts are also recognizing this situation, and they have begun to change access policies so that all students can choose to take an AP class (Kohli, 2015). Today, however, Black students are still underrepresented when it comes to sitting for the AP exam for Computer Science. According to ("The College Board", n.d.), about 30,000 students sat for the exam in 2013. Less than 1 out of 5 of those students were women, about 3% were African American, and nearly 10% were Latino. Upon analyzing the information across the country, African Americans sat for the test in only 11 states (Heitin Loewus, 2014).

The percentage of females who took the exam ranged from approximately 4% in Utah to 29% in Tennessee across the 47 states where girls took the test. Moreover, African Americans pass the exam at lower rate than any other group of students (Heitin Loewus, 2014). As such, taking and passing the AP exam is an indication of the preparedness of students to pursue a career in computing. Improving the number of African Americans that take and pass the AP exam may help with that preparedness. It is critical that female and minority computer science students believe that their teachers respect them as people. It is equally important that teaching occurs in a way that is culturally relevant to the lives of the students (Margolis, 2008).

It is important that underrepresented students perceive computer science instructors as role models who can help them achieve similar status in the world of education. Students must also be made aware of the applicability of computing to their lived experiences (Margolis, 2008). All facets of the learning process must be examined and addressed. For instance, support systems play a vital role for African American female engineers. According to a 2014 study conducted by Rice and Alfred, being supported in every phase of the educational channel is crucial. Efforts to

stimulate interests of African Americans in software development engineering can be improved by addressing issues at all points in the STEM learning process.

Differences in Access to Technology

Differences in introduction to the Internet. African Americans are less likely to have access to computers, or the Internet, in their homes than their Asian and White counterparts. A 2012 study of American college students revealed that Hispanic and Black non-Hispanic college students are more likely than White non-Hispanic college students to have first begun using the Internet at school. The authors of the study indicated that this suggests that a digital divide may originate from discrepancies in home computer ownership, which is likely correlated with socioeconomic status (Jones, Johnson-Yale, Millermaier & Peréz, 2009). The research suggests that Blacks and Hispanics often enroll in college without prior experience using the Internet. This may place them at a disadvantage as their peers may already be effective in using the web to enhance their learning experiences.

Less access to technology in the home. African Americans have less access to broadband in the home. The National Telecommunications and Information Administration issued a report in 2010 titled *Digital Nation: 21st Century America's Progress toward Universal Broadband Internet Access* (Stricking, 2010). The report's findings were that households that have broadband tend to be younger, have higher levels of education, married, Asian or White, younger, and with higher incomes. Conversely, homes without broadband have a tendency to be underemployed, low income, African American or Latino and less educated. Access to high-speed Internet access in the home results in a richer Internet experience. Households equipped with broadband tend to be more likely than those lacking broadband to utilize the web for a broader collection of activities (National Telecommunications & Information Administration,

2010). Further, homes equipped with broadband are naturally more connected to the world and more inclined to have access to educational and business-related opportunities (Seiter, 2008). This research suggests that those lacking broadband access in their homes may be constrained in their activities online and thus be excluded from the advantages of digital content and capabilities.

Differences in mobile device use. African-American youth devote a great deal of their time online to entertainment activities. According to Rideout, Foeher, and Roberts (2010), Latino and Black youth are the heaviest consumers of media via their mobile phones. African American youth spend more time using their mobile devices daily for entertainment than any other ethnic group. Although African American youth have access to mobile devices, generally they are not using them as a means of education or to research career possibilities as software development engineers.

Differences in mobile device adoption. African Americans access the Internet using their smartphones more than any other group. According to a study conducted by the Pew Internet and American Life Project (Livingston, 2011), African Americans were more likely than any other group to go online via mobile phone. Latino and Black adolescents' interactions with mobile phones is particularly vigorous when contrasted with their Caucasian peers, despite the fact that most the majority of young people have moved to smartphones. For instance, in using mobile phones to access the Internet, Latinos are more apt than Whites to utilize mobile devices for accessing phones for accessing web-based communication technologies. Moreover, African Americans are slightly more likely than Whites or Latinos to conduct these activities on their mobile devices.

In 2009, handheld Internet usage on an average day increased by 73% for the general United States populace. However, for African-Americans there was a gain of 141% (Horrigan, 2009). As such, African Americans experience a reduced perspective of what can be accomplished using the Internet as a tool because of this limited access.

Differences in technology experiences in K-12 schools. Students benefit most from technology when the technology is not the main focus of the teaching and learning (Warschauer, 2003). Warschauer (2003) studied two schools, one low-income and the other socially elite and although both schools made liberal use of technology, "the ends to which computers were put were markedly different when the two schools were compared" (p. 132). Warschauer asserts, "Regardless of the subject area, the elite school used technology to help prepare scholars, whereas the poorer school used technology to help prepare people for the work force" (p. 132). How the technology is utilized is crucial. It is imperative that schools with predominantly African American and minority populations use technology in ways that not only improve job skills, but also help produce, but also to produce the scholars and innovators of the future.

The operating conditions of many low-income schools where many African American students find themselves, although well meaning, tend to exacerbate the issue of digital inequality. Demanding working environments and low expectations have restricted scholastic opportunities in several inner-city schools in America (Warschauer, 2003). Even the teachers at the school in the Warschauer (2003) study who attempted to raise the bar academically experienced frustration doing so as a result of inadequate time for preparation, huge class sizes, and lack of modern equipment.

Even though the school received a technology *injection* and had skilled well-intentioned teachers, the net effect was molded and limited by the wider social context. The place to start for

a progressive examination of technology in any establishment should not be the disparities in computing equipment and methods to address it, but instead the focus should be used to aid them in becoming more inclusive, egalitarian, and proportionate (Warschauer, 2003).

Therefore, studying schools holistically when attempting to remedy the situation of digital equity and social inclusion. There is a concern among educators that many schools are not teaching the deeper concepts of problem solving and innovation. Most schools only teach students how to operate software and the basics of computer operation, instead of teaching the more advanced ideas such as problem-solving that serves as the foundation for innovation (Wilson, Sudol, Stephenson, & Stehlik, 2010). Leigh Ann Sudol (as cited in Carnegie Mellon University, 2010), one of the study's authors, suggests that "The point is not that every student needs to become a computer scientist, but that all students have the basic knowledge they need to understand an increasingly technological world. Just like understanding a cell in biology class" (p. 1).

Opportunities with regard to computing education are not equal amongst all institutions. Whether it is in the U.S. or other countries this inequality manifests itself in how students from affluent schools tend to create a new and exciting applications of technology while students from poorer communities are usually are more than likely limited to utilizing the technology in ways that does very little to inspire them to create or innovate (Becker, 2007; Wenglinsky, 1998). Consequently, the promise of technology's impact for social equality can be reversed to produce opposite effect.

As a result, some areas of the population learn to become the creators of the multimedia content of the tomorrow, while others are position to be merely consumers of that content (Warschauer, 2003). The educational opportunities that exist between low-income and affluent

communities are not equal. The issue of digital equity and the importance of usage are not reserved only to schools. Although home access to technology can be a critical component that supports a student's learning, there is evidence that suggests that technology use in the home by itself does not necessarily rectify inequalities with regard to technology's contribution to student achievement.

For example, there is evidence that high-income students that have technology available to them in their homes are much more likely to use it as a tool for school improvement than are those students who come from impoverished backgrounds (Becker, 2007), while another study illustrated that technology access in the home improves the achievement of students who come from affluent communities more than it does for low-income students (Battle, 1999).

As such, just as it has been observed in the schools, merely having access to the computer in the home is not enough. The conditions whereby the computers are being used may need to be examined. There has been research aimed at how technology is used by different groups of learners. Access to the Internet is oftentimes afforded as a benefit to the most proficient learners thereby exacerbating existing areas of bias in schools (Warschauer, Knobel, & Stone, 2004). While examining school use by subject Becker (2007) found that low-income students tend to utilize technology for conducting repetitive lessons in English and mathematics while those from more affluent backgrounds tend to be early adopters of emerging technologies and more likely to see technology as a pathway to innovation and experimentation. These findings were echoed by Wenglinsky (1998) and Warschauer (2003). They also found a comparable focus on remedial or job-related uses of technology among low-income or African-American and Hispanic students compared to more scholarly uses by high-income or Asian and White learners:

> Inequalities in the availability of computer technology and Internet access still exist. But rather than one single, gaping divide, what the nation's schools are grappling with is more a set of divides, cutting in different directions like the tributaries of a river. And increasingly, those inequalities involve not so much access to computers, but the way computers are used to educate children. (Warschauer et al., 2004, p. 565)

These studies illustrate that there is no one aspect of a digital divide but instead several determinants that mold technology's magnification of existing disparities in society and school (Warschauer, 2003; Wenglinsky, 1998). All students should have the opportunity to use computers in ways that increase academic achievement and provide the impetus to for them to become creators and contributors to the world in which they live. More evidence that the issue of digital equity is not about one cause or construct in schools is this qualitative study conducted by Warschauer et al. (2004). In a comparison between low-income and high-income high schools in California, the study observed discrepancies in availability, access and use. One of the main findings of the study was that even though the schools compared favorably with regard to access there was significant differences with regard to usage, support, and home access between the low-income and high-income schools. In the low-income schools there was a lack of networks, there as little access to computers in the home, and the schools were more focused on test scores and attending to students who native language was not English. The study found that high-income students used technology to execute predictive analytics, whereas low-income students utilized computers for personalized learning. With regard to the language arts it did not matter whether students came from an impoverished or affluent background. In both scenarios, schools utilized the technology in the language arts for rudimentary skills such as creating presentation slide decks and composing essays.

Students in the more affluent schools also utilized computers to examine compositions as well as to conduct investigations on the Internet. In the humanities, students in both low socioeconomic status (SES) and high SES schools, conducted web-based research, but students in low SES schools also architected slide presentations. The study asserts that teachers are more inclined to teach low-income students fundamental computer skills because they are assuming that these students do not have technology available to them in their homes. Since, students from low-income backgrounds already face more challenges than more affluent students face, these students can ill afford to be denied any substantive opportunities to learn. This study found that some of the ways that schools are deploying technology to prepare students academically is getting results. The study also found that some of the ways that computers are being used to teach is ineffective. No evidence was found to suggest that technology is helping to close the gap between educational disparities between the schools (Warschauer et al., 2004).

Conversely, the evidence appears to suggest just the opposite: that the addition of technology provides amplification to current forms of disparity in the schools (Warschauer et al., 2004). Computers have become an integral part of society and are critical to both to workforce communication and social networking. It is the social determinants of these uses that need to be studied far more than the machines and the technologies themselves. These social structures need to be corrected and the limitations and low expectations that are built into them remedied.

As Rob Kling explains:

> As this study declares, placing technology infrastructure in poor schools does nothing to help these schools overcome their obstacles. And further any attention given to simply providing equipment detracts from more substantive and innovative solutions to these problems, such an approach can possibly do more harm than good. The idea that

> technology is embedded into our society is a crucial factor in solving the digital divide. What this means is that technology is not an independent force, instead technology combines with social forces and together they create each other in a plethora of ways which have a great deal to do with how certain groups using the technology are affected. (Warschauer et al., 2004, p. 588)

Education is largely a social endeavor. Social issues must be taken into account if disparities in education are to be remedied, and these remedies will include the issues of digital equities. Education is influenced by social factors. Technology cannot be studied without taking factors such as language, culture and economics into account. Urban teachers are less experienced. Low-income schools suffer more from absenteeism. More low-income students are underperforming in Math and English (Warschauer, 2003). Teachers in the less affluent schools incorrectly assumed that only about half of their students had access to technology in their homes. However, the evidence indicates that more than 80% of students in these schools have access to computers in their homes (Warschauer et al., 2004).

All of these components mean that the faculty, administration, and staff, with fewer credentials and less experience, were dedicating much of their resources to remedial literacy and numeracy and computer basics. Consequently, there was less time and attention that could be focused on enhancing learning through academically rigorous uses of technology in the classroom (Warschauer et al., 2004). These fundamental issues of education need to be addressed before there can be any discussion of closing the digital divide and/or remedying the problems of digital equity.

Given these circumstances, it seems unlikely that students who are learning or using computers under these circumstances would come away with aspirations of pursuing careers in

computer science, or understanding that these machines can be used to produce and create opportunities to earn an income. Riel, Schwarz, and Hitt (2002) agree that closing the digital divide involves much more than procuring hardware. It requires developing the expertise and dexterity of teachers utilizing the technology, and dispensing admittance to digital appliances in the community; which Riel et al. refer to this paradigm shift as the "*width, depth, and slope* of the digital divide" (p. 147). They "explore the process of school change, documenting the school and community efforts to close the technical, cultural, and structural dimensions of the digital divide" (p. 147).

Riel et al. (2002) have devised a process that addresses the slope, width, and depth of the digital divide and they intervened in two schools to address these areas and then examining the outcomes.

> The width represents differential access to technology resources in schools. The slope represents differences in the cultural context of use --how and why teachers choose to use computers to support their teaching. The depth represents structural differences in access to, and knowledge of, these evolving computing tools based on an individual's or group's socio-economic and cultural location in society. (p. 149)

Results showed that over 3 years, that access to technology has improved the ratio of students to multi-media computers from 19 to 1 to 4.8 (Riel et al., 2002).

Additionally, by developing the culture of computer use resulted in higher teacher proficiency with technology within these school communities; as a matter of fact, teachers' computer proficiencies jumped significantly as compared to other schools in the district. This increase of skill levels among instructors reflected greater gains in students' technological expertise, resulting in higher student achievement. Based on the findings, the authors recommend

that by significantly changing any two dimensions (i.e., width, depth, or slope), it will help close the digital divide. They also suggest that given the difficulties in addressing societal inequities, it makes sense for educators to focus on changing these dimensions in the schools (Riel et al., 2002).

Therefore, examining the entire system or process around using technology in learning can produce more dramatic effects in learning improvement and use of computers, and this may result more interest in technology as a career choice. Several studies have suggested that there is a major discrepancy in the availability and usage of computers in American schools based on racial and economic lines; African-Americans, Hispanics, and those who are from low-income backgrounds tend to have the least amount of access to computers and when they do have access to computers they are using them in the most remedial of ways (Becker, 2007; Education Week, 2001; Wenglinsky, 1998). Conversely, it has been reported that teachers in low-income communities use computers more frequently than those in high-income communities. However, how the students used the computers was highly dependent on the teacher's perspective and expectations. Becker (2007) concluded that low-income students tend to use computers for drilling exercises while those from more affluent communities are engaged with computers for more intellectual pursuits.

Low-income schools as well as those that are predominately made up of African-American and Hispanic students provide both the lowest access to the Internet and teach their students the most basic uses of computers (Becker, 2007; Education Week, 2001; Wenglinsky, 1998). On the other hand, it has been reported that lower-income schools actually allow their students to use computers for more hours each than do high-income schools (Becker, 2007). But it is how they are using the computers that is so vastly different. Students in low-income schools

are on their computers for more hours each week, however they are using them for more rote, remedial uses as opposed to learning how to use the systems for more innovative and creative uses like their more affluent counterparts.

Wenglinsky (1998) uncovered arrangements of educational technology usage amid disparate kinds of learners, and in opposition much of the literature, Wenglinsky found that "there were no disparities in access to computers at school, or in their frequency of use at home for those families that own a computer at home" (p. 24). However, what ethnic group a student belongs to plays a role with regard to whether or not they have access to technology in the home. For instance, three out of every four Asian or White students had access to a computer in the home compared to nearly 50% of African American or Hispanic students. While access to computers in the home did not vary across racial lines, disadvantaged students "do seem to be less likely to have teachers well-prepared to use computers, and disadvantaged eighth-graders seem to be less likely to be exposed to higher order learning through computers" (p. 24). While things have improved with regard to access to technology in the schools, there is still more work to do as it relates to preparing teachers and providing quality and relevant content using computers. Another report from the federal government agrees with Wenglinsky's findings and highlight more disparities. Teacher readiness to integrate technology in learning is not the same across all schools. According to a 2000 National Center for Education Statistics report (Snyder, 2000), teachers in low-income schools feel less prepared to use technology to teach than those who serve in schools with the lowest percentage of low-income students. The report also indicated that how computers are used in the school is related to socioeconomic status. Students in low-income schools are generally less likely to be exposed to more advanced computer exercises while their higher income counterparts are exposed to using computers such as those

that their higher income counterparts experience such as spreadsheets and word processing (Becker, 2007). But these same teachers are more likely than instructors of higher income students to use computers for skill-and-drill activities (35% versus 26%; Becker, 2007). These schools need to have teachers who are just as qualified and comfortable integrating technology into their instruction as those with higher-income students. Students can't be expected to understand the possibilities of becoming conversant in technology use if the teachers themselves are not prepared, and are only able to use technology in a rudimentary fashion.

However, there are data to suggest that there are discrepancies in access to educational technology, especially on the Internet. Almost all of the schools in the United States had access to the web by the year 2000 to include nearly 80% of American classrooms. Still, when comparing inner-city schools with those in rural areas there is a disparity in Internet connectivity. Nearly 70% of inner-city schools are connected the Internet while schools in rural areas are approaching 90%. Additionally, by the year 2000, schools that had less than 6% minority student body were more connected than those that were majority minority schools (T. Snyder & Hoffman, 2002).

Krueger (2000) investigated the inequities between students with regard to technology use along racial lines utilizing data from the October Current Population Survey (CPS) School Enrollment Supplement in 1984, 1989, 1993 and 1997. Studying these grades from 1984 to 1997 the gap of computer use in school between African American students and White students decreased over that 13 year with the percentage decreasing from 16% to 6%. For Hispanic students the data showed something different. Hispanic students used computers in school more than African American students from 1984 up to 1997, but in 1997 things changed. As of 1997, Hispanic students were less likely (5%) than African American students to use computers (and

11% less likely than their White counterparts) to use computers in school. Krueger also found that in 1997, White students used the Internet in school (20.5%) more than African American students (14.8%) who used the Internet more than (11.8%) Hispanic students. From these data, Krueger concluded, "Black and Hispanic students seem to lag behind in using the latest technology in school" (p. 2).

However, it is not only a matter of income. African Americans students are less likely to access the Internet than their White counterparts, even when income level is taken into account. Vanderbilt University researchers concluded that income is not the only element that determines where the lines of demarcation are drawn at the digital divide. Although the level of poverty of a school is a strong barometer of the level of accessibility to the Internet, money isn't the only variable at play. According to the study, even when income is taken into consideration, White students were more than twice as likely to have access to computers in their homes as African-American students (Education Week, 2010).

This study offers answers to this question, and maintains to understand that there may be a different attitude towards the Internet and using technology between African American students and White students. There definitely still exists an appreciable disparity in technology in the home and online access among White and African-American households (DeBell & Chapman, 2006; Fairlie, 2004; Judge, Puckett, & Bell, 2006). Hargittai and Hinnanti (2008) analyzed more subtle assessments of use by studying variations in young adults' online activities. Their findings indicate that adults with higher levels of education and a background of resource richness use the web for more *capital-enhancing* activities.

The study also revealed that online capability is a critical aspect in the activities people seek online (Hargittai & Hinnanti, 2008). As such, African Americans with lower education

levels may be challenged to make the connection between computer use for entertainment and computer proficiency to secure jobs and produce income (Hargittai & Hinnanti, 2008). Thus, better educational opportunities alone can do much to enhance this understanding and bolster the interest of African Americans toward computing occupations. Academic achievement is improved through access to and use of computers. In 2005, Judge found that those who were the high achievers were those who utilized applications for math and literacy more often than both low and mediocre achievers while in pre-school.

The use of home computers, shared computer areas in classrooms, and the child-to-computer ratio were all positively correlated with scholastic achievement. Moreover, conducting repetitive math and literacy exercises as well as using gaming software was also found to have a positive impact on academic success (Judge, 2005). It is imperative that lower-income schools gain access to the use of computers in order to enhance academic achievement, thereby increasing students' understanding of the nature of technology as a "capital-enhancing activity" (Hargittai & Hinnant, 2008, p. 607).

Several studies have reported that there is a disparity between the availability and usage of technology in American schools, with inner-city schools that are primarily composed of Hispanic, African American, and low-income students consistently experiencing less exposure to emerging technologies and when they are exposed to these technologies the depth of their exposure tends to be at a superficial level (Becker, 2007; Wenglinsky, 1998).

Other studies seem to support this idea of disparity along socio-economic lines. The National Association for the Education of Young Children (NAEYC, 1996), for example, agrees with these findings. In a position statement, the NAEYC confirms that the issue of equal access to technology is crucial, but how the technology is used is just as important. The report confirms

the impact that technology can have on a child's thinking as well as their ability to interact with others. Moreover, the study acknowledges that it may be even more important to provide equal access to students who hail from impoverished communities because for those students the school may be their sole opportunity to be exposed to computers. Further, the study asserts that not only should access to computers be equitable, but also that educational technology be deployed in the classroom.

Further, for students who come from impoverished environments where they may only have access to computers during school hours it is that much more important to provide them with equitable access to technology. Also, the NAEYC (1996) advocates for technology integration in the schools. Therefore, this equity encompasses having teachers that are qualified to craft lessons that that are developmentally and culturally relevant. Educational technology has been shown to have a positive impact on at-risk African American student's mathematics success (Laffey et al., 2003). There have been similar results reported in sight vocabulary (Fishman & Pinkard, 2001).

The literature also suggests that inter-correlations between variables such as grades, technology, and utilization rate shows that availability and usage of computers in the home, computers running applications, computers-to-children proportion, and instructional technologies related positively with academic accomplishment during 1st grade as well as kindergarten. Moreover, frequent use of applications for literacy, mathematics, and simulations in pre-school was positively correlated with academic achievement (West, Denton, & Germino-Hausken, 2000).

Furthermore, the literature goes a step further to reveal that it makes a different what type of application is being used in education. Not all software produces the same results and

educational outcomes are linked to the kind of software that is being utilized (Haugland, 1992). Schools remain a critical place to introduce African-American children to technology, as access to computers from the home remains an area of inequity in the United States.

Even though student access to computers in the home increased between kindergarten and the 1st grade, African-American students still had less access to home computers when compared to White students (Becker, 2007; DeBell & Chapman, 2006). Many of the students in this study were from low-income households; therefore, the disparities in home computer ownership may be due to economic disparities. However, the capability to use a computer while home is crucial for a student's academic achievement, regardless of race or economic status.

These findings strengthen the findings of V. Lee and Burkam (2002), who assert that the absence of a home computer accounts, statistically, for some of the African American/White achievement gap. Knowledgeable educators acknowledge that digital proficiency plays a critical role in creating productive citizens. Understanding that technology has a positive impact on student learning, highlights the importance of closing the gap in access to educational technology. Every child deserves the chance to supplement his or her learning experiences by having access to technological assets, as well as establish the proficiency with technology needed for plentiful participation in society (Judge, 2005).

Students that do not have access to technological assets in the home or at school will most likely fall further behind. Some suggest that these disparities can be explicated by socioeconomic discrepancies, however analysis of the data from December, 2000, demonstrates that the most socioeconomically impaired Asian-American and White families are much more likely to possess personal computers and have access to the Internet in their homes home than corresponding disadvantaged African-American and Latino households (Stricking, 2010). As a

matter of fact, no matter which other variables are controlled for, whether they comprise education level, socioeconomic status, or geographic region, comparable arrangements of the racial digital divide appear (Clark & Gorski, 2001). Saunders (2002) lends credence to this premise.

The result of the 2002 study suggests that African Americans as well as Latinos are more likely to purchase a home theatre than White people, but much less likely to own a personal computer and have access to the web (Saunders, 2002). This breach is the result of a systemic lack of educational and social support for people of color, (especially for African Americans, Latinos, and Native Americans), to pursue professional and academic interests in the computing industry. It is critical that these discrepancies be examined in the context of selective education, socialization, and expectations of African-American people in this country, as well as the related perpetuation of entitlement and power among White people (Clark & Gorski, 2005).

This suggests that African Americans do not deem computers or access to the Internet as a priority even when they have the means to do so. This attitude should be examined as it speaks directly to the issue of attitude and provides a strong case for the digital divide not being merely an economic issue. Teachers who integrate technology into their practice are not merely making a short-term instructional decision. They are initiating the process of student's capabilities and overall connection to the Internet and computers. Students whose only point of interaction with these technologies is established via lower-level thinking experiences are cheated out of more effective learning opportunities as well as a conception of the social, educational, and economic potentialities of these media.

Although some educational technologists insist on hailing computers and the Internet as *the great equalizer*, the truth of the matter is that they simply reestablish and reinforce the status

quo: wealthy students are prepared to thrive in the new technological world, while students mired in poverty are excluded from the digital loop (Gorski, 2005). These findings suggest that bridging the digital divide for African-American children can have an impact on children's academic performance. Several studies have been cited previously suggesting that the ramifications of the digital divide not only impact African Americans' ability to understand computing, but that this great chasm between the *haves* and the *have-nots* may also have detrimental effect on academic achievement (Gorski, 2005; Judge, 2005; Saunders, 2002).

Numerous studies were cited that get to the issue of *usage* (Becker, 2007; Wenglinsky, 1998). Several indicated that ways that computer are used is just as important, if not more important, than actually having access to computers (Haugland, 1992). Additionally, the research also reveals that there is a disparity in how higher concepts of computing are taught such as problem solving and computational thinking. Evidence was also presented that pointed out the disparity between African Americans and other groups with regard to access to computers in the home. It has been suggested that access to computers is critical to the academic achievement of African American students (West, Denton, & Germino-Hausken, 2000). As Riel et al. (2002) have pointed out, this is a multi- faceted combination of social factors that need remediation before we began to see significant improvement in the technological opportunities of African-American students and their European-American peers.

Although usage is a serious factor, unfortunately it is not the only factor. Another obstacle to educational success for African Americans in the information technology field is the image of computing.

The image of computing. Many individuals have an inaccurate picture of what it means to be a software development engineer (Angwin & Castaneda, 1998). The literature reflects that

there may be a problem with the way computer science curriculum is designed and that it should be changed. Even the computer science department at Stanford University decided to overhaul its curriculum over worries that declining overall student body was leading to the number of women, African-Americans and Latinos to dwindle (Quinn, 2010).

Stanford's idea was to make the program more appealing to students. The decline in enrollment of minorities makes those that remain in the program experience a heightened sense of isolation, (Margolis, 2008) which becomes yet another impediment to attracting more African Americans to the field.

The number of core classes for the new curriculum was condensed the core from 15 down to six. Students were also granted the opportunity to concentrate in minor areas such as studio arts or human computer interaction and have the classes count toward their computer science requirements. The result after the first year: The number of students choosing computer science as a major jumped 40% to 123 (Quinn, 2010). Further, the increase continued the following year to another 20% increase. Stanford's computer science faculty also found that there's a substantial interrelationship between the perception of the high-tech economy and the proclivity to choose computer science as a field of study. Some of the factors that are believed to have contributed were incidents such as the Dot-com bubble of the early 2000s burst and instances of *outsourcing* which created a perception among students and their parents that these skills were being commoditized.

The professors at Stanford found that the increase in enrollment was half to do with the revamped curriculum and due to both the revamped curriculum and macro-economic factors. The goal in redesigning the program was to create more options for students and to encourage their motivation to become computer scientists. (Quinn, 2010). The idea was to dispel the notion

that being a computer scientist means "sitting in a cube writing code for 60 hours a week" (p. 2). Given the encouraging results of the curriculum adjustment, designers of the program began to consider student perspectives on the overall appeal, as well as the pitfalls, of the computer science field.

Students are unlikely to pursue a career in STEM if they have negative feelings toward the field of science (Thompson & Lyons, 2008). According to Tai et al. (2006) of the National Science Foundation, perceptions framed during a student's elementary years are likely to result in their choosing careers in professions other than STEM. However not everyone agrees that computer science has an image problem. When assessing the attitudes toward computer science among college-bound high school students, *The New Image for Computing Initiative* (NIC) assessed these identical beliefs between African-American boys and Latino girls, and the findings were quite different. In a 2008 survey conducted by the WGBH Educational Foundation and the Association of Computing Machinery (ACM), messages were developed that portray computer science in a myriad of ways, and the initial responses were gauged among teens (Wilson et al., 2010). The results of the survey showed that most males with aspirations of attending view computer science in a positive light with regard to pursuing it as a field of study.

Moreover, the results also indicated that college-bound African-American and Hispanic teens are more likely than their White counterparts to be interested in computing. One of the primary conclusions of the study was that there was scant racial discernment among young people's beliefs with regard to computer science. Further, the NIC initiative suggests that computing is definitely viewed positively by Hispanic and African-American boys with aspirations to attend college. The NIC initiative affirms that these two groups remain largely underrepresented in both the academy and the technology labor pool, and asserts that if the

problem is not the perception of computing, then other factors need to be studied to determine what other factors are deterring these young people from pursuing careers in the computing fields (Wilson et al., 2010).

Since the literature does not seem to support the idea that the image of computing is a deterrent to African-American college-bound students from pursuing careers in information technology, information about other factors that are making these careers unattractive is critical in order to successfully increase interest in these fields to help eradicate the impending shortage of technical workers. While there is a consensus in the literature that young people are not pursuing careers in the STEM fields, and that African Americans are underrepresented, no one factor has been identified as the root cause. Further, it is not known whether or not the programs that have been identified to help more young people to choose careers in STEM will translate into encouraging more underrepresented groups such as African Americans and Latinos to pursue these professions.

In a 2009 New York Times blog post, "Computer Science Education: It's Not Shop Class," Steve Lohr, also reported on the need to revamp computer science curriculum to make it more appealing to young people. Lohr (2009) points out that "hybrid careers that combine computing with other fields will increasingly become the new American jobs of the future" (p. 1). Lohr stresses that our economy needs to develop more "cool nerds" (p. 1). However, the reality is that too few of the nation's youth are pursing technology careers--often because they are wary of being branded nerds. The article suggests that there are two things that need to change in order to attract more young people to field: (a) the image of computing, and (b) computer science education in high schools.

Professional organizations such as the Association for Computing Machinery and the National Science Foundation along with teacher groups and major technology companies including Intel, Microsoft, and Google, are championing these changes. The article highlighted the fact that one of the current concerns regarding high school computer science classes is that the introductory classes are too often very basic, merely teaching students to use introductory programs such as spreadsheets and word processors, while the advanced courses focus narrowly on more specific software development programs. The National Science Foundation (NSF) is focused on solving this issue by improving computer science curriculums (Lohr, 2009). By the year 2015, the NSF hopes to have trained 10,000 teachers on the new curriculum (Lohr, 2009).

Alfred Spector, vice president for research and special initiatives at Google makes this assessment:

> We need to gain an understanding in the population that education in computer science is both extraordinarily important and extraordinarily interesting. The fear is that if you pursue computer science, you will be stuck in a basement, writing code. That is absolutely not the reality. Curriculum changes must be made with care. Professional organizations and corporations need to be sure to take into consideration what is appealing not only to young people, but also and especially to what is attractive to those groups that are underrepresented. (Lohr, 2009, p. 1)

Exposure to engineers can impact students' perceptions of the field. According to a recent study (Thompson & Lyons, 2008), when students are introduced to engineers in their classrooms, "they obtain a greater awareness and understanding of various engineering fields" (p. 197). The report further asserts that students are more likely to perceive engineering as an attractive career

choice, as it often involves abstract thinking. Exposing African Americans to practicing software development engineers may positively change their perceptions of the field.

The graduation problem. Even when young people decide to major in the computing fields, many of them do not persist to graduation. The American College Testing's (ACT) Educational Planning and Assessment System (EPASTM) is the only longitudinal study that measures students' college preparation in middle school and tracks their progress through high school and college so as to evaluate their persistence and success. The data compiled through this program provides ACT with keen insight into what is working in terms of preparing students to succeed in college STEM coursework. The ACT investigation exposes that the students most likely to study STEM in college and who persevere to realize their degrees are generally those who foster interests in STEM occupations through early career strategies and by enrolling in demanding courses that prepare them for college-level science and math coursework (ACT, 2006).

This study demonstrates that what courses students take in high school is strongly related to how prepared they are for college. The data from this study also suggests that students must take courses that are demanding enough to prepare them for the challenges of higher education and the demands of a professional career (ACT, 2006). As discussed earlier, there is a disparity in how computers are used in schools in low-income communities as opposed to high-income neighborhoods that invariably contain fewer Black and Hispanic families (Judge, 2005). Moreover, this study has suggested that using technology is positively correlated with the academic achievement of African-American students; it follows that it is imperative that these students are presented with ample exposure to STEM subjects early in their academic careers. Students that have chosen to pursue STEM degrees for some reason are not persisting to

graduation. There is some indication that this may be related to the fact that there are not enough minority faculty members in STEM programs. Although the ACT study is not limited to problems of African-American students who do not persist in the STEM fields, the study's findings are aligned to the findings of Price (2011) whose findings advocate that policies to bolster the number of minority faculty members may be an efficacious method of increasing the number of minority students that graduate with a degree in one of the STEM fields.

The ACT findings also align with the recent study from the Bayer Corporation (Bayer, 2010) that illustrates the problem of college instructors discouraging women and minority students from pursuing careers in science. As such, consideration should be given to attracting more minority instructors in the STEM fields as well as encouraging faculty of other ethnic groups to be use discretion in their feedback to their minority students. These students need to be made to feel that these institutions are invested in their success, and that they have the support of their instructors in the successful completion of their degrees. The relationship between the student and the instructor is very important. The majority of Black college students are not graduating and the reasons for not completing their coursework have nothing to do with their academic prowess (Steele, 1992). Some believe the reason for this is that they, as students, are marginalized. There is a consistent reality, regardless of what level the schooling—whether it be grammar school or graduate school—African Americans and Whites are in largely separate worlds that are far from equal, either in the education taking place or the scholastic achievement (Steele, 1992).

Steele (1992) asserts that if African Americans face fewer racial challenges in school, they can overcome substantial obstacles. Regardless of their economic disadvantages as a group, African Americans test scores, when they start school, compare favorably with their White

counterparts. However, it appears that the longer they are in school the less they learn. This suggests that the academic problems of African-American students have less to do with their socioeconomic status, and more to do with the school environment, including but not limited to, the relationships that they have with their teachers. Taking into account that African Americans are being discouraged from pursuing careers in STEM by their instructors (Bayer, 2010) it is extremely important that every option is explored when it comes to removing the racial vulnerabilities these students face.

These students need to be shown that they are valued and that their teachers, schools, and members of their communities views them as valuable, significant contributors to the worlds of STEM and the greater scientific field. Evidence indicates that something oppresses African-American achievement at almost every level of schooling (Steele, 1992). Obviously, those students that are well equipped accomplish more than those that are not as prepared, and this is case whether the student is White or African American, but given any level of academic preparation, African Americans achieve less in successive schooling than do Whites (Steele, 1992).

This pattern has been reported so widely across the nation, and by so many researchers, that it is deemed *law* in this society (Steele, 1992). This conflicted reality has not been resolved in the twenty years that have passed since Steele's report. There is still an achievement gap between White and African American students. However, there have been advancements in pedagogical techniques that have been effective with African American students, such as *culturally responsive teaching*. Teachers implementing culturally responsive teaching must integrate responsive characteristics of students' daily experiences into their studies. Examples of

these characteristics include, prior knowledge, language such as jargon or slang, and extracurricular activities such as sports and music (Delpit, 2006).

These techniques should become standard procedure for schools that educate predominately African-American students. Students need to believe that they can achieve academically. This requires a belief that achievement can be an ensuring basis of self-esteem, and that belief needs consistent affirmation. The crisis in African Americans' education originates from a sense of disempowerment, which tends to undercut an identification with schooling. The pervasiveness of this malady among Black undergraduate students is well known, particularly at predominantly White universities. Under these circumstances, Black students are forced to learn and concentrate on their work in an environment that is uncomfortable and even hostile in some cases and it makes it very difficult to focus and this has a negative impact on their academic performance.

These students become disinterested and lose their enthusiasm for learning. They also display a lack of motivation in their academic pursuits and begin to doubt their abilities to achieve academically. His work followed a main principle that espouses that in order for teaching to be efficacious there must be a strong connection between teacher and student (Comer & Poussaint, 1992). According to Comer and Poussaint (1992), building these relationships requires focusing on the overall climate of the school, molding the climate not to improve teaching, but to create an environment that impresses upon the children the value of learning whereby a child can identify with the importance of academic achievement. The implication is that students need to be made to feel confident and sure of themselves if they are expected to thrive in an intellectual setting. African-American student achievement is linked to school conditions that reduce racial vulnerability (Comer, as cited in Steele, 1992). The work of Steele

(1992) and others demonstrates that African-American students face challenges in school whether they are majoring in STEM discipline or not, but more importantly, if some of the challenges that are not related to aptitude are solved, it be instrumental in building the confidence levels of these students, enabling them to perform more effectively in school, and boosting their abilities to successfully navigate the more difficult STEM subjects.

The literature has revealed repeatedly that when students underperform academically, it is more often than not because of a lack of educational opportunities. According to Milne (2011), it is evident that there are stark differences in students' exposure and experiences. These differences include economic resources, teacher qualifications, rigors of the curricula, teachers' expectations, and the students' parent's involvement in their learning. It is difficult to compare these students with those who have had the opportunities that they have not, although they may be similar in areas of effort, interest, and motivation. In highly diverse and urban schools, what is at the core of student success is the ability of teachers to help transform negative perspectives and transform relations with students to maximize learning opportunities. Teachers who have the ability to adapt to conditions and encourage student success provide a valuable service to underprivileged individuals.

Although, several studies validate high school seniors' interest in pursuing STEM, the literature highlights additional reasons why these students will more than likely not graduate from these programs, one of which is inadequate scientific literacy. The research suggests that graduating high school students they are not adequately prepared for the science classes they are required to take in their freshman year. University tenure systems pose other problems as they usually incentivize professors to publish research as opposed to becoming better teachers.

Moreover, STEM programs are designed to weed out students who are not dedicated to obtaining their degrees (Higher Education Research Institute, 2010).

High school teachers and university professors must work diligently to encourage students to achieve their objectives, regardless of their SES, and be mindful of the disadvantages that are often experienced by students because of their ethnic make-up and backgrounds. It is not only important that instructor send our young people (especially those who have been racially vulnerable) the right messages in terms of valuing them as students, but as it relates to STEM fields, it is equally important that students feel an inclusive element on a positive basis, regardless of religious beliefs, ethnicity, or socioeconomic status. There is evidence that the exact opposite is taking place. According to Freeman Hrabowski (as cited in Boundaoui, 2011), President of The University of Maryland Baltimore County (UMBC), "American attitudes toward science are hurting STEM graduation rates, we in America have accepted that science is just not for everybody" (p. 1). Hrabowski suggests that American society (teachers, parents, professors) sends these messages constantly-the message that implies-that science is not for everybody. These messages have been prevalent for decades with regard to women and the sciences, but now there is evidence that teachers and professors send these messages more broadly (Bayer, 2010; Pollack, 2013). According to Hrabowski, one of the main reasons that American students are not more enthusiastic about studying science is because most adults do not show any excitement about science (Boundaoui, 2011). Further, Hrabowski posits that the assumption that most Americans share that they are not intelligent enough to master math or science is simply not true. In his estimation, the fault lies with the instruction (Boundaoui, 2011).

He asserts that perhaps science teachers are not creative enough. Schools have been known to enroll more science majors than they intend to graduate. Schools do not encourage

students to collaborate, instead they cultivate an environment of ruthless competition (Boundaoui, 2011). He suggests that a better approach would be to have the attitude that "If we accept you in science, you have the ability to do it, and we'll help you succeed" (p. 1). A significantly larger group of students are succeeding at UMBC, and in Hrabowski's estimation, this is due to how UMBC faculty encourages group work as well as spur their teachers to reevaluate their classroom approach. Instead of eliminating all but the best students from advanced math courses, schools must begin to commit to all students gaining math literacy in the same way that they have committed to reading and writing literacy for everyone (Moses & Cobb, 2002). The attitudes of parents, teachers, and our society in general may need to change regarding science and math so as to instill the kind of confidence in our youth to inspire them to work hard in these fields and complete their degrees. Price (2011) suggests that another factor that could improve the persistence of African Americans pursuing degrees in STEM would be to have more minority instructors teaching math and science courses. The study found that African-American students are less likely to abandon a computing degree if an African-American professor teaches at least one of their classes.

These results suggest that policies to increase minority representation among faculty members might also be an effective means of increasing the number of minorities who persist and ultimately graduate within STEM fields. Carter (2006) explored factors that serve as obstacles to students who share a supposed proclivity for computer science but who do not favor computer science as a major. The main reasons for repudiating the major were the same for both genders, however the mentality for selecting the major differed. The disdain for the tedious nature of computing was the chief rationale for why both female and male would not choose computer science as a major, and the choice of another major area of study. Most men chose to

major in computer science because of their passion for video games, while women were excited about the opportunity to apply computing skills in another discipline. Evidently, salary was not a deciding factor among students of the study. Computer science is not offered in most high schools. Although computer science has become a critical component of the economic engine of the United States, most American high schools still do not teach a course in computer science.

As of 2011, only 5% of high schools taught the AP computer science course and only 21,139 students took the exam (Purdue, 2017). There is evidence that when freshmen are made aware of computer science, they gravitate toward it, so much so that some consider switching majors. Students in the Carter (2006) study who were introduced to computer science became interested and reported that before the intervention, they were not aware of what it meant to be a computer scientist. This appears to coincide with the findings of the ACT (2006) study, which reported that those who were introduced to computer science early were more prepared and successful in college. The results illustrated that high school students are acutely missing experience with computing; this is especially true of formal classroom experience. The reason that ranked first for why students consider a career in computing is that computer science allows them the capability to be combined with other fields in which they may have interest. Second was the students' love of video games, and the third most compelling reason was students' previous experience (Carter, 2006).

"Seventy-five percent of the students who had participated in more than three computer-related experiences saw this experience as a positive" (Carter, 2006, p. 10). For both genders, the strongest influence opposing computer science was the repulsion to the sedentary nature of a job in computing (Carter, 2006). Carter's (2006) survey showed that student ignorance of the computer science major was a major factor in the absence of higher numbers of them pursuing

computing careers. Half of the students were opposed to computer science because of the image that many of them had of these particular individuals who worked in the field: that of being very sedentary and sitting in front of a computer and programming for days on end.

There is evidence that suggests that students do not know what they would learn as computer science majors because they are not taught about careers in computing while in high school (Carter, 2006). Most students' only exposure to computer science is using software packages. In order for students to become proficient in computer science, teachers must be properly trained.

A study by Carter (2006) did not produce any evidence that money is the reason that students are declining careers in computer science. These results are in contrast to the *New Image for Computing* study (Wilson et al., 2010). The goal of the *New Image for Computing* study is to make computer science more attractive to women and underrepresented minorities in high school and in college.

It may be that different populations of people have a different view of what computing entails. During high school and the undergraduate level instructors may need to do a better job of introducing all groups to a consistent image of computing as an exciting career choice and help change negative perceptions that many young people have of the field. Another challenge facing African Americans completing degrees in STEM is that universities often employ *weed-out* (i.e., courses that are meant to be difficult to reduce the number of students in the program) courses in efforts to discourage students from pursuing careers in STEM. In a 2011 survey of over 400 chairs of STEM departments from the nation's top 200 research universities producing mostly African-American, Hispanic and American Indian STEM graduates by the Bayer Foundation, it

was revealed that 46% of the chairs agree that weed-out courses dissuade capable students from pursuing STEM majors (Bayer, 2010).

However, a majority of the chairs see no reason to significantly alter their introductory courses to keep more STEM students, including minorities and women. Students can become bored in these lecture-based courses in which instructors often lecture for too long and squander the momentum and excitement for STEM that they had when they arrived. Most initial STEM courses seem to wish to deter those students who are not committed to a degree in STEM by declaring to them that most of them will receive high C or low B grades (Bayer, 2010). This fosters an unpleasant competition and introduces a sense of insecurity that impedes active, curiosity-based learning by students.

Any qualified student who is interested in pursuing a career in STEM should be supported and encouraged to do so, and schools should ensure that services and policies that support these students to be successful are being implemented. Moreover, more engaging ways to teach STEM courses in higher education should be explored, so that students who enter from high school excited about STEM do not become bored and pursue other areas because they become bored and uninterested. African Americans are also behind when it comes to degree completion rate at the undergraduate level as compared to their Caucasian counterparts, but there has been an uptick recently in the number of African Americans enrolling in graduate STEM programs.

The Council of Graduate Schools (CGS) issued a report in 2011 that revealed that "between the fall semesters of 2009 and 2010, there was a 33.6% increase in the number of African-American students entering math and computer science graduate programs" (Council of Graduate Schools, 2011, p. 1). It is believed that most of these students are enrolled in computer

science master programs. The 2011 *Taulbee Survey*, which tracks computer science enrollments and degrees and covers the same period as the CGS, study seems to confirm this, as it breaks down new enrollments by race only for doctoral programs, and found no increase in Ph.D.-seeking Blacks and African Americans (Council of Graduate Schools, 2011). This would indicate that African Americans are just as interested in pursuing STEM programs out of high school as well as graduate programs. This does not mean that they will complete the degrees, however. If they do not, that is an indication that the problems of discouragement from instructors or society in general may be present in graduate level courses as well. While the U.S. leads the world in research and development, American students lag other nations in scientific proficiency. One of the primary rationales proffered for America's low science test scores is the large chasm between low-income and high-income students, which usually manifest is in ethnic differences in test scores. American student rankings appear very different when African-American and White and students' scores are evaluated independently (Roth, 2011).

In one of the leading global exams, the European-based Program for International Student Assessment (PISA), American students scored in aggregate 502 in 2009, which is barely above the national average for industrialized nations of 500. PISA is a global assessment of the literacy of 15-year-olds every three years (The Program for International Assessment, n.d.). The aggregate score for African-Americans of 435 ranks them between Bulgaria and Romania while White students ranked sixth with a score of group score of 532. The problem has been identified as chiefly one of attitude among Americans. Outside of America, parents believe that success in science is determined by the effort put forth (Roth, 2011). However, most Americans subscribe to the idea that good science students are born and their success is not a result of working hard.

As such, at the first sign of trouble in these courses, students tend to resign themselves to the fact that they simply are not good at science or math. The idea that one is born with *the gift* or not is especially detrimental in science, because the essence of being a scientist is that one is always failing (Roth, 2011). Lack of graduation is a huge component as it relates to African Americans pursuing careers in information technology. The literature has revealed several aspects that, if corrected, could provide a huge benefit and contribute in remedying the graduation problem. Ensuring graduation rates among African Americans means that students are encouraged at an early age to become involved in computer science, and provided with opportunities to participate in rigorous coursework that challenges and prepares them to help to prepare them for the classes they will encounter as freshmen in college.

Additionally, schools must provide welcoming learning environments that cut across ethnic and racial lines to include all students in an atmosphere of positive expectations. The attitude of American society towards math needs to change from one in which we feel all students are capable of succeed in math as opposed to the select gifted few. Lastly, if the hope is that more young people who demonstrate an aptitude for computer science are to pursue careers in information technology, the image of the typical computer scientist should be altered on a more positive note. Students with aptitude for the career have opted out because they do not wish to spend their work lives perched in front of a computer screen.

The choices that students make regarding their careers are generally influenced by the experiences and beliefs that they hold about different. The Eccles Expectancy-Value model has two major components professions. There is a psychological component that consists of goals, self-beliefs, values, affective memories, and experience. Then there is also a socialization aspect comprised of the social and contextual influences on the development of goals, values, self-

beliefs and experiences. This model advances the notion that achievement-related choices and performance, such as those connected to enrollment in mathematics, physics, and other sciences, are influenced most directly by a set of values, goals, beliefs, and emotional experiences regarding these subject areas (Messersmith, Garrett, Davis-Kean, Malanchuk, & Eccles, 2008).

In turn, individual differences, gender differences, and ethnic group differences on these psychological indicators and choices are influenced by input from one's environment and from one's own experiences with these activities (Messersmith et al., 2008). When choosing courses and potential careers related to the STEM fields, it is important for students to have a positive self-concept regarding science, math, and particularly the use of computers. Moreover, Messersmith et al. (2008) suggest that parental expectations and support for math ability are a crucial barometer of self-concept, accomplishment and interest, for both genders. Parental behaviors such as a providing a computer, and math exercises at home and providing support for those outside the home are critical in establishing interest in these areas, which promote future choices for students in classes and college majors.

For African Americans, an early attitude of confidence in math may direct males to follow a STEM-related path (Messersmith et al., 2007). During this study, data was gathered on the adolescents' perceptions of career areas involving information technology, as well as information regarding choices that may have been made that steered them away from careers in computer science. Students who, early on, saw themselves as proficient at math, math, and had later taken additional informational technology courses, found proficiency at more difficult computer-related jobs, and therefore felt confident to pursue information-technology careers; most of these individuals were both White and African American. For African-American males,

early perception of having aptitude in math served as a catalyst in the decision to pursue information-technology careers (Fredricks, Alfeld, & Eccles, 2010).

The study also included a qualitative study of adults. It analyzed the question of why minorities and women persist, or leave IT-related occupations. The study found that participants' educational experiences in technology, when negative, were related to selection of non-information technology careers. Further, many participants discussed discrimination and sexism in male-monopolized careers. It was also found that those with high information-technology attainment value and information-technology utility value were the most likely to seek careers information technology-related jobs.

Technology Diversity and Inclusion

Forbes (2011) surveyed 321 companies with at least $500 million in annual revenue and according to the study, 85% believed that diversity drives innovation (Forbes, 2011). Technology companies are under increasing scrutiny to create a more diverse workforce, which is predominately White, Asian, and male (Marcus, 2015). Hispanics make up 4% of the workforce at Yahoo in 2014, while African Americans comprised only 2% of the labor pool. Facebook also reported in 2014 that only 81 of its nearly 6,000 U.S. workforce were African American. This section of the review focuses on two areas that have emerged with regard to workplace culture and hiring practices (Mangalindan, 2014).

Culture at technology companies. Much of the literature indicates that the cultural environment at technology companies is generally not welcoming to women and underrepresented groups. Some believe that although the pipeline issue is a major component to impeding diversity, it is not the primary concern. The primary concern is the corporate structure and culture of tech organizations. In a 2015 *Forbes* article "There Is No Diversity Crisis in

Silicon Valley," Marcus (2015) asserts that while companies can strive to ameliorate faulty hiring practices and train diversity, this will only do so much, because at the heart of the problem is concealed and a sometimes overt discrimination that prevails in the technology industry.

For African Americans working in Silicon Valley, isolation is not an uncommon issue (Margolis, 2008). African-American employees at Google have built a community within the organization called Black Googlers Network (BGN). The group was formed in 2006 and has over 600 members in 10 chapters. The mission of the Black Googlers Network is three-pronged: to cultivate Black leaders, empower communities, and transform technology beyond its four walls. From a practical perspective, BGN is a forum for employees at Google to connect with one another and foster a sense of community (Roberts, 2015). The literature appears to support the notion that in order to retain more women and ethnic minorities, it would make sense to create an atmosphere that is more welcoming to them.

Women in technology. Technology companies have actively shielded the degree of their diversity problems for years. They even went so far as to block freedom of information act requests by suggesting that the ethnic and gender makeup of their workforce was proprietary information (Kessler, 2017). Meanwhile, these organizations scurried to develop solutions to the diversity issue. For example, Google took steps to improve the advancement of its female employees, lengthened maternity leave, and changed their hiring practices to ensure that women were a part of the interview process.

Microsoft instituted a mentoring program to offer more advice to their women employees from senior leaders. Although there were many activities designed to encourage more women to pursue careers in technology, the problem has persisted (Kessler, 2017). Women and minorities

often pursue opportunities in other fields because of the rampant sexism and racism in technology industry.

Organizations can hire more women and minorities; however, without mitigating this crucial issue, they will continue to produce the same results (Marcus, 2015). As mentioned, women are leaving the tech field in alarming numbers. Former senior leader at Microsoft and Amazon, Kieran Snyder (2014) interviewed 716 women across 654 companies in 43 states. All of these women held technical positions. These women held jobs in the technology industry for an average of seven years and then decided to leave the industry.

Twenty-seven percent of the women cited uneasiness working in these companies, describing observable as well as implied favoritism as one of the principle reasons for their departure from the industry. Additionally, the report indicated that women also leave jobs in technology because of a workplace environment that does not lend itself to the needs of its female employees (K. Snyder, 2014). Over 50% of the participants reported that they had encountered resistance on occasions when they expressed decisiveness or anger. Sixty-four percent who are mothers experienced discrimination and gender stereotyping (Williams, Phillips & Hall, 2014). Many women in these companies feel degraded and dispirited, and assert that Silicon Valley is mired in the past. They further claim that they are confronted daily by harassment and sexism, and that they are rarely, promoted or taken seriously (Streitfeld, 2015).

More damning evidence illustrating the uneven culture at technology companies comes in the form of legal allegations. A former employee of Microsoft is charging the company with discrimination against women in technical roles, and the complaint states that women in technical roles are paid less and promoted less frequently than their male counterparts (Rao, 2015). The suit also alleges that “Microsoft policies and practices systematically violate female

technical employees' rights" (p. 1). The suit further asserts that that these policies "result in the unchecked gender bias that pervades its corporate culture" (p. 1). There were comparable disputes earlier this year against Facebook and Twitter (Guynn, 2015a). A female developer, for instance, was terminated in 2013 subsequent to publishing a remark on Twitter about a sexual comment that she overheard by a group of men while attending a development conference (CBS San Francisco, 2013). Ellen Pao decided to confront the rooted male-dominated culture of the technology industry. Her case, a gender bias case, further exposed an environment that generally condoned an atmosphere of masculine dominance, while women often seemed to be consigned to positions of lesser importance (M. Isaac & Streitfeld, 2015).

Women entering male-dominated fields often feel this way, and despite their efforts to assimilate into the corporate culture, resistance from their male counterparts can sometimes prove to be overwhelming, and they move on to other professions. On a more positive note, much progress has been made to improve conditions for women and minority groups in the workplace, and many obstacles to their success have been removed. For example, there is Sheryl Sandberg who serves as chief operating officer at Facebook. Also, Ursula Burns, an African American women, is chief executive officer at Xerox Corporation. Women outnumber men in enrollment at elite universities; however, in the most innovative area of the economy--software engineering--women remain behind. There are a number of women who desire to be engineers, but are confronted by an atmosphere that makes them feel deterred and unrepresented (Hewlett et al., 2013). Executives at technology firms often point to parents, schools, or society for the dearth of females who pursue careers in computer science.

However, there appears to be other causative factors at play. Among the women who enter the computing arena, 56% leave by midpoint of their careers. Not only is this an alarming

rate of attrition, but it is also twice the attrition rate for men, according to research conducted by the Harvard Business School. According to a Harvard study, this is also part of the reason that nearly 30% of the women who depart from technology occupations in favor of roles that are nontechnical (Hewlett et al., 2013). Another study of women of color in science indicated that 100%, of the 60 female scientists interviewed reported experiencing discrimination. Nearly 50% of African-American and Latina scientists reported they had been mistaken for janitors and receptionists, and most African-American, Latina and Asian-American stated they felt pressure to prove themselves to their male counterparts (K. Snyder, 2014).

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Hiring practices. "Black and Latino men are faced with a hiring disparities significantly wider than even the gender gap — one that places additional pressure on those who do get hired to perform well" (Diallo, 2015, p. 1). Reports abound demonstrating the exclusionary effect on employment practices. One of the most telling examples of this is a 2004 study published in the *American Economic Review* titled "Are Emily and Greg More Employable Than Lakisha and Jamal? A Field Experiment on Labor Market Discrimination," finding that job applicants with names that sounded like as if they belonged to an African American received callback interviews 50% less of the time as when compared to those applicants with *White-sounding* names (Lavergne & Mullainathan, 2004). The effect of this bias is that those who might serve to

diversify the work environment because of their rich cultural differences are denied the opportunity to work at these companies.

The end result is that the workplace ultimately resembles the aforementioned Google model, which generally hires White, Asian males on a consistent basis. According to a 2013 study published by Yale, many science professors at American universities believe that female undergraduate students are less capable than their male counterparts with comparable skills and accomplishments (Moss-Racusin et al., 2016). The report asserts, that as a result, their instructors have been less likely to offer the women employment or guidance. On occasions when these females were offered a jobs, compensation was less. According to the science professors, this bias was prevalent. However, the scientists believed their attitudes were presumably due to subconscious cultural influences as opposed to overt prejudice.

Conversely women professors were just as biased as their male colleagues (Moss-Racusin et al., 2016). As such, this example shows that a significant component of improving hiring practices at technology companies could be recognizing and exposing unconscious bias during the recruitment and hiring process. An increasing number of technology companies are employing *diversity training* program in hopes of creating a company culture more welcoming to different communities. Facebook has created a program designed to aid employees in diagnosing bias in the workplace and exposing it (Guynn, 2015a). Unconscious bias supports the notion that females and underrepresented minorities are not as talented as their Caucasian counterparts at STEM.

As a result of this phenomenon, teachers and parents are likely to dissuade minorities and females from pursuing computer-related activities. Latinos and African Americans are generally perceived as less academically competent than Caucasian students. Women of color face the dual

bias of race and gender. This data does not bode well for the fields of computer science and engineering. It has been determined that perceived inequity as a result of bias and stereotyping significantly contributes to the departure of minority workers. Employees of color are three times more likely to mention *maltreatment* as the reason they changed organizations ("Implicit Bias Awareness," n.d.). When unconscious bias creeps into the workplace, it can lead organizations to employ and promote more White men, pay them higher salaries than women and ethnic minorities, and cultivate a workplace environment that excludes anyone perceived as different from the status-quo.

The Implicit Awareness Association Test (Bunaji & Greenwald, 1995) has aided in the awareness of unconscious bias. The test, which measures racial prejudices, has been taken by millions of people online. Recently, corporate America has adopted bias training as part of their overall learning and development strategies. The first major technology company to disclose unconscious bias for contributing to the systemic absence of diversity in the technology sector was Google. In 2013, the search behemoth began training its employees in unconscious bias. Today the company delivers workshops and interactive sessions that coach employees on recognizing and eliminating hidden prejudices (Guynn, 2015a).

Diversity and Inclusion Initiatives

Diversity in the workplace must be directed from the top levels of management, and be reflected in the hiring practices of an organization (Williams, 2014). Efforts are underway on several fronts to improve diversity at technology companies. The problem is being challenged on from an education as well as workplace perspective and several strategies are being employed. This section of the literature review focuses on those efforts being deployed by technology companies, the government, educational institutions and non-profits.

Corporate initiatives. Several major technology companies have committed to improving diversity in their organizations. Intel pledged $300 million to diversify its workforce earlier this year. The chipmaker also promised that by the year 2020, its workforce would be more reflective of the U.S. labor pool. And perhaps even more importantly, the company has created a $300 million venture fund earmarked for minority technology start-ups. Similar announcements from Google and Apple followed; Google is pledging $150 million, and Apple is pledging $200 million (Fussell, 2015). Microsoft is also helping to establish initiatives by supporting computer science education for youth and over the next 3 years, the company has pledged $75 million (Gorman, 2015). Non-profit organizations are targeted to benefit from these donations and resources as well.

A portion of the allotted funds will also be used to expand the Microsoft Technology Education and Literacy in Schools (TEALS) program. TEALS was developed by Microsoft to teach high school computer science and to encourage students with technological abilities that are important in the workplace. The program TEALS also works to improve computer science teacher education (Gorman, 2015). The goal is to be in 4,000 schools in the next 10 years (Guynn, 2015b). Facebook has implemented a rule that requires recruiters to interview minority candidates. Additionally, the company expanded its summer internship program for ethnic-minority computer science majors and started a new internship program for minority business majors (Frier, 2015). Since 2013, Google has been placing engineers at those schools known for graduating the most African-American engineers in an effort to guide the graduates into computing careers at Google (Roberts, 2015). In keeping with these objectives, Google offered paid internships to 30 engineering students from HBCU's this past summer (Kang & Frankel, 2015).

Nonprofit initiatives. The Computing Research Association (CRA) work created a number of programs aimed at showing the benefits of working in the computer science profession. That work includes a number of programs aimed at exposing underrepresented students to professionals in different computer science fields and giving them the tools and resources needed to be successful (Stott, 2015). Code.org. (n.d.), a non-profit that encourages American students to learn computer science, recently announced that it has trained over 15,000 new instructors to begin teaching computer science to approximately 600,000 K-12 students in schools across America.

Another nonprofit group, Black Girls Code (BCG), is also taking action to help solve technology's diversity issue. The organization schedules regular weekend coding workshops for females of color that help them learn the fundamentals of software design and development. BGC is not only about gaining skills in a very lucrative industry, but the organization also leads its participants on field trips to leading technology companies (Westervelt, 2015). Hack the Hood is a non-profit teaches impoverished youth about technology careers by giving them jobs and teaching them how to develop web applications for small companies in their neighborhoods. Google recently awarded the non-profit a half-million dollars for being a winner in its Bay Area nonprofit competition (Shahani, 2014).

All Star Code (ASC) prepares underrepresented minorities for careers in STEM. ASC is dedicated to producing more African-American and Hispanic software development engineers, and one of the goals of the organization is to teach software development to 100,000 students over the decade. The charity offers mentorship, industry exposure, and computer science education. ASC believes that one of the biggest issues facing diversity challenges in the workplace is the lack of awareness regarding opportunities among underrepresented minorities.

This is the first real exposure to technology for many of the program's participants, most of which come from impoverished backgrounds. Graduates of the program have become software developers, and 96% are either pursuing a career in software, or have intimated interest in pursuing computer science as a major (Jackson, 2015).

Political initiatives. The Obama Administration has also joined the call for more diversity in technology. The inaugural White House *Demo Day* was held on August 4, 2015, and the event showcased minority startups. The focus of the event is to highlight the underrepresentation of African-Americans and women venture-capital backed startup. With all of these new developments it seems that technology leaders are finally getting serious about the diversity imbalance in the tech industry (Lapowsky, 2015). In response to recent reports that revealed that many of the world's most prominent technology organizations retain only a 2% Black workforce in their ranks, the Congressional Black Caucus (CBC) which is made up of the most powerful African-American politicians in the U.S. is also getting involved (Bhattacharya, 2015).

GK Butterfield, chairman of the CBC, will soon meet with leaders at Google and Apple in Silicon Valley to inform them to "implement a diversity plan that will place more African Americans in the technology pipeline" (Bhattacharya, 2015, p. 1). The taskforce will meet with executives at Apple, Google, Bloomberg, Intel, Kapor, Pandora and SAP – but not, as it should be mentioned, with Facebook, Twitter or Yahoo, companies with the lowest proportion of Black employees. Butterfield said: "Our goal for this trip is to encourage and partner with these organizations to implement a diversity plan that will place more African Americans in the tech pipeline" (p. 1).

This will potentially lead to a wide range of opportunities, from student internships to positions on the boards of tech companies. “Building a coalition of leaders from the public and private sectors ensures greater diversity and full representation of African Americans at every level of tech by 2020” (Neate, 2015, p. 1). Technology companies have begun to make diversity and inclusion an important part of corporate priority. These organizations are making diversity an executive-level position. In recent months, there have been job postings at companies such as Airbnb and Dropbox. As a result of not *moving the needle* in terms of hiring diverse candidates some of these companies have created a c-suite position being listed as head of diversity.

Dropbox is currently interviewing for this new position and Autodesk is also on the hunt for a director of diversity and inclusion. Airbnb’s new c-suite position has the title of head of diversity and belonging. As such, diversity becomes a major part of long-term corporate strategy, and organizations are allocating resources to devise a comprehensive plan to solve this issue with the same vigor that other corporate challenges are met (Carson, 2015). Legislation is also being introduced to help create more diversity and inclusion at technology companies, and in recent years several pieces of legislation were introduced revolving around the challenges of STEM education.

As these bills target education from K-12 through college, and the aim of the legislation is to increase access for students to STEM subjects and help to prepare them for the innovation economy. As an example of these efforts, HR2159 is listed as the *21st Century STEM Competitive Jobs Act.* The goal of this bill is to inspire employers and schools to collude to engineer Subject and measurements, implement dual college and high school credit, and introduce an internship or apprenticeship as a component of the program to advance STEM curriculum. HR2159 would reward those districts that work with employers with competitive

grants (University of Washington, 2013). There are several other bills with similar aims that are in various stages of committee, and the government is interested in stimulating organizations to take the steps necessary to create a workforce that is prepared for the challenges of the 21st century.

The White House's Race to the Top initiative proposes bold enticements to states inclined to catalyze systemic cures to improve learning in our schools ("Race to the Top", n.d.). Thus far, the program has allocated over $4 billion to 19 states that have developed vigorous strategies designed to remediate the four components (listed subsequently) of K-12 education reform. These funds have affected more than 22 million students and employ nearly 2 million teachers, and as a result over 40,000 schools, representing 45% of all kindergarten through secondary school students and 42% of all low income learners all over the country were impacted ("Race to the Top," n.d.). The primary areas of emphasis include:

> development of rigorous standards and better assessments, adoption of better data systems to provide schools, teachers, and parents with information about student progress, support for teachers and school leaders in becoming more effective, increased emphasis and resources for the rigorous interventions needed to turn around the lowest-performing schools. ("Race to the Top," n.d., p. 1)

Higher education initiatives. STEM initiatives are taking place in college campuses all across America. Universities are creating a much more inclusive atmosphere and instituting strategies to ensure that minority students have the social and academic support needed to persist through to graduation. A U.S. Department of Education grant has been awarded to Rio Hondo College in Whittier, California. The award enables the school to continue to make its This Reauthorization of (TRiO)/Student Support Services program available to who need help

overcoming obstacles to complete their college education, including first-generation college students, students from impoverished background, and disabled students. Every year, the college will receive $247,584, culminating in $1.1 million. Since 2008, Rio Hondo has been dedicated to providing support to students pursuing careers in STEM. The goal is to create the framework of the TRiO program to increase the number of underrepresented minority STEM majors transferring to universities. The program offers a plethora of services designed to foster a positive learning environment (Molina, 2015).

Administrators at Bennett College, a private women's college, are hopeful that a $400,000 federal grant will improve the academic achievement of the school's science and math students. The college has been awarded the National Science Foundation grant, and it will use the funds to develop a tutoring and mentoring program established to improve student retention and graduation rates (Newsom, 2015). Hampton University faculty members have set out to make STEM fields fun for potential STEM majors, and they are using recently obtained grants to help them develop extra programs to reach their goals (Williams, 2015).

They also wish to familiarize students with the vast array of career opportunities that can be available to them as STEM graduates. The school's computer science department has been targeting under-represented minority success, by not only revamping the computer science curriculum, but also broadening student perspectives concerning careers in computer science. The school recently received a grant from NASA, and purpose of the award is for the HU to build the Center for Atmospheric Research Education; a project that will foster even more opportunities for under-represented minority student (Williams, 2015). The AT&T Foundation has donated $15,000 to Central Michigan University (CMU) to encourage females and minorities to get into STEM careers (Holland, 2015).

CMU's largest numbers of majors are those in the STEM fields. The funds will be used to create a robotics program for freshmen, and female role models in engineering will serve as instructors for these courses. The hope is that this will create a much more diversified student population in STEM courses (Holland, 2015). Georgia Tech has received a $5 million donation from Intel. The donation is part of an initiative to boost the number of minority students who strive to become engineers and computer scientists. The *Diversity Scholars Program* created by Intel Corporation is working to recruit and retain minority students to STEM and prepare them to earn post baccalaureate degrees in STEM. Georgia Tech will expand some of its ongoing initiatives, which include a summer engineering institute for promising high school upper classmen as well as a research program for minority students (Davis, 2015).

The University of Vermont (UVM) recently began construction on a $104 million building to overhaul the university's STEM facilities as part of their plan to increase the number of STEM graduates by 50% over five years. One of the features touted is a center to help spur the growth of underrepresented demographics in the STEM areas. As a result of UVM's forward thinking in this area, the graduates that will be coming out of the university will shift in this very dramatic way so that there will be a 50% increase in STEM graduates emerging from UVM in the years ahead (Dobbs, 2015). Another Georgia Tech program that is hoping to increase the number of African American males in computing is DiSalvo's Glitch Game Testers in Georgia (DiSalvo, 2012).

This curriculum connects with African-American juvenile males via electronic game architecture and endeavors to equip them with comprehensive career counseling that may be missing from their current school experience Young African-American men and Latino men play video games more than any other group, yet they are not well represented in computing or other

technology-related fields. Many believed that if they became involved in gaming like as young Caucasian and Asian men do, they would pursue technology careers. DiSalvo (2012) asserts that this is not the case, and decided to form a group that tests games with young African-American men in Atlanta. DiSalvo has made some shocking discoveries; She boldly asserts that African-American males are "actively choosing to not learn in schools because it's not cool" (p. 1).

Her testing program was a way to get them engaged, and the results of her study is that of the 16 men who graduated from high school, 15 have enrolled in college, and of those, 13 decided to major in majors related to computing. The implication is that gaming can be a pathway to a career in computing. The idea is to use what is already part of the culture to introduce new learning. Since game consoles are often are the most powerful computational devices, and in most cases the only Internet devices available to these young men, these consoles become the means for teaching computer science via gaming. The Glitch Game Testers program, unlike other after-school programs with technology labs, treats students as paid employees (DiSalvo, 2012).

This is important because it gives these young men a means to solve an issue in their community (i.e., lack of economic resources), while learning. Survival and learning are not conflicting with each other. The students are not only able to earn money in program but they are also being shown that there is an avenue to do something that you enjoy as a career in STEM. What makes this program different is that it is culturally relevant to the participants and they are able to leverage existing knowledge of gaming as part of their STEM learning projects (Barseghian, 2011).

The program predominately recruits students from low-income Black schools to serve in the quality assurance group for gaming companies. The participants are also mentored by local

students from Morehouse and Georgia Tech. One of the findings of the study was that African-American youngsters viewed some the video game practices that gamers used to hone their craft with ridicule. The study also reported that how urban youth view masculinity is very different than how the typical hacker views it. African-American youth tend to judge masculinity based on physical ability and sports competition as opposed to a rebellion against authority (Barseghian, 2011).

Researchers can uncover much more about learning and its relationship to cultural norms by studying the participation in games as a motivator to learning rather than as a means of assessment. Much can be learned about the connection between learning and culture by studying video game participation as a motivator to learning rather than as a means of assessment. Additionally, studying masculinity may be a key to understanding. There is much to learn from researchers who study how young people move from loving video games to interest in computing and one of the questions to be examined is why a field of work that seems to devalue athletics and sports are deemed unattractive by certain groups. Young people who may be drawn to athletics may be repelled by the image of the typical *computer geek*, whose introverted habits and unkempt physical appearance may resonate negatively (Barseghian, 2011).

Universities are responding, as they are making efforts to make computer science curriculum more appealing to young people in general, and to people of color in particular. On campuses all across America, programs are being established to ensure that minorities are provided with the support needed to succeed in STEM majors such as counseling, mentoring, and tutoring, all in the hopes that these efforts will produce more engineers from minority backgrounds.

Attracting African American Males

Research concerning the factors that attract African American males to computing has been analyzed in a recent study (Charleston, 2010) that examined factors that attract African American males to the area of computer science and its related areas. Three major areas were reported that examined components that attract African American males to the area of computer science and its related areas. The study reported those elements to be cultural specific mentorship, real-time problem solving, and omnipotent applicability of technology in daily life. Interest in computing started in high school or middle school for all of the participants, and was the result of an African-American computer science mentor. The student relationship with the mentor was initiated through culturally relevant school enrichment programs in the math and sciences.

During this time, they were connected with an African and/or African-American male role models in computing. The love of solving problems also emerged, for all of the participants, as a reason for becoming interested in computing. Three general themes emerged from the research in regards to what factors attract African-American males to computer science. Those factors are culturally specific mentorship, the propensity for solving problems in real time/immediate gratification, and the universal application of computing and/or potential for social integration into daily life and living. According to Charleston's (2010) study, mentorship is the key component. Also, these relationships are credited with providing these young men with the self-confidence and knowledge needed to persist in their goals.

It is important that those African-American males who have attained success in the field of computing mentor younger aspirants who dream of becoming computer science professionals. A study conducted by the Creating IT Futures Foundation (2015) titled "Teen Views on Tech

Careers" examined the attitudes regarding the career choices of Latino and African-American youth from urban areas, indicates that the three most popular careers were software developers, technicians and UX/UI designers. Overall, approximately 40% of all Latino and Black teens indicated a high level of interest in a career in technology. The survey also asked what aspects of IT training programs would attract them the most, and 94% of the teen's surveyed showed interest in a technology training program. However, interest was tied to whether or not the program offered compensation (Creating IT Futures Foundation, 2015).

Further, 8% of respondents would be interested if the training taught them skills and techniques that could be used in solving the problems in their community. Perceptions about careers in technology were also measured, and findings indicated that underprivileged urban minority teenagers wrongly assumed that positions in computing, without exception, require an undergraduate degree as a minimum. Members of this group also shared the notion that if one is not extremely proficient in science and mathematics, then one's opportunities to secure employment in technology were remote (Creating IT Futures Foundation, 2015).

Summary of Literature Review

Although African-Americans students' lack of participation in engineering disciplines is well chronicled, very little research has sought to capture their impressions of engineering or ascertain how those impressions might be transformed for the better (NACME, n.d.). In 2007, according to the United States Census Bureau, African Americans comprise approximately 13% of the population of the United States. However, current population survey (CPS) data revealed that African Americans made up 11% of the total workforce and 9% of professional occupations in 2007. However, in the same year, African Americans comprised only 7% of the Networking and Information Technology (NIT) workforce (National Telecommunications and Information

Administration, 2010). This literature review begins with the history of African Americans in America and how, from the very beginning, they were stereotyped as being unintelligent and unable to innovate or invent.

This conditioning has continued for decades, and based on what has been revealed in the review of the literature, continues today for people of color, and women, as well. This literature review has also illustrated that African Americans face a plethora of obstacles, some initiated because of deficient educational opportunities, in their pursuit of careers in information technology. The literature reveals impediments such as digital equity, uses of technology by different groups. African Americans may be using their Internet access more for entertainment than empowerment. The research also includes examples of unequal education between African Americans and students in low-income schools when compared to affluent institutions. Several studies strengthen this finding and its importance with regard to the lack of African Americans working in information technology.

The *geek* image of computing as well as African Americans who do pursue college majors in computing also emerged from the literature. Many African Americans have experienced hardships on the road to graduation in STEM programs, and it has been reported that there is a problem with the way computing is presented to students. The literature reflects that computer science curriculum may be faulty in design, that it should be changed. Still others do not see image as a problem, since the NIC (as cited in Wilson et al., 2010) study reported that African-American males were just as likely to choose a careers in computing in high school. Racism is still identified as a possible factor in the dearth of African Americans pursuing careers in the information technology sector (Tennant, 2011) and many interventions are currently under way to increase the participation of African Americans in general, as well as African American

males, in computing disciplines such as DiSalvo's (2012) Glitch Game Testers in Georgia. In attempts to identify factors that draw African-American males to computing fields, Charleston's (2010) study found that enrichment programs that provide mentorship can play a crucial role in attracting African-American males to this area. Many factors that have been identified to play a role to solve this complex social problem. No one component has been identified as the sole determinant to answer this important and pressing question. Those who are involved in all aspects where an issue has been identified need to be made aware of their contributions to the problems, as well as provide methods to mitigate the negative outcomes that are being produced.

From a social perspective, this would include professionals who may serve as mentors, and parents whose role is to expose their children to technology and help to instill early confidence in math and the sciences. The role of teacher expectations and their relationships with their students has been identified. College professors must do their best to encourage their students in computer science courses, and work to ensure that the material is presented in a way that resonates with underrepresented groups. According to the literature, African Americans face several obstacles from a workplace perspective. Some reports note that the most egregious culprit is the culture at technology companies (Tennant, 2011).

Unconscious bias emerges as a major impediment to African Americans regarding retention, hiring and workplace experiences for people of color. Technology companies are now looking for ways to remove the bias implicit in their hiring practices, as well as improve practices that promote development and leadership capabilities. The literature also revealed that many initiatives are underway to help remediate the many challenges that are prevalent in today's workplace. As a response to the lack of diversity in the technology field, several nonprofits have emerged. Black Girls Code, and Hacking the Hood are just two of the grassroots

organizations that have been founded by minorities, which are concerned about the next generation of Black and minority engineers.

These programs are making an impact. In addition to nonprofits, the public sector has created several initiatives to improve the diversity dichotomy in computing fields. The White House held its first demo day this year, and major technology companies have pledged tens of millions of dollars toward increasing the number of women and underrepresented minorities. In addition, companies have created c-suite level positions, which focus on creating a comprehensive plan for diversity and inclusion for the organization. In reviewing the literature, there is a severe shortage of studies that examine why African Americans are not pursuing careers as software development engineers (Charleston, 2010). Most of the literature is focused on educational inequalities (Warschauer, 2003). Much of the educational literature studies the differences between opportunities for African Americans and other students (Margolis, 2008).

Much of the literature points to the fact that African Americans and women would most likely pursue careers in computing if many of these inequities were eliminated (Snyder, 2014). There is a dearth of research that has studied African-American software development engineers that seek to understand the obstacles and challenges facing them (Charleston, 2010). Further, not much has been written about those who have succeeded in the field and who have extracted the strategies and practices that they employed to overcome difficulties and prejudice. Hopefully, this study will contribute to the literature by doing just that.

Chapter 3: Research Design and Methodology

Gathering and understanding the experiences of African American software development engineers in corporate America through their personal narratives is best achieved by employing a qualitative research design utilizing a phenomenological approach (Creswell, 2003). This chapter describes the method of qualitative research design employing a phenomenological approach and the rationale for its selection for this study. A discussion of the method of sampling and the population are discussed along with the means of securing institutional review board approval and the consideration of the human subjects of the study. Validity and reliability is addressed along with recognizing any researcher bias. This chapter closes with a review of the data analysis process and the formulation of the findings.

The purpose of this study was to examine the success strategies and common personal characteristics of African American software development engineers determined to be contributory to their achievement. This was meant to be achieved by identifying successes and challenges that African American software development engineers in Corporate America have experienced while pursuing their careers in technology, and examining how they were able to overcome their challenges and obstacles on their journey. The need to establish and provide a framework of strategies and practices for overcoming the challenges and obstacles that have resulted in the underrepresentation of African American software development engineers in the technology sector compared to other ethnic groups was acknowledged in Chapter 1.

This chapter discusses the research methods that were utilized to achieve the purpose of this study and to answer the research questions posed with the intent of constructing a framework for the research starting with the nature of the study.

Nature of the Study

This descriptive study will exercise a qualitative approach in answering the research questions proposed. The research questions will inform the open-ended semi structured interview questions to be asked of selected participants. Aligned with Patton's recommendations for open-ended interviews, the questions proposed were architected to elicit "in-depth responses about people's experiences, perceptions, opinions, feelings, and knowledge" (Patton, 2002, p. 23).

Restatement of the Research Questions

1. What strategies and practices are employed by African American software development engineers to overcome the challenges of being part of an underrepresented group in the technology sector?
2. What challenges are faced by African American software development engineers in implementing the strategies and practices to overcome being a part of an underrepresented group in the technology sector?
3. How do African American software development engineers measure success in overcoming challenges of being part of an underrepresented group in the technology sector?
4. What recommendations would African American software development engineers make for future African American software development engineers to be successful as part of an underrepresented group in the technology sector?

This study employs a descriptive approach that blends content analysis and interviews. The next section provides the rationale for choosing a qualitative design with a phenomenological approach as the basis for this study.

Methodology

Qualitative design. The literature review not only revealed a lack of research on African American software development engineers, but the void also includes the field of research dealing with successful leaders in the community. While the area was ripe for exploration, for reasons described hereafter, quantitative research would be less appropriate due to the nature of the population. Some researchers have stated "Qualitative research is typically done when the nature of the situation or the individuals does not permit use of an instrument" (McMillan & Schumacher, 2001, p. 400). They also add, "Qualitative strategies, for example, are appropriate with persons who are extremely busy or persons who are expressive nonverbally or use a second language" (p. 400).

These participants are too busy to complete a written survey, they are also considered too significant to be part of a large survey, and the research can be that much richer by getting the stories and the conversations as opposed to objective non-personalized data. Creswell (1998) gives another reason for choosing qualitative methods for this topic. He thinks that qualitative research should be done when a topic needs to be explored, rather than clarified. He defines exploration as a situation in which, "variables cannot be easily identified—and theories are not available to explain behavior of participants or their population of study" (p. 17). According to Donalek and Soldwisch (2004), "Qualitative research is the organized, systematic exploration of some portion of human experience. It is not concerned with the statistical interpretation of data but rather with the discovery of common emergent themes" (p. 345).

The qualitative research takes place in a natural setting. The researcher should actually become an instrument of data collection that collects words or pictures, and then analyzes them inductively, focusing on the meaning of the interviewees. The researcher should then describe a

process in vibrant and persuasive language to explore a social or human problem (Creswell, 1998). In doing so, "The researcher builds a complex, holistic picture, analyzes words, reports detailed views of informants, and conducts the study in a natural setting" (p. 15). Creswell (1998) articulates eight unique characteristics of qualitative research as follows:

1. Natural setting (field focused) as source of data
2. Researcher as key instrument of data collection
3. Data collected as words or pictures
4. Outcome as process rather than product
5. Analysis of data inductively, attention to particulars
6. Focus on participant's perspectives, their meaning
7. Use of the expressive language
8. Persuasion by reason (p. 16)

Creswell (1998) states a short list of characteristics of a good qualitative study as: (a) employing rigorous data collection procedures; (b) framing the study within the assumptions and characteristics of the qualitative approach to research; (c) using a tradition of inquiry; (d) beginning with a single focus; (e) studying the detailed methods, rigorous approach to data collection, data analysis, and report writing; (f) writing persuasively so that the reader experiences being there; (g) analyzing data using multiple levels of abstraction; and (h) writing in a clear, engaging manner that is full of unexpected ideas. Other researchers state, "The qualitative researcher seeks participants because of their knowledge of and ability to describe the phenomenon or some part of the phenomenon under study" (Donlek & Soldwisch, 2004, p. 365).

Since the design of this study was focused not on the life of an individual but rather on a concept or phenomenon to understand the meaning of experiences of individuals about this phenomenon, it followed phenomenological methodology (Riemen, as cited in Creswell, 1998).

Phenomenological approach. According to Creswell (1998), the focus of the phenomenological research is on understanding a concept or phenomenon such as the psychological meaning of a caring interaction. As mentioned by Creswell (1998),

> In the Riemen study, the researcher talks with 10 individuals who submit to interviews. And the author includes a philosophical discussion about the principles of exploring the meaning of individual experiences and how these meanings can be reduced into a specific description of the experience. (p. 38)

Whereas a biography reports the life of a single person, phenomenology explores the structures of consciousness in human experiences and it has its roots in the philosophical perspectives of Edmund Husserl (1859-1938) and some other philosophers like Heidegger and Sartre (Polkinghorne, 1989). Creswell (1998) articulates:

> Researchers search for the essential, invariant structure (or essence) or the central underlying meaning of the experience and emphasize the intentionality of consciousness where experiences contain both the outward appearance and inward consciousness based on memory, image, and meaning. Phenomenological data analysis proceeds through the methodology of reduction, the analysis of specific statements and themes, and a search for all possible meanings. The researcher also sets aside all prejudgments, bracketing his or her experiences and relying on intuition, imagination, and universal structures to obtain a picture of the experience. (p. 52)

Based on the phenomenological principles, Creswell (1998) summarizes the major procedural matters in using this method:

1. A need to understand the philosophical perspectives of this approach and studying how people experience a phenomenon, especially the epoche concept, where the researcher puts away his or her own ideas away from the phenomenon
2. A need to write research questions in a way to explore the meaning of the experience
3. A need to collect the data from the individuals who have experienced the phenomenon
4. A need to use phenomenological data analysis method
5. A need to conclude with reports that the reader understands the essential, invariant essence of the experience (p. 54).

A strong familiarity in the philosophical presumptions and a non-pre-determined hypotheses or theory is crucial for phenomenology (Creswell, 1998). The aim of the research was to develop comparisons resulting in new insights or reclassifications. Sanders (as cited in Creswell, 1998) states that generalizations are only concerned with the specific subjects under investigation, not the population as a whole, and findings serve as a database for further investigation. Phenomenological research encompasses surveying a small number of subjects and forming patterns and connections of meaning based upon their important statements (Moustakas, 1994). The most common research method of acquiring data is through the use of interviews, as open-ended interview provide the greatest opportunity for data to emerge that develops themes based upon responses (Locke, 2004; Creswell, 2003). For this study, interviews were used and are thoroughly explicated in the next section.

Selection of Data Sources

The selection of data sources for this study was collected from the population described below. These participants were selected by purposive sampling. Careful considerations were taken to protect the participants' rights as necessitated by Pepperdine University and the Institutional Review Board (IRB).

Population. A researcher in qualitative study takes on a sequence of activities in the practice of assembling data, starting with location of a site or an individual to study, gaining access to/and establishing rapport so that participants will provide sufficient data (Creswell, 1998). Creswell (1998) notes "a closely interrelated step in the process involves determining a strategy for the purposeful sampling of individuals or sites" (p. 110). He also adds that the sampling is not a probability sampling; rather it is a sampling so that one can best study the problem under investigation. Creswell states that "in a phenomenological study, the participants may be located at a single site, they must be individuals who have experienced the phenomena being explored and can articulate their conscious experience" (p. 111).

Criterion sampling works best when all the individuals under study represent people who have experienced the phenomenon. The *maximum variation sampling* strategy was used to convert the shortfall of the large amount of variety of the small sample size to an asset (Boundaoui, 2011). According to Patton (2002), "Any common patterns that emerge from great variation are of particular interest and value in capturing the core experiences and central shared dimensions of a setting or phenomenon" (p. 235). The best process for collecting information engages in-depth interviews with as many as 12 persons. Regarding the sample size, Duke recommends studying three to 10 subjects, and Riemen had 10 participants (as cited in Creswell, 1998).

Polkinghorne (1989) suggests that 10 in-depth interviews (lasting as long as 2 hours) as representation of a reasonable size. The self-reflection of the researcher might be added to the 12 in-depth interviews as a preparatory step to interviewing. A variety of strategies were used in identifying and interviewing the successful African American software development engineers. Those strategies included networking, snowballing, criterion or personal knowledge (Creswell, 1998).

Participant description. For the purpose of this study, the researcher defined African American successful software development engineers as African Americans are working or have worked as software development engineers for at least 5 years in a professional information technology department of an organization. The analysis unit was an African American successful software development engineers. The sample was a criterion based, purposive sample from either the personal knowledge of the participants, referred by experts, other participants, or through popular media in the United States. The researcher had personal knowledge of some of the participants as a result of their being former professional colleagues. It was this personal knowledge that allowed them to match the criteria that was used to deem them satisfactory for the study. Criterion based sampling works well in a phenomenological study when all cases must meet some criterion by experiencing the researched phenomenon (Creswell, 1998).

Inclusion criteria. The inclusion criteria for the 15 African American software development engineers selected for this study were that individuals had (a) obtained at least a Bachelor's degree in computer science or related information technology degree with training and/or expertise in a related field that qualified them to be recognized in the workplace as a software development engineer and (b) attained at least 5 years of experience working in a corporate information technology department as a software development engineer.

Exclusion criteria. Based on the focus of the study it was crucial to only include software development engineers who were currently working as software development engineers. They had to be in the position for at least 5 years. Exclusion criteria also included software development engineers that worked outside of the U.S. Additionally, any software development engineer that was self-employed was also excluded from the study as their experiences may yield different results given the fact that entrepreneurial software development engineers path may be entirely different from the journey targeted for this study. There were no restrictions in regards to gender, social status, health, family or background.

Sampling Method: Purposive Sampling

The method of sampling for this study is purposive, utilizing a strategy of maximum variation. The following subsections discuss the sample size and guidelines.

Participants in the study were selected using a combination of purposive sampling techniques Creswell (1998) recommends a much more narrow scope of sampling strategies for a phenomenological study with the criterion that all the participants must have experienced the phenomenon to be studied. All participants were African Americans who have spent at least 5 years working as a professional software development engineer as part of an information technology department. The researcher in his 30 year career in software development has developed a personal database of African American software developers. The researcher will use this data base as a starting point and search the Internet for public contact information of those on the database as the sampling frame.

The researcher employed five steps to arrive at the final list of individuals to utilize as participants of the study.

Step 1. The researcher utilized a public source in the form of a website named *LinkedIn.com*. LinkedIn is a networking site for corporate professionals. Search options are available that allow to allow a search for individuals who work in certain industries, certain companies or work in a specific job roles. The researcher used this site to locate public contact information for folks in his database.

Step 2. The researcher used the search feature to find software developers as the search feature of the site allows for searching by job function. A search was conducted to return a pool of software development engineers and reduced the pool by conducting a search on years of experience as well.

Step 3. For the pool of software engineers who have been in their role of at least five years the researcher needs to determine the race of the individuals as this is part of the inclusion criteria for the study. This can be done by looking at the profile picture initially to be verified later when the invitation to participant is sent out to the potential participant.

Step 4. The researcher then studied the profile of each individual to further limit the candidate pool by assessing individuals based upon their resume, job descriptions, education, recommendations, job history, skills and many other aspects of their professional work history that allows the researcher to apply the remainder of the inclusion and exclusion criteria for including the candidate in the study.

Step 5. During this process and based upon the profiles gathered, the initial database of 30 potential participants were reduced to 15 African American software development engineers that met the inclusion and exclusion criteria. Upon these individuals being identified, the researcher reached out to the potential participants by utilizing the approved IRB recruitment script.

First contact to request participation in the study was made in an assortment of ways including telephone, e-mail, social media and/or personal contact at social events and meetings. Each potential participant was reviewed again to confirm the criterion required to be included in the study. The purpose of the study was discussed with each one. Each participant was also made aware of the estimated obligated time commitment. Each participant was then sent the estimated time commitment as well as the items in the informed consent letter such as recording the interview, confidentiality, and the publishing of the dissertation were discussed.

At this point in the process, if the individual communicated interest in participating in the study, the informed consent form (see Appendix D) was sent to him or her. After the informed consent form was received and accepted, a copy of the semi-structured interview questions was sent to the participant.

Human Subjects Considerations

Attaining access to the participants involved following a process. This process included following the inquiry strategy as well as being granted permission from a human subject review board (Creswell, 1998).

> It is the policy of Pepperdine University that all research involving human participants must be conducted in accordance with accepted ethical, federal, and professional standards for research and that all such research must be approved by one of the University's Institutional Review Board (IRB). (Pepperdine University, n.d.)

"This process involves submitting a proposal to the board that details the procedures in the project" (Creswell, 1998, p. 115). The purpose of the institutional review board was to protect the welfare and dignity of human subjects, and also aid the researcher in conducting an ethical study that complied with applicable regulations.

Participant protection was critical for this study as the data collection method was one-on-one interviews. Each participant in this study received an informed consent form that provided each person with information regarding the study and their role in the study. According to Warren (2002), human subjects regulation of interview research seeks to protect respondents from such things as invasion of privacy, violation of confidentiality, and the distress caused by the interview process itself. The Belmont Report (National Institutes of Health, n.d.) identified three basic ethical principles to consider for the protection of human subjects. These included respect for persons, beneficence, and justice.

Respect. According to the Belmont Report (National Institutes of Health, n.d.), respect for persons divided into two separate moral requirements: the requirement to acknowledge confidentiality, and the protection of those with diminished autonomy by giving them information and time to determine their involvement in the research. The participants in this study received an informed consent form providing them with information regarding the study and their role in the study. The respect issue was addressed in the informed consent by:

- Their right to voluntarily withdraw from the study at any time.
- The purpose of the research and how the participant's view fit into that purpose.
- The researcher will transcribe the interview and send it to each participant for any corrections needed.

Beneficence. The concept of beneficence was formulated as (a) do not harm and (b) maximize possible benefits and minimizes possible harms. The benefits may be to the participants, or may be a more global, societal benefit. The informed consent included the following items to deal with beneficence:

- The form mentioned each participant will be granted confidentiality.

- Any known risks were included in the informed consent form.
- Benefits to the participant or society were mentioned.
- The participant may ask questions for clarity during the research process.

Justice. The idea of justice was relevant to the selection process of the participants. Fair selection of participants can add to the quality of the research. In the interest of being fair and just biases based on race, gender or other cultural differences must be set aside. Riemen (as cited in Creswell, 1998) suggests that because of the in-depth and extensive nature of interviews with participants, it is wise to obtain people who are easily accessible to the researcher. The researcher has completed the Human Participant Protection Education for Research Teams online course. The certificate for completion is attached in Appendix A. Each participant was given the informed consent form to approve. In order to preserve the confidentiality of the participants none of the participants were referenced by name and no other information that may tie the research to the participant was given.

Each participant received a code to keep the obtained data confidential. The researcher will keep the participants' names and addresses, information, consent letters, and other data such as tapes, notes, and transcriptions in a locked file for 5 years for confidentiality protection. According to human participant protections educations for research teams (National Institutes of Health, n.d.): "For certain kinds of research involving no more than minimal risks, and minor changes in approved research, the IRB Chair or a designated voting member or group of voting members review the proposed research rather than the entire IRB" (p. 42). The researcher filed an exempt review with the Pepperdine University Institutional Review Board. Data collection utilizing audio recordings is a research category included in an expedited review.

This study recorded the interviews for transcription and presented no more than minimal risk which, implied expedited review. An *Application for waiver or Alteration on Informed Consent Procedures* form was submitted to the Pepperdine Institutional Review Board for the criteria: to protect participants confidentiality and that the research presents no more than minimal risk of harm to subjects and involves no procedures for which written consent is normally required outside of the research context (Pepperdine University, n.d.).

Data Collection

As mentioned by McMillan and Schumacher (2001), qualitative studies collect data primarily in the form of words rather than numbers and the study gives a complete narrative description, investigation, and interpretation of phenomena. The review of the literature in the chapter 2 was the first step in the data collection process. The next step continued with semi-structured one-on-one interviews of the participants who satisfied the criteria of successful African American software development engineers as was described in the selection of participants section of the paper. Data was obtained from African American software development engineers from various industries with corporate America to include insurance, social media, retail, energy, technology, media, consulting and software.

The method of data collection was in the form of in-depth semi-structured interviews. Information gathered from different levels of experience as well as different genders provided a variety of responses based on their individual experiences. Some have been in the industry for 30 years while others are in the first quarter of their careers. This allowed the researcher to determine overlapping themes common to all participants. Data was collected from African American software development engineers who have been employed as professional software

development engineers for at least five years as a member of an information technology department during the month of February in 2016.

The timeframe of data collection was cross-sectional in nature. The data collection focused on the implementation of best practices and strategies with regard to overcoming the obstacles and challenges to becoming a software development engineer. The phenomenological theory is appropriate for this study as it is focused on the phenomenon of the underrepresentation of African American software development engineers and how they overcome the obstacles and challenges producing this phenomenon and what can be done to prepare aspiring African American software development engineers for success. The phenomena measured was centered on the stories of the past, present experiences, and future aspirations. Data was collected on a software development engineer's strategies, observations, practices and recommendations aimed at providing a roadmap or blueprint for the next generation of African American software development engineers. The use of interviews for data collection generates opportunities for further research and allows the researcher to mine additional areas of interests that emerged from the responses provided by the participants. Before the study could be conducted, the researcher was required to obtain permission to interview human subjects. In the month of December 2015, the researcher was involved in the Institutional Review Board process of Pepperdine University and requested permission to conduct research and interview human subjects that were to be interviewed during the month of February 2016. After receiving approval from Institutional Review Board as well as receiving approval of the recruitment script, the researcher e-mailed African American software development engineers from a list of students that has been drafted over his 30 year career as a software development engineer and outlined to them the critical nature of the study and why they were chosen to participate.

If the researcher failed to connect with one of the chose software development engineers, a request was made on various social media outlets and after confirming e-mail contact address, a follow-up e-mail was sent. Prospective interviewees that agreed to take part in the study received a follow-up e-mail from the researcher to thank them for their participation. The follow-up message included an explanation of the subsequent steps in the process. At this point, it was communicated to the participant that their full contact information will be requested and the researcher will arrange for the interview to take place during the month of February, 2016

Data was collected during the month of February 2016. The researcher used a 19 question open-ended interview instrument (see Appendix G). This interview was conducted in person by the researcher. The researcher met the interviewee based on their availability and schedule and the site of their choosing. In the event that an in-person interview was not possible for whatever reason, the researcher arranged to conduct the interview using voice over internet protocol (VOIP) software such as Skype or FaceTime. The researcher setup the software and provided the interviewee with the necessary technology assistance needed in order to use the software to produce a successful interview without requiring any extra work on the part of the participant. The interview was scheduled last 1 hour and it was scheduled at the convenience of the participant and transcribed using transcription software.

Participants were given the interview questions prior to the interview so they would have an opportunity to reflect on their experiences and provide the best, most accurate and thoughtful answers to the questions. The researcher will arrive 30 minutes before the scheduled interview time. Upon arrival the researcher will review the informed consent form with the participant. The researcher will bring two digital audio recorders to record the interview. The second recorder is a precaution any case there are any issues recording the interview.

Interview Protocol

This section provides a framework for the final interview protocol for the study, as inspected by the preliminary review committee and approved and finalized by the dissertation committee. As the protocol was meant for a distinct one-time usage, traditional methods of determining reliability of a data collection instrument were not applicable.

Interview techniques. The key to qualitative research studies is the interview process (Creswell, 1998). Qualitative interviewing requires asking deep and open-ended questions, as stated by McMillan and Schumacher (2001):

> Qualitative in-depth interviews are noted more for their probes and pauses than for their particular question formats. Establishing trust, being genuine, maintaining eye contact, and conveying through phrasing, cadence, and voice tone that the researcher "hears" and connects with the person elicit more valid data than a rigid approach. (p. 446).

There are a series of steps that Creswell (1998) suggests to be considered in an interview process: (a) identify interviewees based on one of the purposeful sampling procedures, (b) determine what type of interview is practical and will get the most information relevant to the research questions, (c) use adequate recording procedures, (d) design a form about four or five pages in length with about five open-ended questions with enough space between them, (e) determine the place for conducting the interviews, (f) obtain consent from the interviewee, (g) stick to the questions during the interview, (h) try to complete it during the specified time, and finally (i) a good interviewer is a good listener.

This study utilizes semi-structured interviews. According to Creswell (2005), "Semi-structured interviews are interviews in which the researcher asks some questions that are closed

ended and some that are open ended" (p. 598). According to Gorski (2005), semi-structured interviews will be more guided and less dictated by a schedule of questions. During the interview:

- There is an attempt to establish a rapport with the participant.
- The question order is not important.
- The interviewer may probe interesting areas for experiences from the participant.
- The participant may lead some of the discussions while the interviewee follows.

The semi-structured interview format gave the participants the capability to express their thoughts and feelings about the phenomenon. This configuration also gave the researcher the chance opportunity to comprehend the meaning of the behavior and the action of the participant. Conducting phenomenological interviews demanded saying little, handling emotional outbursts, using *ice-breakers,* and asking appropriate questions with patience and skill to determine what others think and feel about their worlds (Creswell, 1998). In semi-structured interviews, probing helps to clarify the ambiguities, deepen the interview process, and allows the participant to feel understood by the interviewer (Seidman, Rubin, & Dilley, 2004). The researcher used two digital audio recorders and one LiveScribe Echo Smartpen and pad to record the interviews simultaneously. Also, the researcher was prepared to pause the recording upon request if the interviewee decided to share information that he or she did not want to be part of the research record. Interviews were expected to last 60 minutes.

Gay and Airasian (2000) summarize good interviewing procedures in a checklist as follows:

- Who are your participants?
- Which interview type is most appropriate?

- Do you have a location that is conducive to conducting an interview?
- Have you configured and prepared your recording equipment?
- Has consent been obtained from participants?
- Did you practice active listening in your interview?
- Did you ask clarifying questions?
- Did you ask open-ended questions?
- Did you allow the participants to express their views without judgment or debate?
- Were you polite? Did you thank your participants after the interview was completed?

The researcher arrived at the interview location on the scheduled day 30 minutes before the start of the interview. The researcher arrived with a LiveScribe Echo Smartpen recording audio pen as well as two Tascam DR-05 portable digital audio recorders. The researcher also employed a backup recorder to ensure the quality of the interview for transcription, with fresh batteries and a supply of extra batteries to finish the interview. Before starting the actual interview, the researcher asked a number of ice breaker questions in an effort to put the interviewee at ease. The researcher asked the participant what kind of day they were having. The researcher also asked the interviewee if there were any questions regarding how the interview was to be conducted before the interview began in earnest.

At this point, if there were not outstanding questions or concerns, the researcher presented the interviewee with the informed consent form to sign. The interviewee would also mark *agree* on the form. The participant's signature is an acknowledgement of their understanding of the risks and/or benefits involved with being a participant. The signed consent forms were secured by placing them in a locked cabinet in which no outside individual was allowed to access them in order to maintain confidentiality of these individuals. Instructions

provided to participants regarding their completion of the open-ended interview accentuated that they take their time during the interview and contribute their opinions and thoughts to the questions asked. The participants were also apprized that the interview is semi-structured and the researcher will be allowed to ask probing questions designed to foster additional clarity and depth in the responses.

The participants was made aware that although the interview was expected to last approximately 60 minutes to complete the session there was no time limit, the only limit was there availability. The participants were was also informed that the study was qualitative in nature and that their responses were to be used as data for a doctoral dissertation focusing on success strategies for African American software development engineers. The information would be helpful in advising future African American software development engineers how to navigate and circumvent the obstacles, challenges and pitfalls that the participants have experienced on their journey to becoming successful in this field.

During the interview the researcher took notes to clarify the interview in the spaces that were prepared under the semi-structured questions. The researcher made a copy of the notes and stored them in a separate word document. During the interview, active listening was employed in which the researcher remained quiet as the participant answered questions and did not add any follow-up commentary to statements that may have sparked a particular interest to the researcher. The interviewer also exercised approaches such as summarization and paraphrasing for clarification upon receiving responses to each question posed to the interviewee (Finlay & Evans, 2009). At the end of the interview, the researcher thanked the participant for their time, and let them know what would be the next steps in the process.

The researcher informed the participant that they would receive a copy of their responses to verify for accuracy. Also, the researcher confirmed that the participant would be open to being contacted for questions of clarity. Two weeks after the interview was conducted the researcher provided the participant with a duplicate of the transcribed interview for the participant to review. This steps gives the participant an opportunity to clarify and/or correct the information provided during their interview session.

Validity

Prime facie validity. This study examines how African American software development engineers can use best practices and strategies to navigate and circumvent the obstacles and challenges present to become successful in an industry where African Americans are severely underrepresented in this role. Data was collected from participants over the course of one month in the form of one qualitative instrument. The instrument utilized to gather data was a group of 19 open-ended interview questions that expedited in answering the dissertation research questions. The following 19 questions interview protocol is used for data collection. The original set of questions on the interview protocol was designed by the researcher. The data collection instrument was developed by the researcher instead of using a previously created interview instrument.

Attention was given to design the protocol questions such that they would be collectively exhaustive and mutually exclusive. The researcher with advice from the dissertation committee decided to independently develop an instrument because the questions that needed to be addressed in the data gathering process for this study were very particular to African American software development engineers. The responses gathered aided in identifying the characteristics professional African American software development engineers must acquire in order to become

successful software development engineers. The exact questions that needed to be utilized for this research did not exist.

The instrument was created and refined by incorporating feedback from a preliminary expert review panel and the dissertation committee. The data collection concentrated on the application of practices and strategies utilized to overcome the challenges and obstacles that aspiring African American software development engineers may encounter in their pursuit of a successful career in the information technology field.

Peer review validity. Validity of the instrument was determined to ensure that the questions on the protocol sufficiently addressed the constructs in the research questions. In order to facilitate this process, a two-step validation process was exercised. First, a table was created that displayed the relationship between each research question and the corresponding interview questions (See Table 1).

Table 1

Research Questions and Corresponding Interview Questions

Research Question	Corresponding Interview Questions
RQ1: What professional and career challenges have you faced as an African American software development engineer?	Interview Question 1: Do you believe you have faced unique challenges as an African American software development engineer? (new) Interview Question 2: What specific obstacles have you faced? Interview Question 3: To what extent do you believe these obstacles have hampered your professional and career growth? Interview Question 4: What are your keys to success for becoming a software development engineer? Interview Question 5: Would you have done anything differently?

(continued)

Research Question	Corresponding Interview Questions
RQ2: What strategies and practices have you employed to overcome your professional and career challenges as an African American software development engineer?	Interview Question 6: What strategies and practices did you use to overcome the obstacles you have faced to become a successful software development engineer? Interview Question 7: What was the most important strategy or practice that you employed in helping you to overcome these challenges? Interview Question 8: Did you join any organizations? Interview Question 9: Did you receive any mentoring?
RQ3: How do African American software development engineers measure success in overcoming the challenges of being part of an underrepresented group in the technology sector?	Interview Question 10: How do you measure success in your career as a software development engineer? Interview Question 11: Have you achieved any of these measures of success? Interview Question 12: If you have not, why do you think you have not, if you have what would you say contribute to your success? Interview Question 13: What factors influenced how you measure your success?
RQ4: Based on their experiences, what recommendations would African American software development engineers make for future African American software development engineers to be successful as part of an underrepresented group in the technology sector?	Interview Question 14: What is the best path to becoming a software development engineer today? Interview Question 15: What advice do you have for African Americans who aspire to become software development engineers? Interview Question 16: Why do you feel there are so few African American software development engineers? Interview Question 17: What book or article on leadership would you recommend to a new software development engineer? Interview Question 18: Do you see any changes taking place that will make it easier for the next generation of African American software development engineers? Interview Question 19: What can companies do to solve the diversity issue in the technology sector?

The table was then reviewed by a preliminary panel of reviewer consisting of three researchers who are currently doctoral students in the doctorate of education in organizational

leadership and doctorate of education in learning technologies (EDOL/EDLT) programs at Pepperdine University. These students are conducting their doctoral dissertations at Pepperdine University and employing a similar research methodology in their own research. The panel members have all completed a series of doctoral level courses in quantitative and qualitative research methods and data analysis.

The panel was given a package that included a summary statement of this research paper, a copy of Table 1, and instructions to follow to assess if the interview questions adequately addressed the constructed investigated in the research question. The directives provided to the panel were as follows: Please review the summary statement attached to acquaint yourself with the purpose and goals of this study. Next, assess the corresponding interview questions. If you conclude that the interview question is applicable to the corresponding research question mark, "The question is applicable to research question 1", then keep as stated. If you conclude that the interview question is not applicable to the corresponding interview question, then delete it. Finally, if you conclude that to be applicable to the research question, the interview question must be amended, mark "The question should be amended as suggested." And in the available space provided recommend your amendment. An additional space is also provided to recommend additional interview questions for each research question.

Expert review validity. The results of the work of the preliminary review panel were then presented to the dissertation review committee. Each panel declared that the proposed interview questions were valid. However the panel did suggest edits with regard to how a few of the questions were worded. Also several of the initial interview questions that were previously aligned with a particular research question were assigned to research questions that they were more suitable to be aligned.

Edits suggested are as follows: Change the order of RQ1 and RQ2. The questions were reversed. Also, the researcher was asked to add several interview questions and assign them to RQ1:

1. Do you believe you have faced unique challenges as an African American software development engineer?
2. To what extent do you believe these obstacles have hampered your professional and career growth?
3. What are your keys to success to become a successful software development engineer?
4. Would you have done anything differently?

The researcher was also asked to add the following questions to RQ2:

1. Did you join any organizations?
2. Did you receive any mentoring?

Several questions were also deleted. The preliminary committee suggested that several questions be removed and the researcher agreed to remove them. Interview questions 3, 6 and 12 were deleted. The following questions (IQ3, IQ6 and IQ12) were removed:

1. What do you enjoy most about being a software development engineer?
2. What challenges have you faced in the workplace to remain in your role as a software development engineer?
3. What attracted you to the field of computer science?

Interview Question IQ8 initially assigned to RQ1 was moved to RQ2. IQ13 initially assigned to RQ2 was moved to RQ4. Both questions were respectively reassigned to alternate research

questions proposed as the committee felt what was being asked from the two interview questions in particular were more aligned with their newly assigned research questions.

One question was also edited for wording. The original question was: What thing or things influenced your measure of success? The question was reworded as: What factors influenced how you measure your success? After discussion with the committee it was made evident to the researcher what the actual intent of the question is. The true intent was to find out how the interviewee came to what determines how they measure success. The researcher agreed and the question was changed. The modified interview instrument can be found in Table 1.

Validity and Reliability of the Study

Qualitative researchers aim for understanding, that deep structure of knowledge that comes from visiting personally with participants, spending protracted time in the field and penetrating to reach detailed meanings (Creswell, 2013). After a study is concluded researchers can be left wondering if they published an accurate account or even if they got it right. In order to answer these questions researchers need to look to themselves, to the respondents and to the readers. There are discussions at play here that produce insight into the validation of a qualitative narrative (Creswell, 2013). Many perspectives exists regarding the importance of validation in qualitative research, the definition of it, terms to describe it, and procedures for establishing it. Lincoln and Guba (1985) propose alternative terms such as verifiability, trustworthiness, credibility, transferability, dependability, and confirmability for qualitative research.

Creswell (1998) asserts that the confirmability and dependability are created by conducting a review of the investigation procedures. Researchers have discovered qualitative equivalents akin to conventional quantitative techniques to validation. LeCompte, Preissle,

Tesch, and Goetz (2008) went this route when they examined the challenges of validation and reliability to their analogs in experimental design and survey research.

Statement of Research Bias

The researcher decided to pursue this project based upon personal career experiences of witnessing the underrepresentation of African American software development engineers while working as a software development engineer over the course of a 30-year career. The researcher was intrigued by the lack of African American software development engineers across multiple modalities of employment, across multiple industries, and across multiple parts of the country. The researcher was intrigued by the experience of isolation and became motivated to investigate this problem in order to help provide a solution to the lack of diversity in the technology industry. The researcher's personal work experience in this area of study has shaped the researcher's perspective with regard to the types of support that can be provided to increase the number of African American software development engineers.

Additionally, the researcher's personal experience allows him to have insight into the advantages and disadvantages of the proposed solutions; and the perception of how the successful implementation of this research could impact the successful increase of the number of African American software development engineers going forward. This research is also aligned with the researcher's passion for technology, social justice and economic empowerment of marginalized groups. It is important to take note in this study as a researcher should always highlight any personal biases involved in a research project (Creswell, 2003).

Bracketing. The researcher was familiar with a few of the interviewees as a result of his career as a software developer and his work in the field of technology diversity, however measures were taken to curtail the impact of the biases in the study through the utilization of

bracketing as defined in the phenomenological approach. The concept of epoche is central in phenomenological studies; where the researcher brackets his own preset ideas about the phenomenon to understand it through the voices of the participants (Creswell, 1998). This is an ideal, but readers become acquainted with the investigator's experiences, and can make an evaluation for themselves as to whether or not the investigator was successful in keeping the focus on the subjects' experiences in the description and excluding any experiences of the researcher (Creswell, 2013). Giorgi (2009) sees this bracketing as not allowing previous knowledge to influence how experiences are defined.

This idea designates more attention on bracketing out the predispositions and "developing universal structures based on what people experience and how" (Creswell, 1998, p. 54). The researcher began the project by describing his own experiences as an African American software development engineer and bracketing out his views before proceeding with the experiences of others. The benefits of the study becomes more reliable dependable through screening the data in a new way as presented exclusively by the participants.

Data Analysis

> Analyzing text and multiple other forms of data presents a challenging task for qualitative researchers. Deciding how to represent the data in tables, matrices, and narrative form adds to the challenge. Often qualitative researchers equate data analysis with approaches for analyzing text and image data. The process of analysis is much more. It also involves organizing the data, conducting a preliminary read-through of the database, coding and organizing themes, representing the data, and forming an interpretation of them. These steps are interconnected and form a spiral of activities all related to the analysis and representation of the data. (Creswell, 2013, p. 76)

Data analysis in qualitative research involves preparing and organizing the data for analysis, subsequently condensing the data into motifs through a technique of classifying and reducing the motifs, and ultimately visualizing the data in figures, tables, or a discussion. Several books on qualitative research corroborate that most researchers follow this general procedure. In order to analyze qualitative data, the investigator utilizes an iterative process of examining data as opposed to utilizing a fixed sequential method. In this process of examination, data is input in the form of text and images and a narrative is produced. The researcher usually stores their data into word processing files that are arranged as words, phrases, and sentences that can be subsequently analyzed either manually or by using software (Creswell, 2013). The data must be stored in such a way that it is easily accessible such as a relational database. As Patton (1980) says,

> The data generated by qualitative methods are voluminous. I have found no way of preparing students for the sheer massive volumes of information with which they will find themselves confronted when data collection has ended. Sitting down to make sense out of pages of interviews and whole files of field notes can be overwhelming. (p. 456)

After the data has been organized, the researchers continue working to get a feel for the rest of the database. Agar (1980), for example, suggested that researchers "read the transcripts in their entirety several times. Immerse yourself in the details, trying to get a sense of the interview as a whole before breaking it into parts" (p. 103). Writing notes or memos in the margins of field notes or transcripts or under photographs helps in this initial process of exploring a database. These memos are short phrases, ideas, or key concepts that occur to the reader (Asmussen & Creswell, 1995). Stake (1995) explains,

> We scanned all of our databases to identify major organizing ideas. Looking over our field notes from observations, interview transcriptions, physical trade evidence, and audio and video images, we disregarded predetermined questions so we could "see" what interviewees said. We reflected on the larger thoughts presented in the data and formed initial categories. These categories were few in number (about 10), and we looked for multiple forms of evidence to support each. Moreover, we found evidence that portrayed multiple perspectives about each category. (p. 66)

The next step is to codify and elucidate the data. In this loop, the main activity of quantitative data analysis is the construction of the categories.

Inter-Rater Reliability/Validity

For inter-rater reliability/validity, the principal researcher will use a three-step process that includes: (a) data coding, (b) peer review validity, and (c) expert review validity. These steps are described in detail in the following sections.

Step 1: Data coding. Data is coded by the principal researcher. In this section the principal researcher crafts detailed descriptions and provides an interpretation based on their own experiences or the views of perspectives in the literature. The detail comes from the authors describing what they see within the context of the setting of the person, place, or event. A qualitative study begins with a good detailed description, and description is at the heart of ethnographic and case studies.

The procedure of coding encompasses assembling the text into small groupings of information, seeking clues for the code from disparate databases being utilized in a study, and subsequently attaching a label to the code. Researchers compile a list of approximately 30 codes.

Those who are less experienced at codifying their data tend to construct more sophisticated lists when examining their datasets. Creswell (2013) offers this perspective,

> I proceed differently. I begin with a short list, "lean coding" I call it – five or six categories with shorthand labels or codes—and then I expand the categories as I continue to review and re-review my database. Typically, regardless of the size of the database, I do not develop more than 25-30 categories of information, and I found myself working to reduce and combine them into the five or six themes that I will use in the end to write my narrative. Those researchers who end up with 100 or 200 categories—and it is easy to find this many in a complex database—struggle to reduce the picture to the five or six themes that they must end for most publications. (p. 232)

Several issues are important to address in this coding process. The first is whether qualitative researchers should count codes. Miles and Huberman (1994), for example, suggest that investigators make preliminary counts of data codes and determine how frequently codes appear in the database. Not all qualitative researchers believe that it is appropriate to count and report the frequency of codes appearing in their datasets. For example, Asmussen and Creswell (1995) assert that reporting on frequencies is more akin to quantitative research and indicate that in their work they may take note of the number of passages connected to a particular code as a measurement of participant interest but they do not report on frequencies in their articles.

The use of previous codes that guide the coding process is another concern. Among researchers, there is not consensus about the use of this technique. Crabtree and Miller (1992) examine several coding strategies that range from preexisting to emergent categories. It is fashionable to use preexisting codes in the health sciences. However, using preexisting codes tends to limit the analysis to those codes as opposed to allowing new codes to emerge which

reflects the ideas of participants in a more conventional way. When a preexisting coding technique is used in analysis researchers are encouraged to available to the notion of more codes emerging during the analysis.

Another concern is how to generate code names. These names can come from a few different places. Code names may also emerge from the exact phrases or words uttered by the participants. They might also be borrowed from other disciplines such as the health or social sciences, or they could be names the investigator comes up that is appropriate to describe the information. Researchers are encouraged to search for codes suited to describe information and develop themes (Creswell, 2013). These codes can epitomize

- Knowledge that investigators suspected they would find prior to the study,
- Knowledge that investigators were surprised to find, and
- Knowledge that is unusual to investigators.

After codes have been established, the analysis continues with the segregation of the text into themes. Typically, this process of classification yields between five and seven themes. Themes in qualitative research are vast pieces of data that are made up of many codes assembled to create a common meaning. Creswell (2013) see these themes as a family of themes with descendants characterized by groups of data. The process of taking a large database of text in various forms and reducing it down to five or seven families can be a very challenging process. The key is to repeatedly find ways to distinguish and separate the data in digestible chunks that can then be used to write the final narrative.

Related to these challenges are the kinds of data a qualitative investigator codes. The investigator may be conducting narrative research and seeking stories; lived experiences within a particular context or setting such as in phenomenology; processes or interactions such as in

grounded theory; cultural themes such as in ethnography; or a detailed consideration given to a particular individual or group over a period of time such as a case study (Creswell, 2013).

Another method of deliberating over the types of data would be to use a deconstructive approach (Czarniawska, 2004). Czarniawska (2004) marks the data analysis strategies utilized in deconstruction, adapted from Martin (as cited in Czarniawska, 2004), that helps to delineate the type of information to be studied from qualitative data no matter the approach:

- Breaking up a dichotomy, uncovering it as an incorrect difference
- Studying the dead air
- Attending to places where the text is contradictory or nonsensical
- Concentrating on the components that is most idiosyncratic in the text to locate the restrictions of what is possible
- Interpreting metaphors as a rich source of various connotations
- Evaluating double entendres that may point to an unconscious sub-text
- Dividing group-specific and generic sources of prejudice by rebuilding the text with swapping of its primary elements

In this study, several themes and patterns emerged from the responses extracted from the interviews. During the coding process a master inventory was stored of all the codes that were created and used in the study. This information facilitated the researcher to develop a solution to the research questions posed for this study. The researcher employed the coding process to define categories within the spiral analysis process.

Step 2: Peer review validity. After the initial coding, to establish interpreter reliability, a co-reviewer process was utilized. A panel of two co-reviewers consisting of two doctoral students with the goal of arriving at consensus regarding the coding results of the researcher

individually assessed the researchers coding. Upon completion of this assessment, the co-reviewers then discussed the themes and key phrases with the researcher and recommended changes and modifications as needed.

Step 3: Expert review validity. The principal researcher then reviewed the co-reviewers recommendations with one of the members of the dissertation committee before finalizing the coding process. Based upon the data analyzed, the researcher plans on presenting the findings in the impending chapters of the dissertation by referring to the key themes that have emerged from the coding, their descriptions, and sample participant quotes in Chapter 4.

Summary of Chapter 3

Chapter 3 opened with an introduction of the chapter and its constituents associated to the research design and methodology of the study. The research questions were restated and a discussion highlighting qualitative research and why it was selected as the method of evaluation for the addressed in this study. The chapter proceeded to discuss the use of phenomenology in the study as the examining of an individual's personal recollections of experiences that they have encountered. The analysis unit was defined as African American software development engineers in the technology sector. The inclusion criteria was that these individuals had (a) obtained at least a Bachelor's degree in computer science or a related field in science or engineering and (b) has worked as a professional software development engineer as part of an information technology department for at least 5 years.

The method of purposive sampling of individuals was explicated. Human subjects' consideration was described and the steps taken to initiate and complete a review by Pepperdine's Institutional Review board was outlined. Data collection in the form of a structured in-depth interview was reviewed including an overview of the interview protocol and the

creation of the data collection instrument used for the study. Validity and reliability were discussed. This included an explanation of the function a panel of three experts served to provide constructive, honest feedback and suggestions to the 19 interview questions proposed by the researcher that was to be utilized for the study. Afterwards, a statement of researcher bias was provided. An examination of the data analysis process was explained, in which the researcher spoke to the utilization of memos, data entry and storage, and coding.

The chapter concluded with a look at the data, which is to be expounded upon as the research findings in Chapter 4.

Chapter 4: Findings

The U.S. economy is one driven by technology and innovation, however there is a scarcity of African Americans pursuing careers in software development (Jones & Trop, 2015). The U.S. must continue to build companies that take advantage of a diverse, creative workforce that constantly innovates in order to remain competitive in the world economy (Sarkissian, n.d.).

The number of minorities employed in the technology sector and participating in technology startups in the United States is disproportionate to their percentage of the populace (Bagley, 2014). Nearly half of U.S. companies are struggling to fill critical areas within their organizations, the most difficult positions to fill include engineers and information technology staff (Sarkissian, n.d.). The best course of action would be to increase the representation of those groups who have been historically underrepresented (Margolis, 2008).

Researchers have conducted studies to explore the factors contributing to the underrepresentation of African Americans in the field of software development (Charleston, 2010). Scholarly research on the under representation of African Americans in technology span studies of the ramifications of history, education, access, and diversity. Given the trends in the U.S. population and the browning of America coupled with the challenges that technology companies are reporting in their efforts to fill these positions it is critical to encourage more African Americans and other underrepresented minorities to pursue software development careers.

Accordingly, participants in this research study provided key insights regarding strategies, best practices, and challenges experienced by African American software development engineers when pursuing careers in software development. Additionally, participants' perspectives provided an insightful understanding of what is necessary in order to

maintain a successful career as professional software development engineers in corporate America. In an effort to seek further understanding, this study employed a descriptive, phenomenological approach in addressing the following research questions:

1. What strategies and practices are employed by African-American software development engineers to overcome the challenges of being part of an underrepresented group in the technology sector?
2. What challenges are faced by African-American software development engineers in implementing the strategies and practices to overcome being part of an underrepresented group in the technology sector?
3. How do African-American software development engineers measure success in overcoming the challenges of being part of an underrepresented group in the technology sector?
4. What recommendations would African-American software development engineers make for future African-American software development engineers to be successful as part of an underrepresented group in the technology sector?

Recruitment of Participants

Participants in this study included African American software development engineers who are currently working full-time as a professional software development engineers on a corporate software development team. These participants represent members of the underrepresented groups in technology. The inclusion criteria require that:

1. Participants have obtained at least a Bachelor's degree in computer science or related information technology degree with training and/or expertise in a related field that qualified them to be recognized in the workplace as a software development engineer

2. Participants have at least 5 years of experience working on a corporate software development team.
3. Participants must be African American.

Summary of Recruited Participants

A total of 35 African American software development engineers received invitations to participate in the study. Invitations to eligible participants were made on a rolling basis, starting with the first 15 identified participants, and then contacting more participant candidates as necessary, until the researcher identified 15 participants that met the inclusion criteria and were willing to participate in the study. Attempts to recruit participants were concluded upon the identification of 15 qualified participants.

Prospective participants received an e-mail requesting participation in the study regarding the underrepresentation of African Americans in software development. Of the 35 African American software development engineers invited to participate in the study, 17% did not respond. Participant inclusion criteria required that participants have earned a degree in computer science and that they have been employed as a professional software development engineer for at least 5 years. Participants were deemed ineligible after the researcher received an e-mail response from the potential participant indicating that they did not meet one of these criteria, therefore, making them ineligible to participate.

One (2%) participant replied to the research invitation with a written declination to participate in the study. Figure 1 presents participant responses. Some of the reasons expressed by potential participants included: (a) unavailability due to personal obligations, and (b) potential participant required compensation to participate in the study. Those who responded expressing willingness, ability, and eligibility to participate, were provided a letter of intent to participate.

The Letter of Intent provided general information regarding the nature of the study and any risks and benefits for participating. Additionally, each participant was provided a copy of the modified Informed Consent. A total of 15 participants expressed the willingness and eligibility to participate in the study.

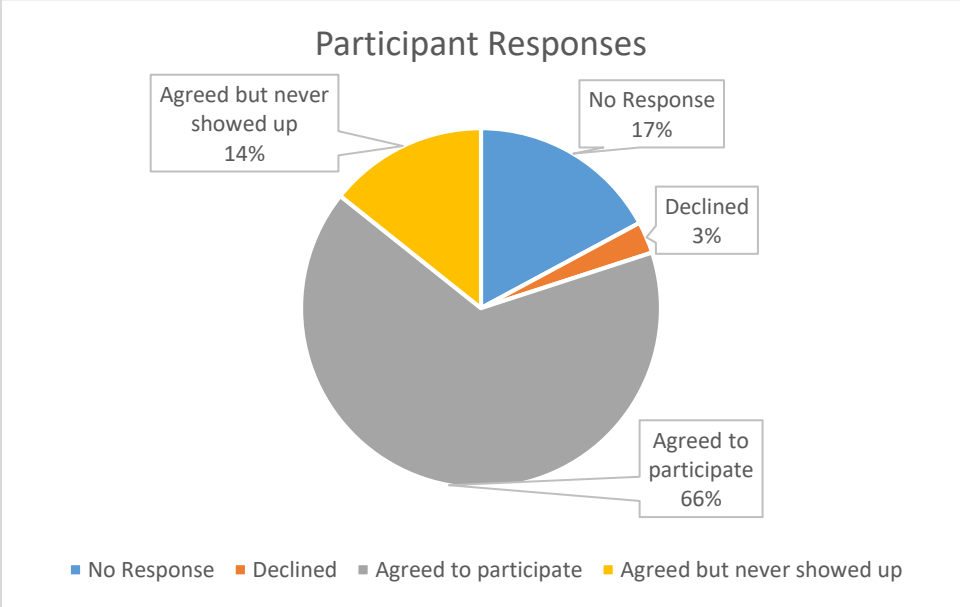

Figure 1. Participant responses.

Data Collection

The data for this study was collected from the participants throughout the month of March 2016. Given the geographical distribution of the participants, all interviews except one were conducted through Internet computer technology tools. Before the interview was conducted, participants were given additional information regarding the conditions and terms of their participation, including that the audio for the interview was being recorded. All participants agreed to have their interviews recorded. Some participants gave permission to be directly quoted.

Relationship between research and interview questions. At the start of the interview, the researcher reviewed with the participant the parameters set forth in the Informed Consent

document. Data collection was facilitated using semi-structured interviews that lasted up to 60 minutes. Each participant in the study was asked 19 research-based interview questions appertaining to the underrepresentation of African Americans in the software development engineering arena. Research question one asked: What professional and career challenges have you faced as an African American software development engineer? To address this question, the participants were asked the following five interview questions:

1. Do you believe you have faced unique challenges as an African American software development engineer?
2. What specific obstacles have you faced?
3. To what extent do you believe these obstacles have hampered your professional and career growth?
4. What are your keys to success for becoming a software development engineer?
5. Would you have done anything differently?

Research question 2 asked: What strategies and practices have you employed to overcome your professional and career challenges as an African American software development engineer? To address this question, the participants were asked the following four interview questions:

6. What strategies and practices did you use to overcome the obstacles you have faced to become a successful software development engineer?
7. What was the most important strategy or practice that you employed in helping you to overcome these challenges?
8. Did you join any organizations?
9. Did you receive any mentoring?

The third research question asked: How do African American software development engineers measure success in overcoming the challenges of being part of an underrepresented group in the technology sector? To address this question, the participants were asked the following four interview questions:

10. How do you measure success in your career as a software development engineer?
11. Have you achieved any of these measures of success?
12. If you have not, why do you think you have not, if you have what would you say contribute to your success?
13. What factors influenced how you measure your success?

The fourth research question asked: Based on their experiences, what recommendations would African American software development engineers make for future African American software development engineers to be successful as part of an underrepresented group in the technology sector? To address this question, the participants were asked the following six interview questions:

14. What is the best path to becoming a software development engineer today?
15. What advice do you have for African Americans who aspire to become software development engineers?
16. Why do you feel there are so few African American in software development engineers?
17. What book or article on leadership would you recommend to a new software development engineer?
18. Do you see any changes taking place that will make it easier for the next generation of African American software development engineers?

19. What can companies do to solve the diversity issue in the technology sector?

During the interview, the researcher engaged in active listening techniques to foster interviewee participation. The researcher paraphrased questions as required and provided clarity as requested by the participant. At the end of the interview, the researcher provided a thank-you statement acknowledging the time the participant volunteered to be a part of the research study (Creswell, 2013). As outlined in the Informed Consent, all participant information or any reference made to individuals or the participants' respective institution were redacted from the transcripts, ensuring transcripts were deemed anonymous. The 15 identified eligible participants represented the diversified specifications of the selection criteria. The participants possessed different levels of education.

The education of the participants ranged from the level of Bachelor's degrees to the doctoral level. The participants also possessed varying levels of experience in corporate America as software development engineers ranging from five years to thirty years of experience. Each participant was employed as a professional software development engineer on a corporate software development team. There were 13 male participants and two female participants in the study. The 15 participants represented 14 unique American corporate information technology departments geographically disbursed throughout the continental United States. Eight companies were located in the state of Texas, and the remaining six companies were located in the following states; Washington, New York, Illinois, Georgia, and South Carolina and the District of Columbia.

Data Analysis

The audio recordings of the participant interviews were transcribed into Word documents. Table 1 presents days on which each participant interview was conducted. The

transcribed data was reviewed analyzed following Giorgi's (1997) five-step approach to data analysis and interpretation. The data was collected, read, coded, themed, and summarized. After the data was transcribed, the researcher read and reviewed the transcripts to understand the depth and breadth of the participant experiences (Creswell, 2013). Hard copies of the transcripts were produced. The hard copies were organized and reviewed. The transcribed data was examined, and all key terms and phrases were identified. A spreadsheet was developed to organize the data submitted by the participants. The identified key terms and phrases were entered into the spreadsheet accordingly where categories were established.

Table 2

Dates of Participant Interviews

Participant	Interview Date
P1	March 10, 2016
P2	March 10, 2016
P3	March 14, 2016
P4	March 13, 2016
P5	March 14, 2016
P6	March 14, 2016
P7	March 25, 2016
P8	March 21, 2016
P9	March 22, 2016
P10	March 22, 2016
P11	March 23, 2016
P12	March 23, 2016
P13	March 25, 2016
P14	March 25, 2016
P15	March 26, 2016

Inter-Rater Reliability

A multi-step coding process helped to establish consistency in researcher findings . Participant responses were reviewed, and key words and phrases that summarized the statement were identified. The results of the analysis were presented to a preliminary committee of two doctoral students enrolled in the Organizational Leadership program at Pepperdine University.

The co-reviewers discussed the themes, triangulated (Armstrong, Gosling, Weinman, & Marteau, 1997) the findings, and provided the recommended changes. Recommended changes included recategorization of identified key words and phrases, and refinement of thematic naming conventions. Their insights and suggestions were appreciated and invaluable in assessing the data and presenting the findings. The recommended changes were incorporated into the analysis accordingly.

Data Display

The research questions informed the open-ended semi structured interview questions to be asked of selected participants. Aligned with Patton's recommendations for open-ended interviews, the questions proposed were architected to elicit "in-depth responses about people's experiences, perceptions, opinions, feelings, and knowledge" (Patton, 2002, p. 23). Overarching themes which emerged from the data, are discussed as follows:

Research question one. Research question one asked: What professional and career challenges have you faced as an African American software development engineer? To address this question, the participants were asked the following five interview questions:

1. Do you believe you have faced unique challenges as an African American software development engineer?
2. What specific obstacles have you faced?
3. To what extent do you believe these obstacles have hampered your professional and career growth?
4. What are your keys to success for becoming a software development engineer?
5. Would you have done anything differently?

Interview question 1. Illustrated in Figure 2, participants expressed two major themes in response to the first interview question IQ 1: Do you believe you have faced unique challenges as an African American software development engineer? Participant responses were categorized as follows: (a) Yes.

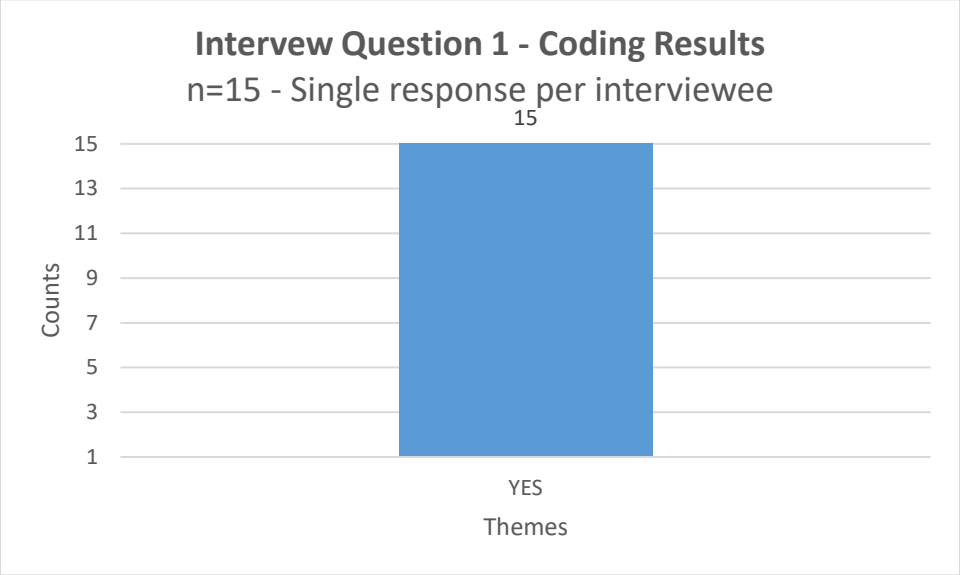

Figure 2. Themes and frequencies of responses associated with interview question 1.

Yes. Of the 15 participants, 100% indicated that they have faced unique challenges as an African American software development engineer.

Interview question 1 summary. Illustrated in Figure 2, participants expressed one major theme in response to the first interview question. IQ 1: Do you believe you have faced unique challenges as an African American software development engineer? Participant responses were categorized as follows: (a) Yes. 100% indicated that they have faced unique challenges as an African American software development engineer.

Interview question 2. When participants were asked IQ 2: What specific obstacles have you faced? Illustrated in Figure 3, participants expressed five major themes in response to the second interview question: (a) training support and opportunities, (b) cultural background, (c)

societal perceptions, (d) leadership qualifications and interpersonal skills, and (e) confidence self-esteem and self-worth.

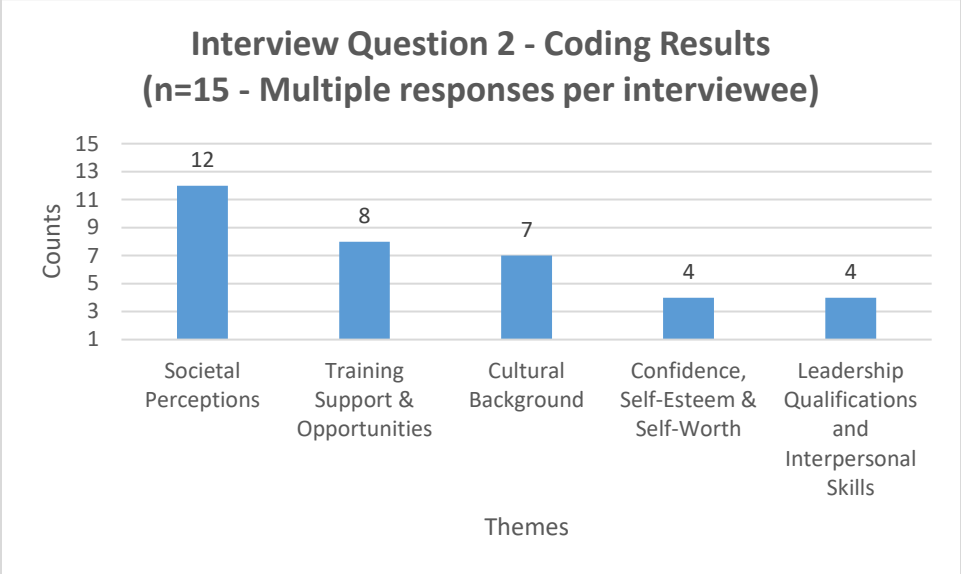

Figure 3. Themes and frequencies of responses associated with interview question 2.

Training support and opportunities. Eight (53%) out of the 15 participants expressed the lack of training support and opportunities as an obstacle faced as an African American software development engineer. Participants described a variety of circumstances that accounted for the lack of training support and opportunities. P4 discussed alienation playing a role when it came to having the same opportunities as others (personal communication, March 14, 2016). P15 described a lack of mentors particularly African American mentors that could have helped in navigating the terrain in corporate America as well as someone to help with career planning (personal communication, March 26, 2016) while P3 indicated that not having access to a network or support group and feeling isolated in a very challenging and seemingly unwelcomed environment was a formidable obstacle to overcome (personal communication, March 10, 2016).

Cultural background. Six (40%) of the 15 African American software development engineers, P1, P3, P4, P8, P10, and P12 expressed that not having culture in common with their colleagues and managers was a major obstacle that needed to be mitigated in order to have a

successful career as a software development engineer. Several participants provided examples of how differences of culture affected their ability and opportunities in the workspace. Examples included having a difficult time communicating with co-workers and/or managers, the ability to be your authentic self in the workplace, and having to work to be perceived as someone who is not harmful or threatening.

Societal perceptions. Twelve participants' responses identified societal perceptions as a challenge faced being an African American software development engineer. Participants expressed the importance of changing the perception of African Americans as it relates to their ability to master science and math. With regard to how this perception of being viewed as incapable of being able to understand what is needed to do a good job as a software development engineer one of the participants gave an example of what he was told by one of his managers when a project was falling behind schedule and he was seeking clarification regarding the requirements for a project: "You just have a problem understanding abstract concepts" (P2, personal communication, March 10, 2016). The participant expressed that he felt that this deep rooted belief has had a profound effect on how this has hindered his ability to move up in the company.

Leadership qualifications and interpersonal skills. Two participants' responses identified leadership qualities and interpersonal skills as challenges to being an African American software development engineer. Participants expressed the importance of being able to recognize that you are being judged differently. P1 exemplifies this notion by responding "you have to be an overachiever just to be seen as above average" (personal communication, March 10, 2016). P10 confirms this is as an obstacle responding to interview question 2 by stating that "the biggest obstacle faced is legitimizing myself" (personal communication, March 22, 2016).

Confidence, self-esteem, and self-worth. Four participants' responses identified confidence, self-esteem, and self-worth as obstacles they faced to be a successful African American software development engineer. P4 indicated that they were always being talked down to in a condescending manner. P5 expressed that not feeling welcome in the workplace as a peer was an obstacle faced. And P14 described that the culture of the organization that is so exclusionary that the decision was made to leave the company. P15 offers this statement around that decision as he quickly learned that "the assumption is that as a Black person you can't be the smart guy in the group" (P15, personal communication, March 25, 2016).

Interview question 2 summary. When participants were asked interview question 2: What specific obstacles have you faced? Participants reflected on their many experiences that they have lived over the course of their careers up to the point of the interview. Participants expressed five major themes in response to the second interview question: (a) training support and opportunities, (b) cultural background, (c) societal perceptions, (d) leadership qualifications and interpersonal skills, and (e) confidence, self-esteem, and self-worth. Of the 15 participants, 12 expressed overcoming societal perceptions as an obstacle to becoming a successful African American software development engineer. Eight out of the 15 participants expressed the lack of training support and opportunities as an obstacle faced as an African American software development engineer. Six of the 15 African American software developer engineers, P1, P3, P4, P8, P10, and P12 expressed that not having culture in common with their colleagues and managers was a major obstacle that needed to be mitigated in order to have a successful career as a software developer.

Interview question 3. Participants expressed five major themes in response to the third interview question 3: To what extent do you believe these obstacles have hampered your

professional and career growth? As illustrated in Figure 3, participants attributed: (a) societal perceptions; (b) cultural background; (c) training support and opportunities; (d) leadership qualifications and interpersonal skills; and (e) confidence, self-esteem, and self-worth as general themes to what extent their professional and career growth has been hampered. As all (100%) of the participants previously stated in IQ1, they felt that they have experienced unique obstacles as African American software development engineers, for this question participants reflected upon many of the negative experiences that illustrated how their careers have been hampered. Several of the participants requested time to tell stories to illustrate their point. P7 describes how her work is not recognized and those who are less educated and accomplished are able to rise up the ranks rather easily. She laments when responding to IQ3, "when I look at people that are not minorities with the either the same skill set or less skill set they have gotten a lot further along, they were promoted really easily" (personal communication, March 22, 2016).

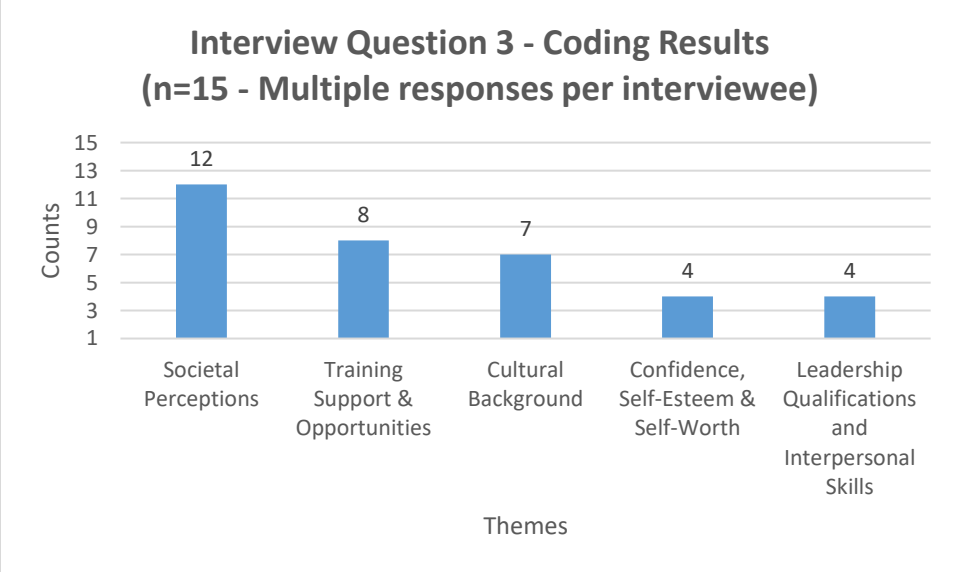

Figure 4. Themes and frequencies of responses associated with interview question 3.

Societal perceptions. Societal perceptions were identified as the biggest obstacle responsible for hampering career growth. P14 exemplifies this sentiment when he states that "the assumption is that you can't be the smart guy in the group" (personal communication, March 25,

2016). P13 indicated that people assume that you know less than you do. People constantly question your expertise and that any mistakes that you make are magnified; P13 also indicated that despite her level of expertise and accomplishments it has taken her much longer to be offered a role in management. P12 discusses how managers doubt or question your technical strategy and you may be challenged to prove yourself and the validity of your ideas where others ideas are more readily accepted. You have to earn their respect.

Cultural background. Seven (46%) of the 15 participants indicated that cultural background was a factor in hampering their professional and career growth. P3 discusses how "they are going to promote those who they have more in common with culturally" (personal communication, March 14, 2006). To help aspiring African American software development engineers to navigate the terrain, P3 stresses the importance of mentorship of having someone to give direction when faced with some of these obstacles.

Training support and opportunities. Eight participants' (53%) responses identified the lack of training support and opportunities as a factor in hampering their professional and career growth. Participants expressed the importance of having a mentor or someone who can help you to over the professional isolation that you may face. With regard to training support and opportunities, those who are not isolated and who have more of a social structure enhances their opportunities for advancement. When answering IQ3, the lack of a social structure to lean on in the workplace. P3 states:

> I don't have a built-in network like the Asian developers or the European developers. I don't freely have access to mentorship. When you are not part of these social groups you are not necessarily looked at the same way as they would look at their buddy or someone who is in their social circle and that makes it more difficult to collaborate. Also, when

> seeking learning opportunities I would receive very little help when I asked a question and most times I would not receive any help at all. (P3, personal communication, March 14, 2016)

Confidence, self-esteem, and self-worth. Confidence, self-esteem, and self-worth were noted as critical in hampering your professional and career growth. As originally mentioned in IQ 2, participants elaborated on the role that societal perceptions, cultural background, and training support and opportunities played in determining the opportunities for professional growth and advancement as an African American software development engineer.

Leadership qualifications and interpersonal skills. Two participants (13%) , P1 and P10, specifically addressed leadership qualifications and interpersonal skills as an important aspect career advancement. As work is being done on projects, P1 emphasized the reality that as an African American software development engineer you have to be an overachiever simply to be seen as above average in the eyes of your coworkers and managers Although not a common theme widely addressed by participants, P10 noted the role that having good interpersonal skills plays in professional and career growth. Learning to understand the ramifications of subtle communication such as being over managed. You have to learn that being over managed is a way of communicating with others that you are not doing a good job. As expressed, "I had to hone my communication skills. I would go into meetings and one-on-ones with manager and lay it all out. Let's talk this out, plain and clear because we have to get past this" (personal communication, March 22, 2016). Participant 13 confirms this when she expressed "You have to recognize the importance of people skills and politics" (P13, personal communication, March 25, 2016)

Interview question 3 summary. Participants expressed five major themes in response to interview question 3: To what extent do you believe these obstacles have hampered your professional and career growth? Participants attributed (a) societal perceptions, (b) cultural background, (c) training support and opportunities, (d) leadership qualifications and interpersonal skills and (e) confidence, self-esteem, and self-worth as general themes to how professional and career growth was hampered. All participants provided similar responses to the second interview question, but highlighted additional specifics.

Interview question 4. The fourth interview question in the series (IQ4) asked, What are your keys to success for becoming a software development engineer explores what factors contribute to the success of African American software development engineers? Responses were categorized in two major themes as illustrated in Figure 5: (a) education and training skills, and (b) leadership qualifications and interpersonal skills.

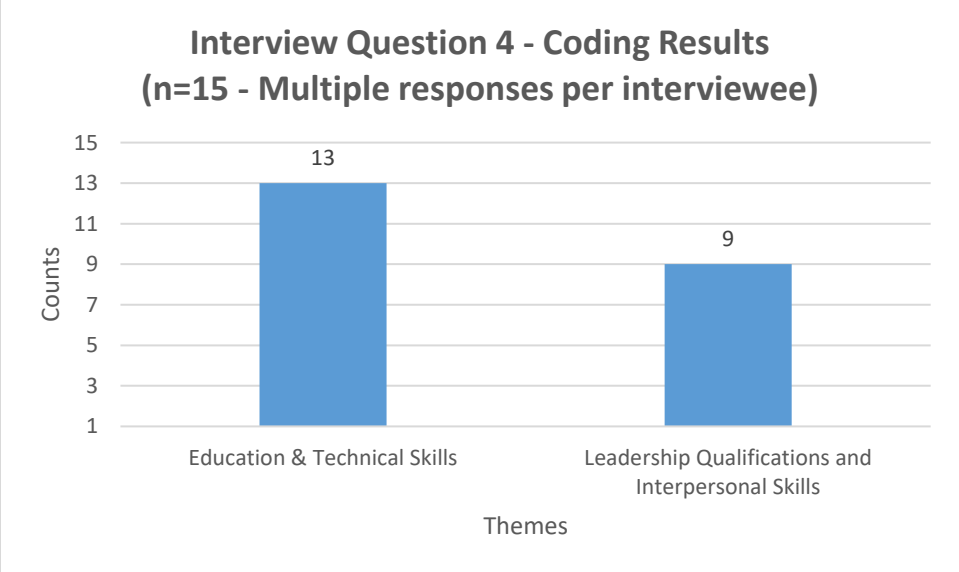

Figure 5. Themes and frequencies of responses associated with interview question 4.

Education and technical skills. Of the 15 participants interviewed, 13 (87%) discussed education and technical skills as a key to being a successful software development engineer. P1 described the process of "tinkering" on your own time as a critical aspect of learning on your

own in order to become a world-class software development engineer. Hard work in terms of being willing to spend time outside of work is critical because successful software developers are expected to stay current and keep abreast of changes in the industry as well as the technologies that are being used. It is very important for any software developer to have a willingness learn what you do not know.

There are a number of methods that software development technical skills can be obtained. P7 stresses the importance of doing the hard stuff or doing the work that others shy away from as a means for accelerating your learning and opportunities. P8 emphasized the enormous amount of personal time that is spent reading as a successful software development engineer. Practicing your craft every day is key to being successful as a software development engineer. P10 sums up the importance of learning very succinctly "read everything you can" (personal communication, March 17, 2016).

Seven (47%) of the 15 participants who identified education and technical skills as a key to success, also identified the importance of staying relevant of staying up-to-date with regard to technical skills. P2 stated that developers should "pay attention to your industry and know where things are headed and then try to preempt it by making sure you have at least a basic understanding of where it is going and what you need to know" (personal communication, March 10, 2016). P12 described a process of personal continuing education that includes:

> Preparing for technical interviews, reading as many books and articles as I can, enrolling in courses to refresh skills to make sure that I am current with some of the individuals that I am competing with for jobs and doing the best that I could to keep up with current technology. (personal communication, March 23, 2016)

P4 stated “technology is constantly evolving, it is best that you stay ahead of that wave as much as possible” (personal communication, March 13, 2016).

Leadership qualifications and interpersonal skills. Of the 15 software development engineers interviewed, nine (60%), P1, P2, P3, P5, P6, P7, P8, P13 and P15 identified leadership qualifications and interpersonal skills as helpful in becoming a successful software development engineer. Although each participant gave a different example of leadership and interpersonal skills that could be of benefit to a successful career as a software development engineer. Leadership qualifications and interpersonal skills included confidence, persistence, communication skills, determination, focus, mentorship, networking, and passion.

Interview question 4 summary. The fourth interview question in the series (IQ4) asked, What are your keys to success for becoming a software development engineer? This question explores the factors that contribute to being a successful African American software development engineer. Responses provided were based on the participants’ experiences from working on corporate software development teams in the United States. Responses were categorized in two major themes: (a) leadership qualifications and interpersonal skills, and (b) education and technical skills.

Nine (60%) of the 15 participants identified leadership qualifications and interpersonal skills as important to being a successful software development engineer, citing skills such as communication, confidence, persistence, communication skills, determination, focus, mentorship, networking and passion. Of the 15 participants, 13 interviewed described education and technical skills as critical keys to being a successful software development engineer.

Interview question 5. Participants expressed two major themes in response to the fifth interview question 5: Would you have done anything differently? As illustrated in Figure 6,

participants answered (a) yes and (b) no as general themes to would you have done anything differently in your career? As 11 out of 15 (73%) of participants stated that if given the opportunity they would have done things differently in their careers. P1 stated that he would have been more proactive in his career. P3 indicated that he would have attended a better school more known for their computer science program. P5 shared that he would have chosen a different area of specialization stating "I would have bypassed application development and gone straight into data" (personal communication, March 14, 2016). Four out of the 15 participants responded with no and that they would not change anything in their careers.

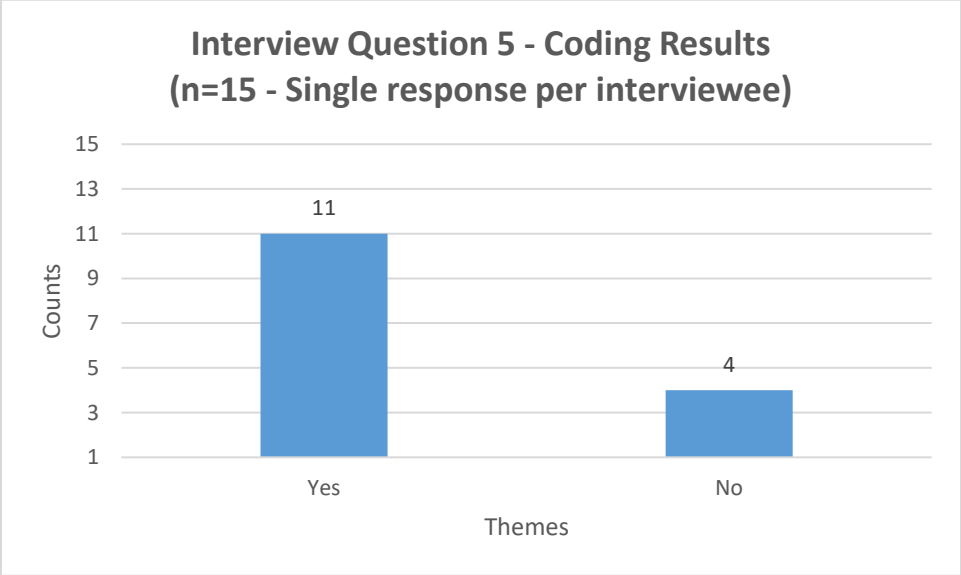

Figure 6. Themes and frequencies of responses associated with interview question 5.

Research question 1 summary. Scholarly research has determined the under representation of African Americans in technology and software development (Kang & Frankel, 2015). The first five interview questions helped to explore the first research question: What professional and career challenges have you faced as an African American software development engineer? Participants were asked if they believed that they have faced unique challenges as an African American software development engineers. All participants indicated that they faced challenges and obstacles being African American software development engineers. Participants

identified training support and opportunities, cultural background, societal perceptions, leadership qualifications and interpersonal skills, and confidence, self-esteem, and self-worth as obstacles they faced as African American software development engineers. Similarly, when asked in what ways these obstacles has hampered their career and professional growth, participants expanded upon their responses from the previous question and provided additional examples of how these obstacles and challenges have cost them opportunities for advancement and enrichment of technical abilities that would have furthered their careers. Leadership qualifications and interpersonal skills along with education and technical skills were listed as keys to success for young aspiring African Americans who are interested in pursuing careers as software development engineers. In all of the examples provided, all responses were based on experiences learned from careers as software development engineers working in American corporate software development teams.

To round out the final interview question asked of participants with regard to what professional and career challenges they have faced as African American software development engineers participants were asked if they would do anything differently in their careers.

Research question two. Research question two asked: What strategies and practices have you employed to overcome your professional and career challenges as an African American software development engineer? To address this question, participants were asked the following four interview questions:

6. What strategies and practices did you use to overcome the obstacles you have faced to become a successful software development engineer?
7. What was the most important strategy or practice that you employed in helping you to overcome these strategies?

8. Did you join any organizations?
9. Did you receive any mentoring?

Interview questions explored challenges and obstacles faced as African American software development engineers in corporate America. Additionally, participants shared strategies and practices used to overcome those identified challenges.

Interview question 6. Illustrated in Figure 7, participants expressed five major themes in response to IQ 6: What strategies and practices did you use to overcome the obstacles you have faced to become a successful software development engineer? Participant responses were themed as follows: (a) personal brand; (b) emotional intelligence; (c) communication tactics; (d) confidence, self-esteem, and self-worth; and (d) continuing education.

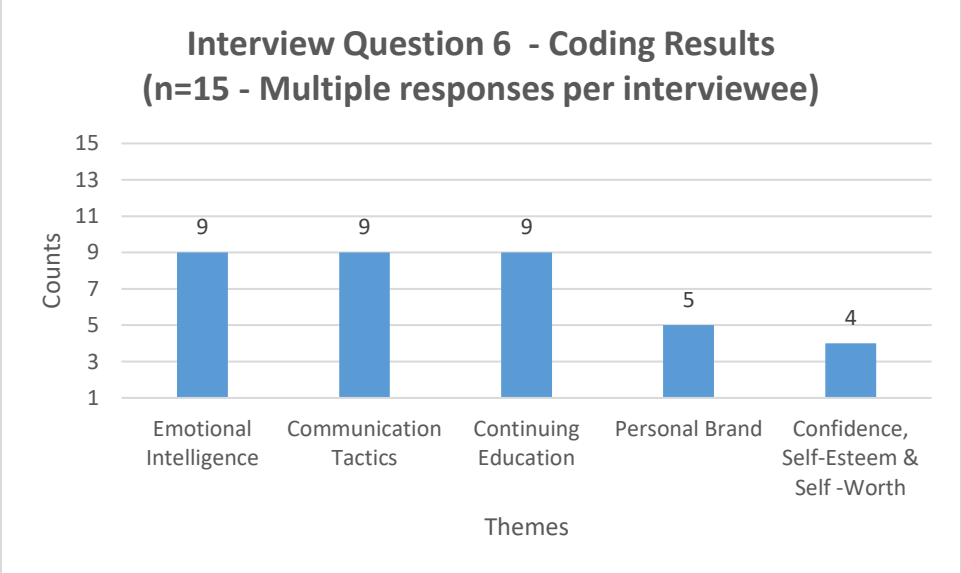

Figure 7. Themes and frequencies of responses associated with interview question 6.

Emotional intelligence. Of the 15 participants, nine (60%) referenced the effect and impact that emotional intelligence had on overcoming the challenges and obstacles faced as an African American software development engineer. While discussing the importance of emotional intelligence as a strategy P12 indicated that this strategy has been important to him in his technical career but also in his career in education stating that “I try to be less of a threat”

(personal communication, March 23, 2016). The participant then proceeded to give several examples in which learning to be emotionally intelligent served him very well in his career as a software development engineer, one such story culminating with a conversation in which a co-worker said to him after he grew a goatee "whoa you look really intimidating, you just look threatening" (personal communication, March 23, 2016). P12 further stated "whenever I am in these environments I try to show myself to be as friendly as possible and I try to always have a smile on my face" (personal communication, March 23, 2016).

P11 acknowledged the importance of emotional intelligence when interacting in the workplace so that you are not seen as "the angry Black man" (personal communication, March 23, 2016). P11 continued to confirm the importance of emotional intelligence by sharing a few stories where this strategy has paid dividends. When answering this question, P11 also discussed how this strategy is also used to solve another one of the challenges faced as African American software development engineer which is the isolation of being the only one in the development meeting. He further asserts,

> Emotionally and mentally I can't get caught up if they look at me differently as the only brown person in the room. And if they do look at me differently, I can't get caught up in that. I am here just like they are and I have a job to do. (P11, personal communication, March 23, 2016)

As a software development engineer there is a lot of time and effort spent discussing and vetting ideas. P11 discussed this dynamic when answering IQ6 indicating that "if you disagree with a White woman you have to take your voice down and put some distance between you and them. You can't be up on them and disagree with them" (personal communication, March 23, 2016). P9 acknowledged the importance of emotional intelligence when he identified that

"having thick skin" (P9, personal communication, March 22, 2016) is an important strategy when overcoming the obstacles as African American software development engineer. P7 also identified emotional intelligence as a key strategy of overcoming obstacles as an African American software development engineer. In order to be a successful African American software development engineer it is important you not only understand that there is a bias against you but that you also can't let the bias get to you. It is important that do not accept the bias. P7 shared that when a co-worker makes a negative comment about him he has learned to not take it as a slight but to understand that he or she is just ignorant and their comment is an illustration of such, then "it is easy to digest whatever they say" (personal communication, March 14, 2016).

Communication tactics. P2 provided a disturbing and insightful look into the extent to which communication tactics are necessary to be a successful African American software development engineer. P2 gave an example in which he used surrogates to get his ideas accepted on the team because whenever he presented them they were rejected and thus proving that he was capable of doing what needed to be done:

> The other way I went about proving myself was to reduce my temperament. And what I mean by that is instead of me being the advocate of every idea that I had, I used surrogates to advocate for me like this White dude that I used him and I gave him ideas and starting getting results once I started doing that. I was getting my ideas accepted. I wasn't getting credit for them because they were coming from somebody else. But he knew. He was honest, he respected me, he sought my opinions, he sought my advice, unfortunately he was not the decision maker who could give me the promotions that I needed but I was okay with that in the sense that I was impactful in the business without

being the lead advocate for the changes that I wanted to see come about. (personal communication, March 10, 2016)

Nine of the participants (60%) indicated that mastering communication tactics was a critical strategy for overcoming the challenges of being an African American software development engineer. P1 expressed the importance of being able to code switch, code switching is the practice of alternating between two or more languages or varieties of language in conversation and P4 described the importance of documenting everything. P7 cited "identifying really quickly who are your advocates and who are your adversaries" (personal communication, March 25, 2016) while P9 was concerned with time lost in his career due to not recognizing when games were being played. P9 lamented that:

> I don't have time to play around. I just want to be straight up with you and if I feel like there is a problem let's have a meeting, let's talk about it, tell me your issues, tell me your grievances. Any obstacles that I may have I like to meet it head on. (personal communication, March 22, 2016)

In reference to obstacles and challenges, P9 suggests incorporating taking classes to learn how to communicate better. P11 described the importance of being social with his co-workers "up to a point" (personal communication, March 23, 2016). P12 suggests that these obstacles may be less about computing and more about race stating that "I have faced these same obstacles in other industries" (personal communication, March 23, 2016). He further asserted the importance of making sure his "communication skills were on par" (personal communication, March 23, 2016) and that an aspect of that communication was to "try to be seen as less of a threat" and to "try to show myself to be as friendly as possible" (personal communication, March 23, 2016).

Continuing education. Of the 15 participants, nine (60%) referenced the importance of continuing education as a strategy to overcoming obstacles faces as an African American software development engineer. P1, P2, P3, P5, P6, P8, P9, P11 and P12 all indicated that continuing to educate yourself over the course of your career is a crucial to overcoming the obstacles faced. While discussing the importance of continuing education as a strategy P12 asserted that "it is important to add to your education and skillset as much as possible" (personal communication, March 10, 2016). Although several of the participants indicated that education was key, a mix of educational strategies emerged. Participants P1 and P2 discussed the importance of practice as a component of your education. P1 states that your goal as a developer should be to "be world class" (personal communication, March 10, 2016). However, other participants (P5 and P8) viewed the education component more as the ability to stay current which was primarily accomplished via constant reading on technical subjects. While describing the importance of education and how reading is crucial, P5 indicated that "I did a lot of self-research, a lot of self-development" (personal communication, March 14, 2016). P8 indicated that it is important to adopt the profession and in order to do that "we have to read the journals, we gotta go to the blogs, we gotta pick up the books, stay in tune" (personal communication, March 21, 2016).

Personal brand. Although only five of the 15 participants identified personal brand resources as a strategy, P5 provided a thorough discussion around creating a powerful personal brand as a strategy for overcoming obstacles as an African American software developer engineer, stating, "I don't want to change my identity or my culture just to be a developer" (personal communication, March 21, 2016). Expanding on the strategy of personal brand P5 also stated that African American software development engineers should "be professional in the

knowledge as this is your bread and butter at the end of the day, and don't be afraid to be a professional by reading your journals and going to meetings for your profession" (personal communication, March 21, 2016).

Confidence, self-esteem, and self-worth. Although not a common theme, four of the 15 participants noted the importance of confidence, self-esteem, and self-worth as a strategy for overcoming obstacles as an African American software development engineer. P2 acknowledged the role that confidence may have on being a successful African American software development engineer, and the impact that a lack of confidence may have in African Americans either not pursuing careers in software development or leaving once they arrive because "it is about confidence, and it is about seeing us in large numbers doing this, because when you see your peers doing it then it becomes believable" (personal communication, March 10, 2016).

Interview question 6 summary. Participants expressed five major themes in response to IQ 6: What strategies and practices did you use to overcome the obstacles you have faced to become a successful software development engineer? Participant responses were themed as follows: (a) personal brand; (b) emotional intelligence; (c) communication tactics; (d) confidence, self-esteem, and self-worth; and (e) continuing education. Nine of participants cited the importance of emotional intelligence as a strategy to overcome obstacles as an African American software development engineer. Nine of the participants (60%) indicated that communication was an important strategy to overcome challenges as well. Nine of the participants also acknowledged that continuing to learn is a major strategy. Five of the 12 participants noted the importance of creating a strong personal brand. Four of the 12 participants identified confidence as a strategy.

Interview question 7. Participants expressed five themes in response to the seventh interview question (IQ7), What was the most important strategy or practice that you employed in helping you to overcome the challenges of being an African American software development engineer? As illustrated in Figure 8, participants identified (a) personal brand; (b) emotional intelligence; (c) communication tactics; (d) confidence, self-esteem, and self-worth; and (e) continuing education as themes.

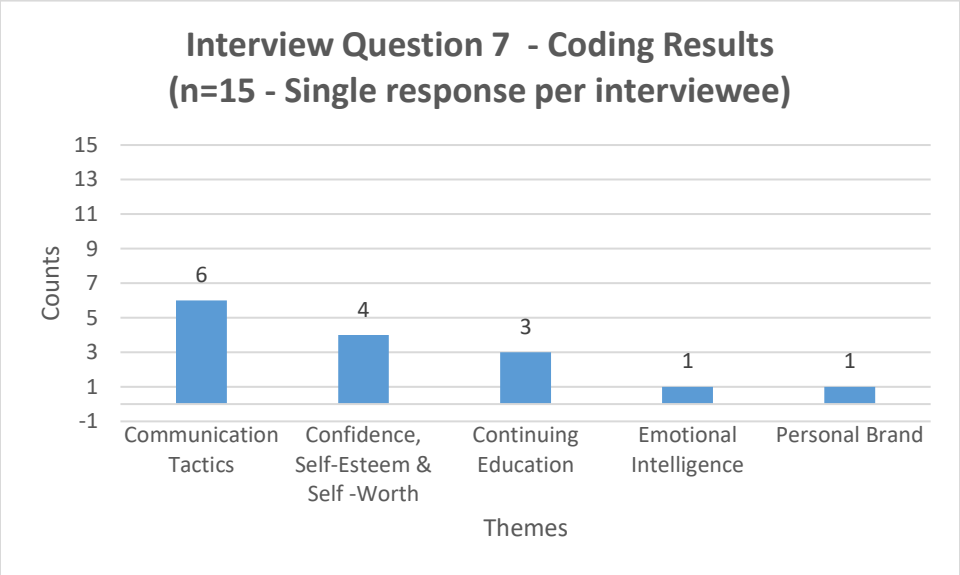

Figure 8. Themes and frequencies of responses associated with interview question 7.

Communication tactics. Of the 15 participants, six (40%) cited effective communication skills as the most important strategy for overcoming obstacles as an African American software development engineer. While discussing the importance of communication skills as a strategy P1 stated "There is always going to be someone in a meeting that challenges you. You are going to have to check them and let them know that you know your stuff" (personal communication, March 10, 2016). P7 confirmed the criticality of having effective communication skills when she stated "you need to be able to quickly identify who are your advocates and adversaries" (personal communication, March 25, 2016) in the organization. P13 lamented about how it took her so long to understand that she needed to "engage others in her success" (personal

communication, March 25, 2016) while P10 suggests it is worthwhile to devote time to learning how to communicate more effectively.

Confidence, self-esteem, and self-worth. P2, P7, P8, and P14 indicated that the most important strategy for overcoming obstacles as an African American software development engineer is confidence. P2 acknowledge that confidence is critical because as an African American you will have to "prove yourself and earn their respect where others did not" (personal communication, March 10, 2016). P2 also stated that confidence is critical because early in his career his professors as well as his early managers questioned his ability. He stated: "If I believed them and I did not have confidence in myself that I could do it, it could have been devastating" (personal communication, March 10, 2016). With regard to confidence playing a role in overcoming obstacles P14 took an entirely different approach and decided to found his own software development company. While discussing strategies to overcome the obstacles he faced he stated "after being in the workplace for a very short time, I knew I had to figure out how to do this myself" (personal communication, March 25, 2016). P7 listed confidence as her most important strategy as well. She calls it "taking the road less traveled" (personal communication, March 25, 2016). When asked to clarify what she meant she went on to state: "you have to be willing to do the things that no one else wants to do. You have to be willing to do the hard stuff" (personal communication, March 25, 2016).

Continuing education. Three of the 15 participants described continuing education as the most important strategy in overcoming obstacles. P5 expressed the importance of "diversifying my skillset" (personal communication, March 14, 2016). P3 shared this sentiment: "you have to be able to look ahead and you can't be afraid to learn new things" (personal communication, March 14, 2016).

Emotional intelligence. Only one of the participants cited emotional intelligence as the most important strategy to overcoming the obstacles faced as an African American software development engineer.

Personal brand. Only one of the 15 participants mentioned maintaining a personal brand as a strategy to overcoming obstacles. Although not a common theme, four of the 15 participants noted the importance of confidence, self-esteem, and self-worth as a strategy for overcoming obstacles as an African American software development engineer. P2 acknowledged the role that confidence may have on being a successful African American software development engineer, and the impact that a lack of confidence may have in African Americans either not pursuing careers in software development or leaving once they arrive because "it is about confidence, and it is about seeing us in large numbers doing this, because when you see your peers doing it then it becomes believable" (personal communication, March 10, 2016).

Interview question 7 summary. Participants expressed five themes in response to the seventh interview question (IQ7), What was the most important strategy or practice that you employed in helping you to overcome these challenges? Participants identified (a) communication tactics; (b) confidence, self-esteem, and self-worth; (c) continuing education, (d) emotional intelligence; and (d) personal brand. Six of the 15 participants (40%) cited communication tactics as the most important strategy in overcoming obstacles as an African American software development engineer. Four participants described confidence as the most important strategy for overcoming obstacles. One participant listed emotional intelligence and one participant listed personal brand as the most important strategies for overcoming obstacles as an African American software development engineer.

Interview question 8. Participants expressed two themes in response to the eighth interview question (IQ8), Did you join any organizations? As illustrated in Figure 9, participants identified (a) yes and (b) no.

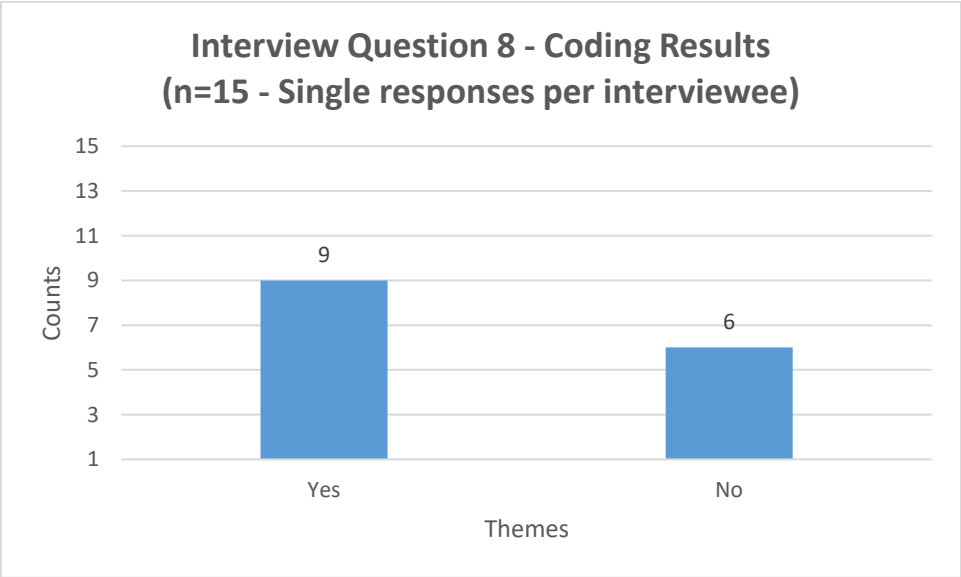

Figure 9. Themes and frequencies of responses associated with interview question 8.

Yes. Nine of the 15 participants (60%) indicated that they joined organizations as a strategy for overcoming the obstacles they faced being an African American software development engineer. P13 provides an introspective look into the role organizations play in overcoming obstacles and simply states:

> Expanding your network is the most important strategy. Because I have seen that just working really hard and being very thorough can only get you so far. It is when other people sort of validate your expertise is when you start seeing more and more responsibility being thrown your way or more and more acceptance of where you are and that only comes from external validation unfortunately. The more you expand your network, the better you are seen as a very successful engineer. (personal communication, March 25, 2016)

P11 expressed that joining organizations "provides a lot of learning and camaraderie" (personal communication, March 23, 2016), while P12 shared that it is important to join organizations from a signaling perspective, "signaling my legitimacy and letting people know that I know what I am doing by being around those people" (personal communication, March 22, 2016). P2 and P6 discussed the significance of joining more organizations from an online perspective. They both listed sites such as LearnDevNow and PluralSight as organizations that have benefitted them.

No. Six of the 15 participants expressed that they did not join any organizations as part of their strategy to overcome the obstacles they faced as African American software development engineers. P4, P6, P7, P10, P12, and P14 all indicated that joining organizations was not a part of their success strategy. P4 lamented that he did attempt to join a few organizations but he was disappointed in the experience. As an alternative to joining traditional organizations, P6 recommends using online resources as well as "networking with other more experienced developers" (personal communication, March 14, 2016). Although P10 indicated that he has not joined in organizations, he shared during the interview that is something that he probably should consider. In response to this question he stated: "I have not, but this conversation has been enlightening to me so far. That would be massively helpful just to speak with other men and women that are like me" (personal communication, March 22, 2016).

Interview question 8 summary. Participants expressed two themes in response to the eighth question (IQ8), Did you join any organizations? Participants identified (a) yes and (b) no. Nine of the 15 participants described joining organizations as a strategy for overcoming obstacles as it relates to being an African American software development engineer. Six of the 15 participants (40%) indicated that they have not joined organizations as a strategy. Three of the six mentioned that although they have not joined traditional organizations they have joined

online sites such as PluralSight and LearnDevNow which to a certain degree meets some of the needs filled by traditional organizations.

Interview question 9. Participants expressed two themes in response to the ninth interview question (IQ9), Did you receive any mentoring? As illustrated in Figure 9, participants identified (a) yes and (b) no.

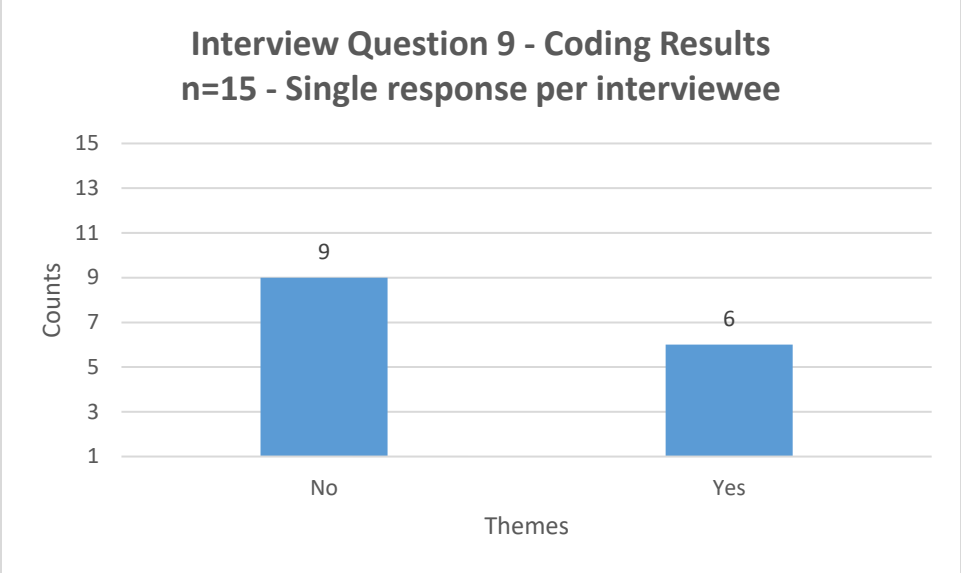

Figure 10. Themes and frequencies of responses associated with interview question 9.

No. Of the 15 participants (67%), 10 indicated that they did not receiving any mentoring during their career as software development engineers. P15 discussed the importance of mentoring while answering IQ1: What obstacles and challenges have you faced as an African American software development engineer? P15 indicates that he feels that the lack of mentorship is the biggest obstacle that African American software development engineers need to overcome. He has not received any mentoring and below he discusses his regrets with regard to the lack of mentorship:

> I am jealous of the support structure that is in place for Black lawyers that doesn't exist in technology. As a Black man, I am jealous because I'm out there by myself when my homies started to go to law school they had a Black study group. When they started

> practicing law, they connected with a Black law firm. They had Black judges as mentors. In my career in technology, there were no Black classmates. The real challenge is the lack of a support system in place. That's the big challenge. The biggest challenge to me is finding a mentor who really wants to take me under their wing and really show me the ropes. The biggest challenge is people who look like you who have the same passion for being a person of color and of technology those two things in one person is hard to come by. (personal communication, March 26, 2016)

P3 agrees with the challenges of the lack of mentorship stating: "I don't have a built-in network like the Asians or Europeans. I don't freely have access to mentorship" (personal communication, March 14, 2016). P13 shared that she "really didn't have a lot of mentors, a lot of support" (personal communication, March 25, 2016). As a strategy she suggests "making people that I admire my mentors unofficially" (personal communication, March 25, 2016). P14 who views the obstacles faced by African American software developers as motivation was not sure if he received mentorship. When reflecting on the question his response was "I am sure there were attempts made, and if that was the case then I rejected it" (personal communication, March 25, 2016). He went on to state that "No I did not receive any mentoring but that was probably more my fault than anyone else's" (personal communication, March 25, 2016).

Yes. Five of the 15 participants indicated that they received mentorship as part of overcoming the obstacles they faced as African American software development engineers. P1, P6, P7, P8, and P11 all indicated that they have received mentoring as part of overcoming obstacles they faced as African American software development engineers. P6 described how the mentoring he received helped to build his confidence and pushed him to apply for positions that he did not feel he was ready to pursue. He received encouragement from his mentor that

increased his confidence which has been crucial to his career. P8 considers mentors to be the most important factor to African Americans reaching their full potential as software development engineers. P8 gave his thoughts on the importance of mentorship when he stated "I have had Black mentors to help me that are programmers. Bringing cooler people into the industry I think is where we will be able to become our best as information technology professionals and software developers and web developers" (personal communication, March 12, 2016).

Interview question 9 summary. Participants expressed two themes in response to the ninth question (IQ9), Did you receive any mentoring? Participants identified (a) yes and (b) no. Of the 15, 10 participants reported that they did not receive mentoring as a strategy for overcoming obstacles as it relates to being an African American software development engineer. Five of the 15 participants (33%) indicated that they had received mentoring as a strategy for overcoming obstacles.

Research question 2 summary. Four interview questions helped to explore the second research question: What strategies and practices have you employed to overcome your professional and career challenges as an African American software development engineer? To explore this further, participants were asked the following questions:

6. What strategies and best practices did you use to overcome the obstacles you faced to become a successful software development engineer?
7. What was the most important strategy or practice that you employed in helping you to overcome these challenges?
8. Did you join any organizations?
9. Did you receive any mentoring?

Participants expressed five major themes in response to IQ 6: (a) personal brand; (b) emotional intelligence; (c) communication tactics; (d) confidence, self-esteem, and self-worth; and (d) continuing education. Nine of participants cited the importance of emotional intelligence as a strategy to overcome obstacles as an African American software development engineer. Nine of the participants (60%) indicated that communication was an important strategy to overcome challenges as well. Five of the 12 participants noted the importance of creating a strong personal brand. Four of the 12 participants identified confidence as a strategy. In discussing strategies and best practices, participants were candid and passionate in sharing their experiences and they took pride in revealing the strategies that they have had to learn in order to overcome their obstacles. Nine of the participants also acknowledged that continuing to learn is a major strategy.

In response to interview question 7, what was the most important strategy or practice that you employed in helping you to overcome these challenges? Participants provided examples that were categorized into five themes: (a) personal brand; (b) emotional intelligence; (c) communication tactics; (d) confidence, self-esteem, and self-worth; and (d) continuing education. Six of the 15 participants indicated that the most important strategy was communication tactics. The participants indicated that it is not only important to be an effective communicator, but it is also important to be able to discern conditions in your environment. Four of the participants indicated that confidence, self-esteem, and self-worth was the most important strategy. This them was illustrated mostly as the importance of having confidence in an environment where you are constantly being challenged and discouraged. Only three of the participants named continuing education as the most important strategy while personal brand and emotional intelligence was listed by one participant each as the most important strategy.

Interview question 8 asked participants if they had joined any organizations as a strategy to overcome obstacles. The following two themes were identified: (a) yes and (b) no. Nine of the 15 participants indicated that they had joined organizations as part of their strategy to overcome obstacles. Six of the 15 participants did not join any organizations.

Participants expressed two major themes in response to IQ 9: (a) yes and (b) no. Interview question 9 asked participants if they had received any mentoring as a strategy to overcome obstacles. Of the 15 participants, 10 indicated that they had not received any mentoring while five of the participants had received mentoring as a strategy to overcome the obstacles they faced.

Research question three. Research question three asked: How do African American software development engineers measure success in overcoming the challenges of being part of an underrepresented group in the technology sector? To address this question, participants were asked the following four interview questions:

10. How do you measure success in your career as a software development engineer?
11. Have you achieved any of these measures of success?
12. If you have not, why do you think you have not, if you have, what would you say contributed to your success?
13. What factors influenced how you measure your success?

Interview question 10. Illustrated in Figure 11, participants expressed four major themes in response to the tenth interview question, IQ 10: How do you measure success in your career as a software developer? Participant responses were categorized as follows: (a) influence; (b) compensation; and (c) longevity; and (d) confidence, self-esteem, and self-worth.

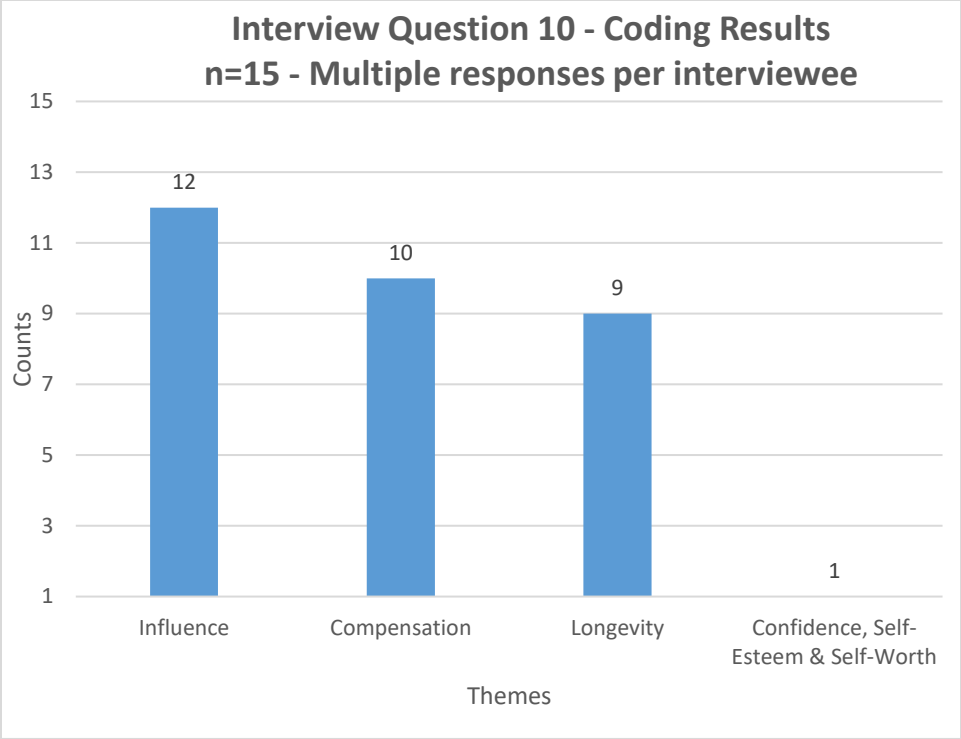

Figure 11. Themes and frequencies of responses associated with interview question 10.

Influence. Of the 15 participants, 12 (80%) expressed that they measure success by the level of influence their work garners. P1 expressed this measurement of success: "I measure success by how much of a craftsman you are. You should be trying to become world class. Are you world class as a programmer, are you influential" (personal communication, March 10, 2016)? P7 concurs and indicated that she measures success by

> how many people have started to write code on what I talked about, how many people have started to publish apps or use the services based on what I talked about. How many people have used my code that I published to get them started to publish a game or an app. (personal communication, March 25, 2016)

P7 suggested that measuring success for developers is not necessarily about money but about getting others to utilize your ideas and technology. He shared that "if I do not make a ton of money I won't be upset or disappointed because now I am more about figuring out how I can use

these skills to encourage and inspire others" (personal communication, March 21, 2016). P6 acknowledged that is important to him to be recognized by his peers as a "deep and thorough developer" and he also shared that he measures success by "how I am viewed by my peer community" (personal communication, March 23, 2016).

Compensation. Ten participants indicated that compensation in one form or another was how they measured success. Only five of the 15 participants did not list money as a measure of success, however the measures of success given by these five directly contribute to earning more income. For example, P1 suggest that one should not focus on money but instead focus on being a "world class" (personal communication, March 10, 2016) developer. In the field of software development, the salary you are paid is directly correlated to how skillful you are as a developer. P7 discussed many of the ways that uses to measure success but during the interview she admitted that:

> For me success is different than from other people, for them success is literally getting accolades and getting attention but for me I don't have that button that that is that important, that to me is only a means to an end. I want to get the awards and accolades only if that means it's going to evaluate of me getting that promotion or me getting that higher title because that means there will be more money. (personal communication, March 25, 2016).

P10 also views money as his main measure of success lamenting that "in a perfect world, money wouldn't matter, but it does, and so moving up is kind of a validation on the work that I've put in. So, I measure success as a mixture of money, title and recognition" (personal communication, March 22, 2016).

Longevity. Nine of the 15 participants (60%) expressed that longevity was how they measured success in their career as software development engineers. P4 discusses longevity as a measure of success: "If you're still around after 5 years or so, if you have that longevity, obviously you are doing something right" (personal communication, March 13, 2016). P12 indicated that "For me it's all about measuring myself from year-to-year, looking at the growth. What new skill sets have I learned, have I made myself more valuable" (personal communication, March 23, 2016). P5 reflected that initially "getting hired was a measure of success" he continues that "after about 5-8 years I started to look at the projects themselves as my measure of success" P5 suggests that after working as a developer for a few years and proving that he was qualified for the work the quality of the projects should improve. P2 discussed how he used his progress on the job as a measurement of his success. He expands on this notion of progress/longevity:

> I measure success also by the progress that you make, but the progress has to be tempered. The reason the progress has to be tempered is because sometimes it's not based on you. You can do your job very well but if your manager's not happy with you, if your manager is a bozo, bonehead, prejudiced individual you're not going to go too far. (personal communication, March 10, 2016)

Confidence, self-esteem, and self-worth. P6 was the only participant who provided a thoughtful discussion with regard to confidence, self-esteem, and self-worth. He shared that he measures success in terms of his "internal barometer of confidence" (personal communication, March 14, 2016). He gave an example of how this works well for him particularly as it relates to job interviews. P6 expands upon this discussion:

> Success for me is when I can sit right in front of somebody or close to somebody during moments when I am job hunting and I can talk to them as if listen I am just here to tell you what I know and what I have the capacity to know. I am not here begging you to hire me. I always want to send that message across very clearly. I am just exploring the opportunities here. If we click, then let's do this, if we don't I will be glad to shake your hand and walk out the door. (personal communication, March 10, 2016)

Interview question 10 summary. Participants expressed four major themes in response to the tenth interview question, IQ 10: How do you measure success in your career as a software development engineer? Participant responses were categorized as follows: (a) influence; (b) compensation; (c) longevity; and (d) confidence, self-esteem, and self-worth. Of the 15 participants, 12 (80%) expressed that they measured success as influence. Ten participants indicated that compensation is how they measured success in their careers as software development engineers. Nine of the 15 participants (60%) expressed that longevity was how they measured success in their career while only one participant expressed that confidence, self-esteem, and self-worth as a measurement of success.

***Interview question 11*.** Illustrated in Figure 12, participants expressed two major themes in response to IQ 11: Have you achieved any of these measures of success? Participant responses were themed as follows: (a) yes and (b) no.

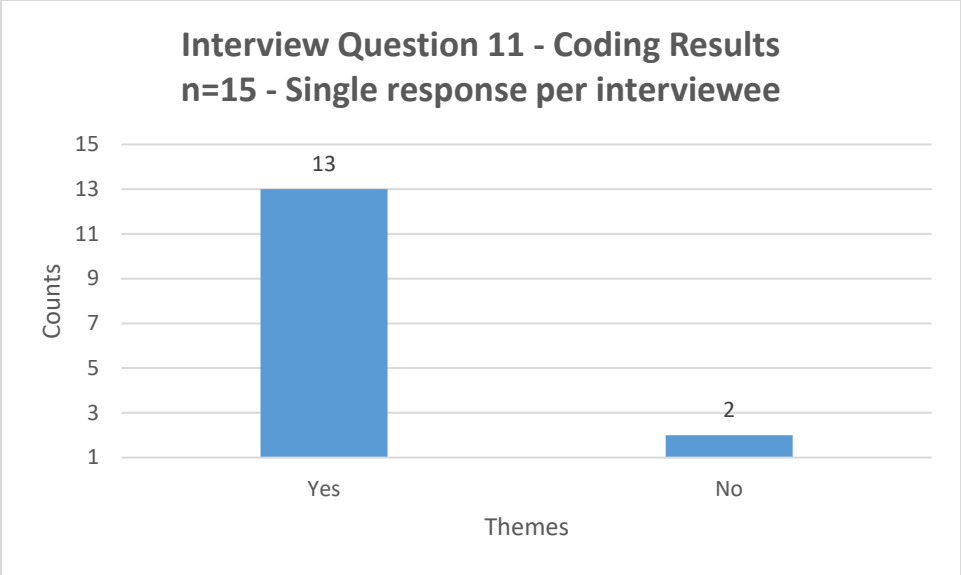

Figure 12. Themes and frequencies of responses associated with interview question 11.

Yes. Of the 15 participants, 13 (87%) expressed that they have achieved some of the measures of success identified in the previous question.

No. Only two of the participants felt that they had not achieved any of the measures of success P9 and P12. Both P9 and P12 were two of the younger participants who had not been in their careers as many years as some of the other participants. P12 indicated in several cases he did not achieve his measure of success because "it would require me to give more than I was willing to give" (personal communication, March 23, 2016). P9 laments that it was a lack of focus that has kept him from reaching his measures of success. He gives more insight into this issue when he states: "being able to focus on one thing" would be his main reason as to why he has not reached several of his measures of success as a software development engineer (personal communication, March 22, 2016).

Interview question 11 summary. Participants expressed two major themes in response to IQ 11: Have you achieved any of these measures of success? Participant responses were themed as follows: (a) yes and (b) no. Of the 15 participants, 13 (87%) expressed that had achieved the

measures of success that they identified in IQ10. Only two of the participants indicated that they were unable to achieve any of the measures of success.

Interview question 12. Illustrated in Figure 13, participants expressed two themes in response to IQ 12: If you have not, why do you think you have not, if you have what would you say contributed to your success? Participant responses were themed as follows: (a) internal factors and (b) external factors.

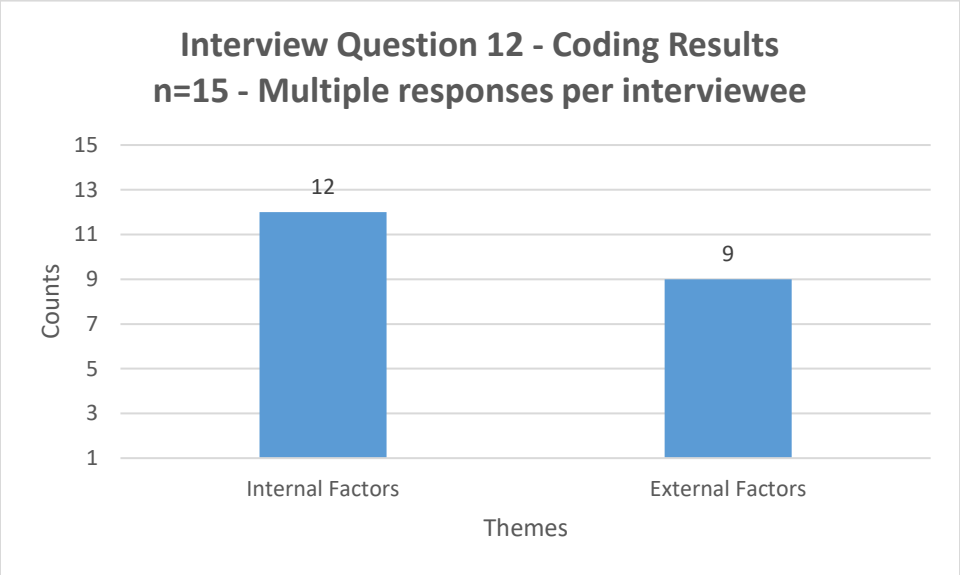

Figure 13. Themes and frequencies of responses associated with interview question 12.

Internal factors. Of the 15 participants, 12 (80%) responded with internal factors. P2 expressed the importance of client satisfaction, and "in the end the person that is paying for the product is happy with what I deliver that is how I measure success" (personal communication, March 10, 2016). As software development engineers began to understand more about the climate of corporate software development organizations they began to measure success in ways that matter to them, P4 the importance of controlling your emotions. P7 discussed the criticality of "taking the road less traveled and by that I mean doing the hard things, doing the things that others do not want to do" (personal communication, March 25, 2016). P3 recommends that African American software development engineers understand:

> Training only takes you so far. You can read a book and the book will give you this much information. If you can take that and say ok I have mastered all of this the book can't tell me anything else, I ask what else can this thing do? Come up with your own concepts, come up with your own development. Be willing to reach out and learn and push my envelope and continue to try to understand things that other people haven't understood. The goal is always to be the guy that they can't get along without, to be a recognized expert. (personal communication, March 14, 2016)

External factors. Nine participants touched on the external factors of measuring success, highlighting the necessity to establish a strong network for success as African American software development engineers. P1 provided a reminder that "programming everyday" (personal communication, March 10, 2016) as a practice was instrumental in helping him to achieve his measures of success. P13 reiterated the importance of finding others to validate your expertise. P7 amplified this point and recommended African American software development engineers to:

> Identify really quickly who are your advocates and who are your adversaries and being astute enough to find that out and also opting to work with people who have influence. I am not a networking kind of girl but I had to learn that as well, to get rid of the obstacles you have to…ok so this person thinks you're pretty cool or whatever, what project can you find that's on the road less traveled to work with this person who has influence, who is at a good level to make sure that they have that great impression of you and has actual data points of how good you're doing outside of your current group. (personal communication, March 25, 2016)

Interview question 12 summary. Participants expressed two themes in response to IQ 12: If you have not, why do you think you have not, if you have what would you say contributed to

your success? Participant responses were themed as follows: (a) internal factors and (b) external factors. Of the 15 participants, 12 (80%) responded with internal factors such as controlling your emotions and taking on work that others may view as too difficult. Nine participants touched on external factors playing in role in reaching their measures of success as African American software development engineers, highlighting the necessity to establish a strong network as well as quickly identifying your advocates and adversaries.

Interview question 13. Illustrated in Figure 14, participants expressed two themes in response to IQ 13: What factors influence how you measure your success? Participant responses were themed as follows: (a) internal factors, and (b) external factors.

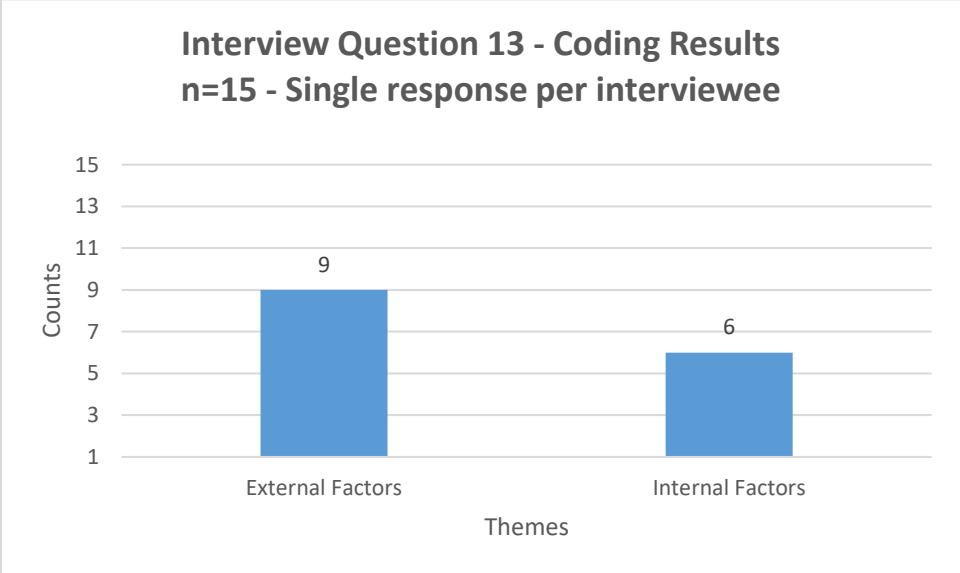

Figure 14. Themes and frequencies of responses associated with interview question 13.

Internal factors. Of the 15 participants, six (40%) responded with internal factors. P2 expressed how "past experiences" (personal communication, March 10, 2016). P5 discusses how "wanting to be relevant" (personal communication, March 14, 2016) was a driving force in shaping his ideas around measuring his success as an African American software development engineer. When asked how do you measure success P6 listed money as one of his measurements when answering IQ10 How do you measure success in your career as a software development

engineer? When asked here the question here with regard to how money became a measure he simply states: “money is a universal measurement of success” (personal communication, March 14, 2016).

External factors. Nine participants touched on the external factors as playing a role in how they came to measure success as African American software development engineers. P11 mentions family and friends playing a major role in how he measures success. During the conversation he gives insights as to why he uses his family and friends stating “I get feedback from my family and friends. Your family and friends are going to keep it real with you” (personal communication, March 23, 2016). P13 discusses how she “looks at people who other people view as successful” and that informed her parameters around how she measures success. P12 identified aspects of his background and the impact his past experiences had on his formation of measurements of success in his career. P12 gives more details around his past experiences and how it relates to his measures of success below:

> Because of my background, coming from a single parent home, coming from a home where we didn’t have a whole lot, financial as a measurement of success popped up to the top. Financial was always one of those things where, ok this is more important to me because of the past experiences I’ve had. It is all about what’s important to you. Recognition is the least important thing for me. (personal communication, March 23, 2016)

Interview question 13 summary. Participants expressed two themes in response to IQ 13: What factors influenced how you measure your success? Participant responses were themed as follows: (a) internal factors and (b) external factors. Of the 15 participants, six (40%) responded with internal factors such as their past experiences and the desire to be relevant playing a role in

how they forged their measures of success. Nine participants touched on the external factors to getting feedback from family and friends.

Research question 3 summary. Interview questions 10-13 helped the researcher explore the third research question: How do African American software development engineers measure success in overcoming the challenges of being part of an underrepresented group in the technology sector?

Participants expressed four major themes in response to the 10th interview question, IQ 10: How do you measure success in your career as a software development engineer? Participant responses were categorized as follows: (a) influence; (b) compensation; (c) longevity; and (d) confidence, self-esteem, and self-worth. Of the 15 participants, 12 (80%) expressed that they measured success as influence. Ten participants indicated that compensation is how they measured success in their careers as software development engineers. Nine of the 15 participants (60%) expressed that longevity was how they measured success in their career while only one participant expressed that confidence, self-esteem, and self-worth as a measurement of success.

Participants expressed two themes in response to IQ 12: If you have not, why do you think you have not, if you have what would you say contributed to your success? Participant responses were themed as follows: (a) internal factors and (b) external factors. Of the 15 participants, 12 (80%) responded with internal factors such as controlling your emotions and taking on work that others may view as too difficult. Nine participants touched on external factors playing in role in reaching their measures of success as African American software development engineers, highlighting the necessity to establish a strong network as well as quickly identifying your advocates and adversaries.

Participants expressed four themes in response to the 11th interview question, IQ 11: Have you achieved any of these measures of success? Participant responses were themed as follows: (a) yes and (b) no. Of the 15 participants, 13 (87%) expressed that had achieved the measures of success that they identified in IQ10. Only two of the participants indicated that they were unable to achieve any of the measures of success.

Participants expressed two themes in response to IQ 12: If you have not, why do you think you have not, if you have what would you say contributed to your success? Participant responses were themed as follows: (a) internal factors, and (b) external factors. Of the 15 participants, 12 (80%) responded with internal factors such as controlling your emotions and taking on work that others may view as too difficult. Nine participants touched on external factors playing in role in reaching their measures of success as African American software development engineers, highlighting the necessity to establish a strong network as well as quickly identifying your advocates and adversaries

Participants expressed two themes in response to IQ 13: What factors influenced how you measure your success? Participant responses were themed as follows: (a) internal factors, and (b) external factors. Of the 15 participants, six (40%) responded with internal factors such as their past experiences and the desire to be relevant playing a role in how they forged their measures of success. Nine participants touched on the external factors to getting feedback from family and friends.

Research question four. Research question four asked: Based on their experiences, what recommendations would African American software development engineers make for future African American software development engineers to be successful as part of an underrepresented group in the technology sector?

To address this question, participants were asked the following interview questions:

14. What is the best path to becoming a software development engineer today?
15. What advice do you have for African Americans who aspire to become software development engineers?
16. Why do you feel there are so few African American software development engineers?
17. What book or article on leadership would you recommend to a new software development engineer?
18. Do you see any changes taking place that will make it easier for the next generation of African American software development engineers?
19. What can companies do to solve the diversity issue in the technology sector?

Interview question 14. Illustrated in Figure 15, participants expressed one theme in response to IQ 14: What is the best path to becoming a software development engineer today? Participant responses were themed as follows: (a) education, research, and training.

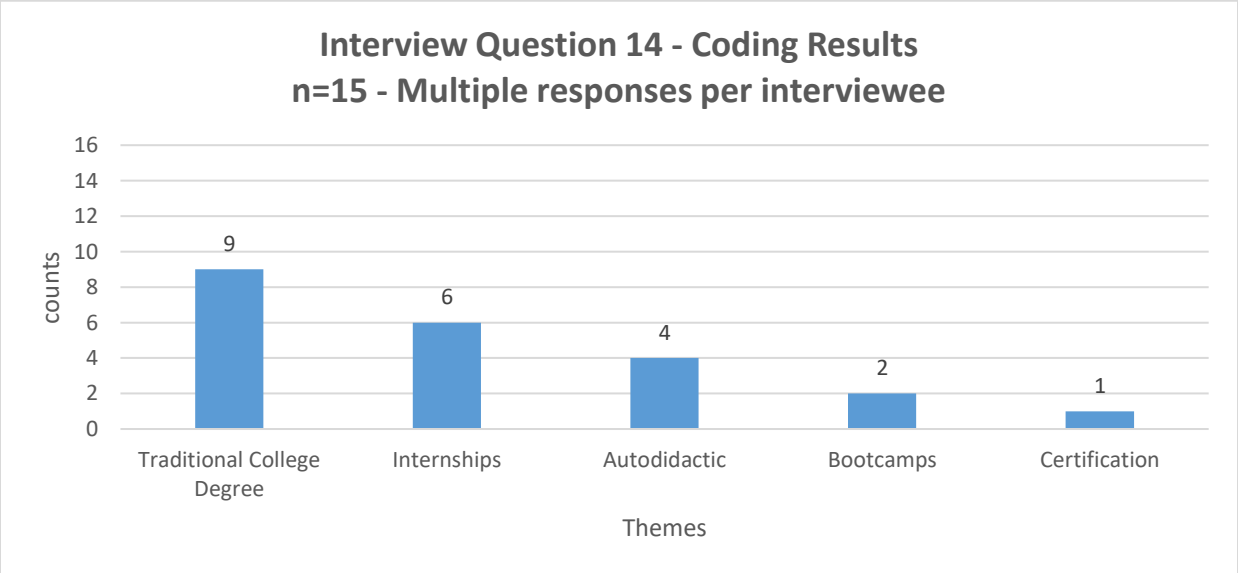

Figure 15. Themes and frequencies of responses associated with interview question 14.

Traditional college degree. Nine (60%) of the 15 participants indicated that the best path to becoming a software development engineer today was to earn a traditional 4-year college

degree in computer science. The participants gave varying methods of obtaining the necessary education ranging from earning a traditional 4-year college degree in computer science to attending an accelerated coding bootcamp. P4 explains why he feels that earning a traditional 4-year college degree in computer science is the best approach:

> I would still hold to getting a 4-year degree. I have worked with a guy who had degrees from some of these quick degree places and he just wasn't well versed. And that's what I feel about some of these nanodegrees. When I look at job requirements it specifically says that they want a bachelor of science in computer science or engineering or math, or they want that Master's degree and they may consider experience. I don't know how you are going to meet that experience requirement if you don't have a degree. I would say definitely the proper education is the way to go. Make sure you get that Bachelor of Science degree. (personal communication, March 13, 2016)

P7 also indicated that the best path to becoming a software development engineer was to earn a college degree in computer science. She passionately explains the value of a formal education in computer science

> I still think college is a very valuable way to learn how to be a developer. Because they are going to push you in the things that people do not get on their own and they don't get in bootcamps. To be a great developer you have to go through the pain. And that is why I am glad that I am back in school but it is definitely painful. People that are really passionate about algorithms, and passionate about data structures and passionate about the mathematical equations and the theories of it. And while you are going through that you think this is the stupidest crap ever and am I ever going to use it? And really in a way you don't but if you want to innovate and make something new, you actually do. And it's

> funny as a career point, people are going much faster back to those ways of you are going to get grilled really hard on algorithms, on data structures, how do you get to the middle point of a linked list? And if you're self-taught, what has happened with all of these quick ways to get places a lot of people have missed those key things. Once you have those backgrounds, everything else is made easier and you can make things more efficient and you realize where you can go. I do still feel like it is very valuable to have that education that I think it would be very difficult to get otherwise. (personal communication, March 25, 2016)

Internships. Six (40%) of the 15 participants indicated that the best way to become a software development engineer was to gain experience and gain it early.

Autodidactic. Four (27%) of the 15 respondents; P1, P3, P11, and P15 indicated that the best path to becoming a software development engineer was to learn on your own or be self-taught.

Bootcamps. Two of the participants listed bootcamps as the best way to path to becoming a software development engineer.

Certification. One participant indicated that certification was the best way to become a software development engineer.

Interview question 14 summary. Illustrated in Figure 15, participants expressed five major themes in response to the fourteenth interview question. IQ 14: What is the best path to becoming a software development engineer today? Nine of the 15 respondents; P4, P7, P8, P9, P10, P11, P12, P13 and P14 indicated that the best path to becoming a software development engineer was to earn a 4-year college degree in computer science. Six of the 15 participants indicated that the best way to become a software development engineer was to secure an

internship to gain experience and gain it early. Four of the 15 respondents; P1, P3, P11, and P15 indicated that the best path to becoming a software development engineer was to learn on your own or be self-taught (autodidactic). Two of the participants listed bootcamps as the best way to path to becoming a software development engineer. One participant indicated that certification was the best way to become a software development engineer.

Interview question 15. Illustrated in Figure 16, participants expressed three themes in response to IQ 15: What advice do you have for African Americans who aspire to become software development engineers? Participant responses were themed as follows: (a) education, research, and training; (b) leadership and interpersonal skills; and (c) emotional intelligence.

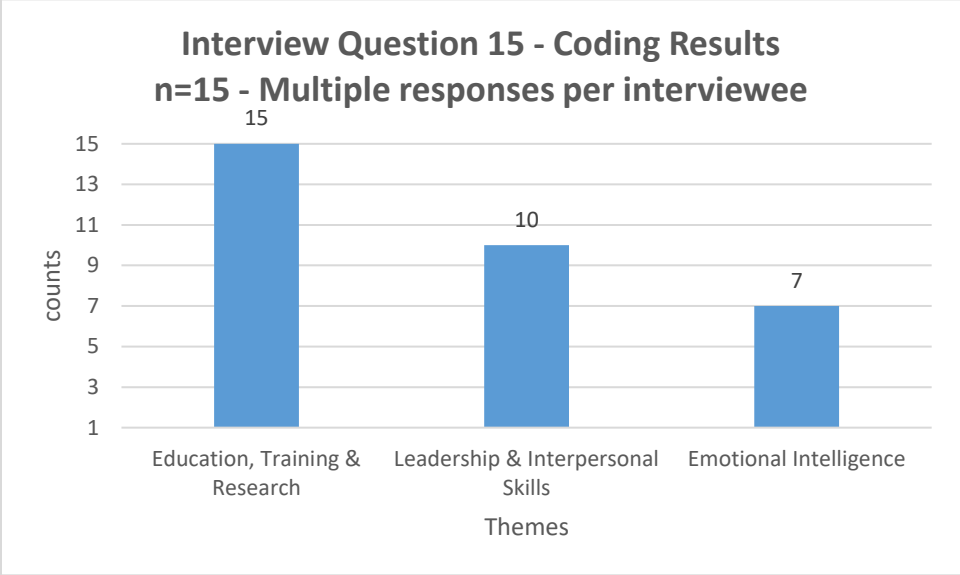

Figure 16. Themes and frequencies of responses associated with interview question 15.

Education, research, and training. Of the 15 participants, 100% indicated that some form of education, research, and training was the advice they had for African Americans who aspire to become software development engineers. Participants listed varying methods of education that could be used including bootcamps, internships, autodidactic, certification, and obtaining a formal 4-year college degree in computer science. Nine of the 15 respondents; P4, P7, P8, P9, P10, P11, P12, P13 and P14 indicated that the best path to becoming a software development

engineer was to earn a 4-year college degree in computer science. P12 clarifies why getting a 4-year degree in computer science is absolutely critical for African Americans in particular who aspire to become software development engineers. She wants aspiring African Americans to understand that:

> If you're Black the best way is the traditional approach that I took. You should try to get your degree in computer science or information technology and while you are in college you need to have an internship at a prestigious job somewhere where you want to live if possible or work at that place during the summers. I feel like that's the best approach because despite whatever accolades and with my degree in computer engineering and at the time I also had an internship at NASA, people were still turning me away from jobs, saying "Oh, you don't have enough experience." Other people get more of a pass when taking a non-traditional approach, so if you're not Black then you can go to a bootcamp and get hired and get a job as a junior developer, no problem. (personal communication, March 25, 2016)

Leadership and interpersonal skills. Of the 15 participants, 10 (67%) identified mastering leadership and interpersonal skills as advice for African Americans who aspire to be software development engineers. P3 discusses the importance of having access to quality mentorship. P6 mentioned how important it is to have a good attitude and to understand that you are going to have to "earn respect" (personal communication, March 14, 2016). P13 discussed the importance of "forcing people to see you as the expert that you are" (personal communication, March 25, 2016). Two of the 15 respondents; P2 and P8 indicated that the best advice that they could give would be to way to build your own software development shop.

Emotional intelligence. Seven participants (47%) identified developing your emotional intelligence as advice they would give to aspiring African American software development engineers. P2 laments that in order to become a software development engineer African Americans must be "ready to go against built-in prejudices" (personal communication, March 10, 2016) and P4 agrees with this sentiment and advices African Americans to "have a thick skin" (personal communication, March 13, 2016). P5 explains that to become a software development engineer and to be successful requires many hours of practice and study on your personal time. P5 clarifies this position by stating aspirants must "be passionate and like what you are doing" because you will be spending many hours outside of work honing your craft (personal communication, March 14, 2016). P13 advises that to become a successful African American software development engineer you have to learn to not take the bias personally.

Interview question 15 summary. Illustrated in Figure 16, participants expressed three major themes in response to the 15th interview question. IQ 15: What advice do you have for African Americans who aspire to become software development engineers? Participant responses were categorized as follows: (a) education, research, and training; (b) leadership and interpersonal skills; and (c) emotional intelligence. Of the 15 participants, 100% indicated that some form of education, research, and training was the best path to becoming a software development engineer. Of the 15 participants, 10 (67%) identified leadership and interpersonal skills as critical to becoming a software development engineer. Seven participants (47%) identified emotional intelligence as being an important component to becoming an African American software development engineer.

Interview question 16. Participants expressed three major themes in response to the sixteen interview question: Why do you feel there are so few African American software

development engineers? As illustrated in Figure 17, participants attributed (a) training support and opportunities, (b) cultural background, and (c) societal perceptions as general themes to why there are so few African American software development engineers.

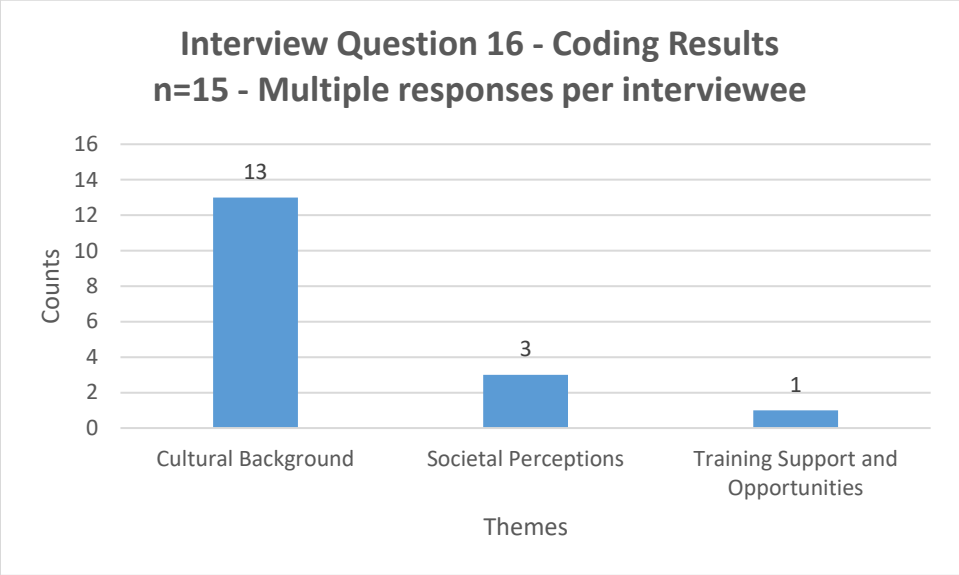

Figure 17. Themes and frequencies of responses associated with interview question 16.

Cultural background. Cultural background was identified as one of the main reasons why there are so few African American software development engineers. Of the 15 participants, 13 (87%) identified cultural background as one of the reasons why there are so few African American software developers. P6 laments that "in the Black community people think you need to be a genius to be a software developer (personal communication, March 14, 2016). P7 described that Blacks are dissuaded and discouraged from pursuing careers in software development. He further explained that "computer science is not being promoted in Black communities" (personal communication, March 25, 2016). P8 had a different response in relation to culture. His point of view was more about the culture of software organizations. He indicated that corporate software development shops are "not seen as places where we can be ourselves" (personal communication, March 21, 2016). P9 believes that computer science has a stigma in

the Black community of being too hard and P10 describes how in the Black community it is not "cool" (personal communication, March 22, 2016) to be good at math and/or computer science. P14 offers insight as to why he thinks culture is crucial

> I think that Black people have a fear of math and science. Black people have this xenophobia and it creates a bubble that Black people in America live in. Science and all of that other stuff almost looks magical to Black people. We don't look at Neil deGrasse Tyson as one of us. We don't look at Ben Carson as one of us. We look at Jay-Z as one of us. I believe that Black people learn communally as opposed to individually. Learning is an interactive process in the Black community. And so you find things that allow interactivity, like the arts, and sports and entertainment and stuff like that is where you find Black people excelling. And something else that tells them to sit down, be quiet and stare at a computer or look at a book we don't necessarily excel that well in. Black people also have this fear that if I do excel at this I will be ostracized from my own group as well as ostracized from the larger group. (personal communication, March 25, 2016)

Societal perceptions. Three (20%) of the 15 participants indicated that a societal perceptions played in role in why there are so few African American software development engineers. P2 expressed that there is a perception in society that Blacks can't do technical work. P5 indicated that Blacks are not wanted and that racism plays a role in why there are so few African Americans in software development. P13 discussed how you "you just don't see a lot of Black people doing technical things" (personal communication, March 25, 2016). P13 further explained how the media also plays a roles. African Americans needs to understand

> I also think that you just don't see a lot of Black people doing technical things. So, if it's a movie the hacker person is like a nerdy White guy then that's who you assume are

> people who can be hackers or commercials, I mean it's just like whatever media propaganda is that really, really super smart people are White and like Black people can like hip hop dance and whatever. So, I just feel like that whole, yeah, the media I think is a huge reason why Black people don't want to see themselves there and then I think like they also feel it's just too hard. (personal communication, March 25, 2016)

Training support and opportunities. Only one of the 15 participants felt that a lack of training support and opportunities were involved in why there are so few African American software developers. When answering IQ16 P11 expressed "they cut them off early, they discourage them early. The system is to blame, the educational system is to blame and also it's the Black family and Black families understanding of what the education is" (personal communication, March 23, 2016).

Interview question 16 summary. Participants expressed three major themes in response to the sixteen interview question: Why do you feel there are so few African American software development engineers? As illustrated in Figure 16, participants attributed (a) training support and opportunities, (b) cultural background, and (c) societal perceptions as general themes to why there are so few African American software development engineers. Of the 15 participants, 13 (87%) identified cultural background as one of the reasons why there are so few African American software developers. Three (20%) of the 15 participants indicated that a societal perceptions played in role in why there are so few African American software development engineers. Only one of the 15 participants felt that a lack of training support and opportunities were involved in why there are so few African American software developers.

Interview question 17. The fourth interview question in the series, IQ17, what book or article on leadership would you recommend to a new software development engineer? explores

what books or sources of information helped to shape the strategy or practices that has helped these African American software development engineers to overcome the obstacles and challenges they faced in their careers. The participants gave range of books that they found useful and the books were categorized in four major themes as illustrated in Figure 17: (a) technical; (b) business; (c) leadership and interpersonal skills; and (d) confidence, self-esteem, and self-worth.

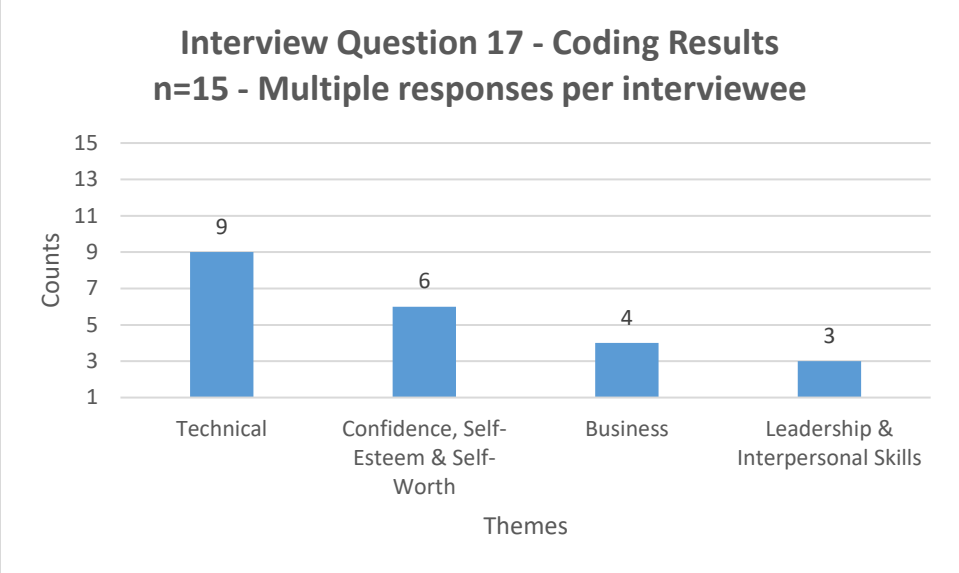

Figure 18. Themes and frequencies of responses associated with interview question 17.

Technical. Of the 15 participants interviewed, nine (60%) indicated that technical books played a major role in overcoming the obstacles they faced as African American software development engineers. When asked to give his recommendations of books that he felt would be useful to aspiring software development engineers P1 gave this passionate endorsement of *The Little Schemer* and *Structure and Interpretation of Computer Programs*:

> Paul Graham is one of my favorite authors. If I could give myself one book my favorite book of all time is *The Little Schemer* and my argument for that being the best book. *The Little Schemer* and *Structure and Interpretation of Computer Programs* those two books are the best, probably the best programming books I felt that have ever been written and

> my argument for that is you will go through all of computer science in one book, whereas if you buy a Java book you will just learn Java. (personal communication, March 10, 2016)

P14 describes the Unix Network Programming as one of the technical books that was most instrumental in his success as a software development engineer. He states: "it taught me so much about understanding how computers work" (personal communication, March 25, 2016).

Confidence, self-esteem, and self-worth. Six of the 15 participants described books that relate to their confidence, self-esteem, and self-worth. P4, P6, P8, P9, P12 and P14 all mentioned books that helped them to maintain their self-esteem and confidence while facing the obstacles and challenges that come with being an African American software development engineer. P4 listed *Brainwashed* and *The Warmth of Other Suns* as books that were helpful to him early in his career. *Powernomics* and *Blueprint for Black Power* were described by P8 when answering IQ17. P9 mentioned *The Alchemist*. P12 discussed *Good Is Not Enough: And Other Unwritten Rules for Minority Professionals* and P14 describes *The Philosophy and Opinions of Marcus Garvey* as

> the book that helped guide my philosophy is called *The Philosophy and Opinions of Marcus Garvey*. That's probably the most important book right because it guides the whole why are you even looking to them. Once you get the knowledge, build your own! (personal communication, March 25, 2016)

Business. Four of the participants described books on business that helped them to overcome the obstacles and challenges they faced as African American software development engineers. P2 described how he learned the importance of being able to look ahead and stay focused on what may be merging. He credits *The Road Ahead* by Bill Gates, a book that he read

any college that taught him a lesson that he has been benefiting from through is career. P11 stresses that African American software development engineers should consider starting their own businesses. When asked were if there were any books he could suggest he recommended *The Art of the Start*. He felt this book was important because

> it talks about how to start a business. It is written by Guy Kawasaki who used to work for Apple. So, he says stuff like don't write a business plan, create a PowerPoint and but get on with making your thing solve a problem that you're focused on. (personal communication, March 23, 2016)

Leadership and interpersonal skills. Three participants, P6, P10, and P13 described books that specifically addressed leadership and interpersonal skills that participants believed were helpful in being successful as software development engineers. P6 described Leadership and Self Deception. P10 expressed the importance of having good social and people skills and recommend *How to Win Friends and Influence People.* P13 agrees. The two books she suggested were *The Platinum Rule* and *Soft Skills*. She was particularly exuberant about how recommendation of *Soft Skills: The Software Developer's Life Manual* and shared that:

> I really recommend that one because it touches on the various aspects that when you're starting out you don't really you're just happy to have a job and you're still thinking in that job mindset instead of thinking about your career and looking at yourself as your own brand and I think once you adopt that mentality where you're a brand then you start to make more strategic decisions and it's easier for you to move on when something isn't working in harmony with your brand. Just like Nike will drop Sharapova in two seconds because she accidentally failed that drug test because that's not in harmony with their brand. (personal communication, March 25, 2016)

Interview question 17 summary. The fourth interview question in the series, IQ17, what book or article on leadership would you recommend to a new software development engineer? explores what books or sources of information helped to shape the strategy or practices that has helped these African American software development engineers to overcome the obstacles and challenges they faced in their careers. The participants gave range of books that they found useful and the books were responses were categorized in four major themes as illustrated in Figure 17: (a) technical; (b) business; (c) leadership and interpersonal skills; and (d) confidence, self-esteem, and self-worth. Of the 15 participants interviewed, nine (60%) indicated that technical books played a major role in overcoming the obstacles they faced as African American software development engineers. Four of the participants described books on business that helped them to overcome the obstacles and challenges they faced as African American software development engineers. Three participants, P6, P10, and P13 described books that specifically addressed leadership and interpersonal skills that participants believed were helpful in being successful as software development engineers.

Interview question 18. Illustrated in Figure 19, participants expressed two major themes in response to IQ 18: Do you see any changes taking place that will make it easier for the next generation of African American software development engineers?

Participant responses were themed as follows: (a) Yes and (b) no.

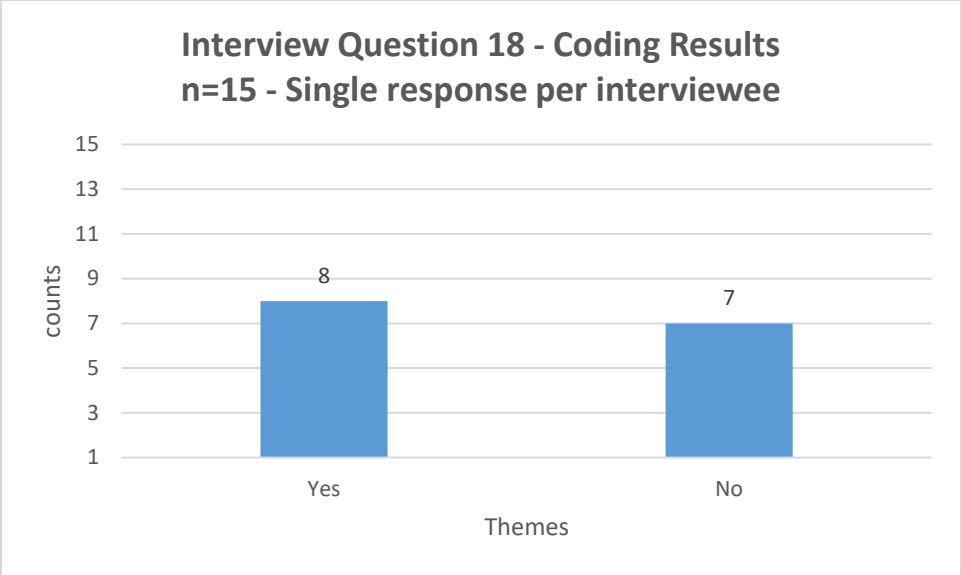

Figure 19. Themes and frequencies of responses associated with interview question 18.

Yes. Of the 15 participants, eight (53%) expressed that they do see changes taking place that would make it easier for the next generation of African American software development engineers. P3 discusses how he sees that

> there is an outreach for Blacks in STEM and so I am optimistic that they would have it better. I do see a lot of junior Black kids in the industry. I know some young programmers that are very good and very motivated, so I am optimistic. I am optimistic that things will improve. (personal communication, March 14, 2016)

P4 asserts that

> right now the answer to that question is the industry has recognized that the Black American, the Black resource is missing and so many of them are seeking us out, they are looking for us and they're saying that we don't exist, and so there are programs out there to help them develop us. (personal communication, March 14, 2016)

P13 does agree that things are getting better but only "to an extent" (personal communication, March 25, 2016). She explains

> I think that the conversation is taking place out in the open, and I think that helps some people who want to change, see there is a problem and try to change. I think that may help if you happen to interview with that one person. But in general, no I don't think there is oh, just do normal thing, the same things a White person does and you will have the same amount of success, no I don't think so. (personal communication, March 25, 2016)

No. Seven of the participants indicated that they did not see any changes taking place that would make it better for the next generation of African American software development engineers. P1, P2, P6, P7, P8, P10, and P12 all expressed that they did not see any changes taking place that would make it better for the next generation of African American software development engineers. P10 lamented that he does see changes taking place but laments that he is not sure if these efforts will make a difference in the Black community. He shares that

> It's nice that it's becoming a hot field and some of the stigmas that used to be attached to it are starting to fall off, but uh, you know maybe. It seems like they're trying to push it as early as elementary school and maybe some people will wake up to that and reach out to it whereas before they wouldn't have. But what I'm really looking for is a role model and I don't really see that yet. I just see it's kinda the movement that everyone needs to code and we need to hire more women and that's great and all but I don't really see the outreach that I'd like to the Black community. (personal communication, March 22, 2016)

P8 was harsher in his evaluation. He explains how he believes the current efforts are "trivial and mediocre" and suggests that "a lot of times the effort is not completely there and it's not always as genuine as I think it should be and it may not be as well thought out as it should be" (personal

communication, March 21, 2016). P8 went on to question the motives of these efforts. He believes that

> If they wanted to hire more Blacks to get into the field or encourage more Blacks to get into the field there are ways to do that. They can bring around individuals like you and individuals in other disciplines that are Black experts. There are Black psychologist that have studied and worked with Blacks that talk about this a lot. Someone I am thinking about is Jawaanza Kunjufu. He talked about this on Donahue probably twenty or thirty years ago how do we get more Black computer scientists? You need to bring in those type of individuals who have studied Black people for so long and they have identified these issues long ago. If you want to be serious about it. (personal communication, March 21, 2016)

Interview question 18 summary. Participants expressed two major themes in response to IQ 18: Do you see any changes taking place that will make it easier for the next generation of African American software development engineers? Participant responses were themed as follows: (a) yes and (b) no. Of the 15 participants, eight (53%) expressed that they do not see any changes taking place that would make it easier for the next generation of African American software development engineers. Seven of the participants indicated that they did not see any changes taking place that would make it better for the next generation of African American software development engineers.

Interview question 19. Participants expressed four themes in response to the final interview question, IQ 19: What can companies do to solve the diversity issue in the technology sector? As illustrated in Figure 20, in four major themes emerged: (a) organizational culture, (b) create opportunities, (c) authenticity, and (d) nothing.

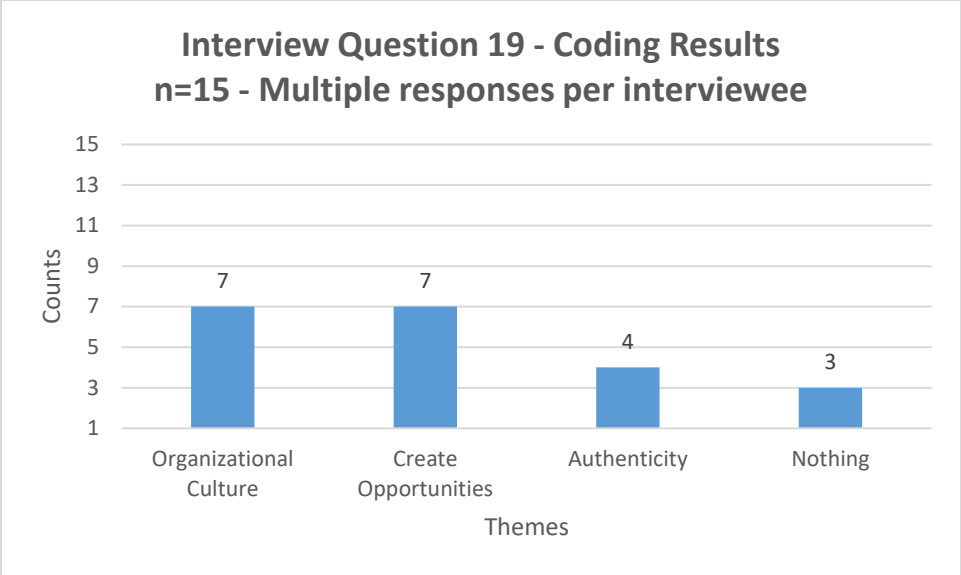

Figure 20. Themes and frequencies of responses associated with interview question 19.

Organizational culture. Seven of the 15 participants (47%) expressed that changing the organizational culture is something that companies can do to solve the diversity issue in technology. When asked IQ19, P1 recommended that companies create a meritocracy and reward people for their ideas. He informs us that

> Work in general needs to move more towards a meritocracy and pure meritocracy. Because Black people for many different reasons we're kinda like an honor culture. And if we come up with an idea, we want to be able to blog about it, we want it to be ours and we want to be compensated we don't want to be ripped off. And that happens in a true meritocracy. We don't believe that we're going to get a fair shake any other way. We're not going to get it because of some network or because one of our cousins is a high ranking person. So, we want it to be fair. Our ideas need to be ours and we need to be rewarded for them. (personal communication, March 10, 2016)

P3 simply states "promote more Black people" (personal communication, March 14, 2016). P7 asserts that companies need to take a harder look at bias and create a culture where employees are not punished for advocating for diversity in the workplace. P12 asserts that companies should

also bring more minorities into management roles and bring strong and open minded people into management. P13 suggests that companies should consider changing the wording that they used when they put out a job posting. She also believes that companies need to bring in a dedicated group of people who care about diversity and that they should try to create environments that lead to diversity so that "once they hire someone, instead of having that person feel alone and uncomfortable and eventually leave or be pushed out" (personal communication, March 21, 2016).

Create opportunities. Seven participants indicated that creating opportunities is something that companies can do to solve the diversity issue in technology. P5 was very specific in his answer with regard to how to create these opportunities suggesting that companies should "pay for it" (personal communication, March 14, 2016). When asked why thinks companies should pay he elaborated on this position:

> I think one incentive that companies can do is pay for it. I think that they have the need. They say they need more Blacks in technology. Then put your money where your mouth is and build development training programs specific to company needs, specific to what that particular organization is looking for in a developer. Come up with a two- year development strategy for getting that person from novice to being useful in their organization. And put the money there. Get people into those programs by not charging them a dime and phase it out so that if they reach a certain phase they can start earning money. (personal communication, March 14, 2016)

P6 agrees that it is critical to create opportunities for African Americans in software development especially entry level positions. P6 expresses that companies should create entry level positons

for them and he explains why this is so important to African Americans who aspire to be software development engineers:

> I really hope and pray that the day comes in America when many of these big companies would deliberately choose to create even if only one or two entry-level positions. I want to see a kid learn and be given a shot knowing that he or she just finished training. That they need to get exposed to the industry. Even if you pay them $15.00 an hour rather than $35.00. Give them that opportunity. Because I will tell you why. You see African Americans are up against the average White guy who because of the color of his skin will potentially be given a break. And the average Indian guy who because the information technology industry in particular is so overloaded with Indian managers that they would deliberately bring him on knowing that he probably doesn't even have one year of experience under his belt, but they will tell him what to do. (personal communication, March 14, 2016)

P10 believes that reskilling people is one way that companies can create opportunities that will help to solve the diversity issue in technology. He believes that "they should reach out to people that are underemployed and I think they should take a close look at transferrable skills" (personal communication, March 22, 2016). P11 touts the benefits of internship programs and describes how his daughter has benefitted from landing an internship.

> She wrote Python for 3 ½ months and they paid her good money and gave her a stipend of $5,000 for housing. She is going back this year at a higher salary and she is going to write iPhone apps. She will be using Objective C and Swift. (personal communication, March 23, 2016)

Authenticity. Of the 15 participants, four (27%) cited authenticity when asked can companies do to solve the diversity issue in the technology sector. P10 asserts that technology companies need to be sincere in their efforts. P13 suggests that technology companies should accurately document their diversity numbers. P8 informs us that one of the things technology companies can do is to "get serious about understanding the problem" (personal communication, March 21, 2016). P4 gives more insight about how companies can demonstrate their authenticity by responding that companies are "going to have to go into the hood" (personal communication, March 20, 2016). When pressed about how this would make a difference P4 explained the importance of exposure and told the following story of opportunity:

> I got my foot in the door because AT&T reached out to an HBCU. Because this problem was going on 15 years ago. I was finishing my computer science degree at Prairie View A&M University and AT&T came over there and said we want to get one of your best students and we want to give him this coop. He is going to work for us for 6 months and we will get his feet wet. I went and did it and that is how I got started. I became a junior software engineer working in San Antonio, right off Broadway for a Black-owned company. And what I did, I took it and ran with it. I started going part-time over at UTSA and continued my degree. It was only supposed to be 6 months but it turned into 34 months for me. So, I think they are going to have to go into these HBCUs and they are going to have to go into the hood. The same way that they go and get these athletes. They are going to have to go and seek them out. I really think that is the most effective way, the quickest way. (personal communication, March 20, 2016)

Nothing. Only two participants, P2 and P14, responded to this question from a completely different perspective. Their response indicates that they feel that there is nothing for technology

companies to do to solve the diversity issue. P2 indicated that the government should play a major role and make it a requirement to hire African Americans in these positions. P14 had a different perspective although he agrees that there is nothing that technology companies can do. However, instead of placing the burden on the government he places it squarely on the shoulders of Black people. When asked to elaborate on his position he gave a deeper insight to his premise

> My problem is the question is misleading. I don't believe that there is anything that they can do. I don't want them to do anything. I think that if they do anything that they do will hurt more than help. I think that individuals can build tech companies to solve problems in their environment. (personal communication, March 25, 2016)

Interview question 19 summary. Participants expressed four themes in response to the nineteenth and final interview question, IQ 19: What can companies do to solve the diversity issue in technology? Participants named (a) organizational culture, (b) creating opportunities, (c) authenticity, and (d) nothing. Seven of the 15 participants (47%) expressed that changing the organizational culture is something that companies can do to solve the diversity issue in technology. *Seven* participants indicated that creating opportunities is something that companies can do to solve the diversity issue in technology Of the 15 participants, four (27%) cited authenticity when asked can companies do to solve the diversity issue in the technology sector. Only two participants, P2 and P14, responded to this question by citing that there is nothing that companies can do to solve the diversity issue in technology.

***Research question 4 summary*.** Six interview questions helped to explore the final research question. Based on their experiences, what recommendations would African American software development engineers make for future African American software development engineers to be successful as part of an underrepresented group in the technology sector. For

IQ14, participants expressed one major theme in response to the fourteenth interview question. IQ 14: What is the best path to becoming a software development engineer today? All 15 (100%) of the respondents indicated that education, research and training is the best path to becoming a software development engineer today. Four of the 15 respondents; P1, P3, P11, and P15 indicated that the best path to becoming a software development engineer was to learn on your own or be self-taught. Six of the 15 participants indicated that the best way to become a software development engineer was to gain experience and gain it early. Two of the participants listed bootcamps as the best way to path to becoming a software development engineer. One participant indicated that certification was the best way to become a software development engineer and another participant indicated that internships was the best path. In response to IQ15, participants expressed three major themes in response to the fourteenth interview question. IQ 15: What advice do you have for African Americans who aspire to become software development engineers? Participant responses were categorized as follows: (a) education, research, and training; (b) leadership and interpersonal skills; and (c) emotional intelligence. 100% indicated that their institution lacked a specific policy that addressed cyber-harassment. Additionally, participants indicated that cyber-harassing behaviors would be addressed within the context of the institution's existing policies. Of the 15 participants, 100% indicated that some form of education, research, and training was the best path to becoming a software development engineer. Of the 15 participants, 10 (67%) identified leadership and interpersonal skills as critical to becoming a software development engineer. Seven participants (47%) identified emotional intelligence as being an important component to becoming an African American software development engineer. When asked IQ16, participants expressed three major themes in response to the sixteen interview question: Why do you feel there are so few African American software

development engineers? As illustrated in Figure 16, participants attributed (a) training support and opportunities, (b) cultural background, and (c) societal perceptions as general themes to why there are so few African American software development engineers. Of the 15 participants, 13 (87%) identified cultural background as one of the reasons why there are so few African American software developers. Three (20%) of the 15 participants indicated that a societal perceptions played in role in why there are so few African American software development engineers. Only one of the 15 participants felt that a lack of training support and opportunities were involved in why there are so few African American software developers. The fourth interview question in the series (IQ17, What book or article on leadership would you recommend to a new software development engineer?) explores what books or sources of information helped to shape the strategy or practices that has helped these African American software development engineers to overcome the obstacles and challenges they faced in their careers. The participants gave range of books that they found useful and the books were responses were categorized in four major themes as illustrated in Figure 17: (a) technical; (b) business; (c) leadership and interpersonal skills; and (d) confidence, self-esteem, and self-worth. Of the 15 participants interviewed, nine (60%) indicated that technical books played a major role in overcoming the obstacles they faced as African American software development engineers. Four of the participants described books on business that helped them to overcome the obstacles and challenges they faced as African American software development engineers. Three participants, P6, P10, and P13 described books that specifically addressed leadership and interpersonal skills that participants believed were helpful in being successful as software development engineers. Participants expressed two major themes in response to IQ 18: Do you see any changes taking place that will make it easier for the next generation of African American software development

engineers? Participant responses were themed as follows: (a) yes and (b) no. Of the 15 participants, eight (53%) expressed that they do not see any changes taking place that would make it easier for the next generation of African American software development engineers. Seven of the participants indicated that they did not see any changes taking place that would make it better for the next generation of African American software development engineers. Participants expressed four themes in response to the nineteenth and final interview question, IQ 19: What can companies do to solve the diversity issue in technology? Participants named (a) organizational culture, (b) creating opportunities, (c) authenticity, and (d) nothing. Seven of the 15 participants (47%) expressed that changing the organizational culture is something that companies can do to solve the diversity issue in technology. *Seven* participants indicated that creating opportunities is something that companies can do to solve the diversity issue in technology Of the 15 participants, four (27%) cited authenticity when asked can companies do to solve the diversity issue in the technology sector. Only two participants, P2 and P14, responded to this question by citing that there is nothing that companies can do to solve the diversity issue in technology.

Summary

The first five interview questions helped to explore the initial research question: What professional and career challenges have you faced as an African American software development engineer? From the coding, themes for strategies and best practices emerged. As the first interview question revealed, 15 of the 15 participants (100%) believed that they have faced unique challenges as African American software development engineers. Some of the obstacles faced by the participants include societal perceptions, lack of training, cultural background, confidence, and leadership. Most software development engineers who participated in this study

believed that these obstacles have hampered their professional and career growth as it relates to upward mobility or opportunities for promotion. 86% of the participants described education as the key to success for software development engineers. Eleven of the 15 participants expressed that they would have done something differently when reflecting upon their careers.

Four interview questions helped to explore the second research question: What strategies and practices have you employed to overcome your professional and career challenges as an African American software development engineer? Software development engineers identified societal perceptions, training support and opportunities, cultural background, confidence, self-esteem, and self-worth, and leadership qualifications and interpersonal skills as major strategies and practices. Most of the participants indicated that part of their strategy to overcome obstacles including networking and joining organizations. Most of the respondents however, had not received any mentoring during their career.

Interview questions 10-13 helped the researcher explore the third research question: How do African American software development engineers measure success in overcoming the challenges of being part of an underrepresented group in the technology sector? Most software development engineers measured success in terms of influence, longevity, compensation, and confidence, self-esteem and self-worth. Most of the participants indicated that they achieved some of their measure of success. Those that had not achieved the measures of success admitted that it was due to their lack of focus or dedication to their craft. Most the software development engineers expressed that internal factors influenced how they came to measure success. The final five interview questions helped to explore the last research question: Based on their experiences, what recommendations would African American software development engineers make for

future African American software development engineers to be successful as part of an underrepresented group in the technology sector?

African American software development engineers echoed many of the themes examined in the previous research questions, reemerging the notion of the complexities of being an underrepresented African American software development engineer in corporate America.

Chapter 5: Conclusions and Recommendations

Software engineering is a very rewarding and challenging career, and being successful in this role as an African American requires much more than simply having an aptitude for science and technology. Recently in the field of computing, there have been many efforts on many fronts to increase the number of women and minorities who pursue careers in technology and software development, yet there is little research on why there are so few Hispanics, Native Americans, and African Americans pursuing careers in software development (Charleston, 2010). In order to contribute to literature in the field, this study served to contribute valuable and worthwhile knowledge to aid African Americans who aspire to become software development engineers. Moreover, the results of this study will also provide technology companies, schools, universities, and African American communities with resources and information that can be used to create opportunities and environments that produce quality African American software development engineers that will enhance the creativity and innovation of their respective companies.

This chapter serves to discuss the conclusions and recommendations of the study. A summary of the study will be presented along with a discussion of the findings and a look at implications for various groups. Additionally, recommendations for future research will be shared and the chapter will conclude with final thoughts regarding the study.

Summary of the Study

The purpose of this study is to determine what can be done to encourage more African Americans to become software development engineers. The literature review provided the contextual background needed to create the four intentional research questions and 19 open-ended interview questions. This study employed a qualitative research design with a

phenomenological approach, which is used to study the significance of human experiences from the perspective of the individual who lived the experience (Locke, 2004; Moustakas, 1994).

For the purpose of this study African American software development engineers were defined as individuals who had obtained at least a 4-year degree in computer science or a related discipline, currently held a position as a professional software development engineer in an American company, and had been a professional software development engineer for at least five years. Fifteen interview participants were selected by a purposive sampling approach with a maximum variation sampling in order to find shared patterns spread throughout individual experiences. This method was determined to be a valuable practice as it allowed themes to develop from heterogeneity (S. Isaac & Michael, 1997; McMillan & Schumacher, 2006). The criteria for maximum variation identification in this study included: position title, industry (public or private), geographic location, age, gender, educational achievement, marital status, and family background.

To answer the four research questions, an interview instrument was developed and subsequently validated by two Pepperdine doctoral candidates who served as inter raters, as well as an expert panel. Semi-structured interviews were conducted with 15 participants. The raw data was in the form of interview transcripts, which were transcribed from the audio recordings of the semi-structured interviews. To determine coding, the researcher and the two inter-rater reviewers utilized inductive content analysis. Once the transcripts were coded, themes began to emerge. Inter-raters were critical to this study as they strengthened the study's reliability. Results of the coding were reviewed by the researcher who then provided them to the inter-raters to review and provide suggestions. The results of the analyses were examined with proposed themes, which were resolved and accepted. Finally, these findings were presented in Chapter 5.

Discussion of the Findings

The findings of this study were specifically geared toward African American software development engineers. Throughout the following sections, results of the study will be reviewed. Additionally, analysis focused further on specific themes that stood out in each respective research question and how these may relate universally to African American software development engineers.

Results for research question one. Research question one asked, What professional and career challenges have you faced as an African American software development engineer? To answer this question, a focus was placed on African American software development engineers and their ability to effectively:

- Deal with the cultural barriers that are present in corporate America for African Americans who are part of a software development team, which is part of a larger corporate information technology department, and how to deal with these barriers in a way that does not hinder your career path;
- Being able to handle the isolation of being the only African American on your team and learning how to handle situations that you have never faced without the luxury of having a mentor or someone who has already traveled the path;
- Be prepared to be seen as an individual who is not capable of performing the work. African Americans in the field of software development must expect to have to prove themselves in ways that their contemporaries do not. They must be able to handle the double standard and learn to persevere while watching others who are less qualified ascend;

- Be able to communicate effectively. African American programmers not only have to be able to understand what messages are being communicated to them, but they must also be able to communicate effectively in order to ensure that others on the team recognize their expertise and be willing and able to demand the respect and credit that is due to them. Soft skills are even more important than the technical skills needed to perform the work;
- Maintaining your confidence is important because the journey to becoming a software development engineer is rife with opportunities for discouragement.
- Acquiring and maintaining education and technical skills is paramount. If an African American software development engineer is able to overcome the obstacles and challenges faced they must at the end of the day have the ability to get the work done in an efficient and innovative fashion. Without the ability to do the work, the other concerns become moot.

Analysis of research question one. Based on the themes that emerged from this research question, with 13 instances of it (27%) mentioned within responses for its respective interview question, it was evident that acquiring and maintaining education and technical skills was one of the top challenges associated with being an African American software development engineer.

The findings from the four interview questions address research question one. Throughout their reflective narratives, four aspects of acquiring and maintaining educational and technical skills stood out from the interviewee responses:

1. Being willing to work during non-working hours in an effort to stay relevant and up-to-date in a field that is constantly changing is a huge part of acquiring and maintaining technical skills in this field.

2. You have to be willing to invest in yourself when it comes to learning. It is not always the responsibility of your company to train you, if you wish to learn something new that you think will be relevant in the future, be willing to invest in yourself to get that training.
3. The amount of reading that is required to keep up in this profession. Software developers are constantly reading in order to dive deeper into a technology or learn something new. If you do not have a love for reading this will be a very tough career in which to thrive.
4. In reflecting upon daily experiences with regard to maintaining technical skills, one participant discussed how she felt the need to take the road less traveled. She spoke about how she would be willing to do the hard work or to do the things and work on the projects that others were not willing to do. Her idea was that everyone was spending time learning the same technologies while she focused learning those technologies that no one was learning so that when the time came for someone to have expertise in that she would be one of the few if not the only one who could answer the call. As a result, she has always been in a position to offer something of value and relevancy as a software developer. Although this may seem challenging to a new software developer, this is an excellent strategy for a couple of reasons. First in many cases in order to learn the more advanced skill requires you to master the more fundamental knowledge, so you are still learning what other developers are learning but you are simply using that knowledge as a starting point as opposed to the endpoint. And you are learning it all as one process. When the rest of the team or other developers decide to move to the next step you are already there and positioned

as knowledgeable on the subject. It is a great way to demonstrate drive and ambition as well as differentiating yourself as having knowledge in an area that no other developers on the team has yet to broach. Secondly, confidence is a key component of being successful as an African American software developer. The more confidence you can build early the more prepared you are to withstand attacks on your ability later. Taking on the hard challenges is a great way to continue to build your confidence. This is especially critical for new software development engineers especially if you are African American because you are always being asked to prove yourself. You are doubted from the moment you walk into the position by your peers. However, the moment they realize that you understand something that they don't, or that you have solved something that they could not Figure out, then a level of respect is earned and you will have gone a long way to overcome one of the biggest obstacles to being an African American software development engineer.

Results for research question two. Research question two asked, What strategies and practices have you employed to overcome your professional and career challenges as an African American software development engineer? To answer this question, a focus was placed on African American software development engineers and their ability to effectively:

- Maintain a personal brand that aligns with the brand of their team and employer;
- Remove their emotions from situations they may encounter in the workplace that are unfair, demeaning, and discouraging;
- Develop their communication skills, and being able to identify advocates and adversaries very early in the process of joining a team, project or company;
- Maintain your confidence, self-esteem and self-worth; and

- Dedicate yourself to methods of continuing education.

For example, P13 spoke to the need for enhanced communication skills. She revealed the importance of documenting your successes and engaging others in your successes. It is critical to receive external validation for your work. One can do this by expanding their network. Not only should African American software development engineers develop and enhance their communication skills, they should also develop their emotional intelligence as well. One must understand and be aware of what others are thinking of you in the workplace. And it is absolutely critical to develop "thick skin" and become impervious to all of the negative commentary and remarks that may come your way. As an African American software development engineer, one must absolutely be able to control your emotions in the workplace.

Analysis of research question two. Based on the themes that emerged from this research question, it was determined that the findings from the four interview questions asked did address research question two. With nine instances (34%) of this theme mentioned, it was evident that having a high level of emotional intelligence is vital for African Americans to be successful as software development engineers. Interview participants overcame the challenges mentioned in RQ2 through creating a professional personal brand, developing a high level of emotional intelligence, developing sophisticated communication tactics, developing and maintaining their confidence, self-esteem, and self-worth, and continuing to improve their education and enhancing their technical skills.

Throughout their reflective narratives, three aspects of the importance of African American software development engineers having a high level of emotional intelligence stood out from interviewees responses:

1. African American software development engineers may need to be less aggressive when presenting their ideas, as enthusiasm for your ideas may be perceived incorrectly. Also, it has been reported that ideas coming from African American software development engineers are rejected not based on merit but based on the source of the idea;
2. Try to be less of a threat. Work to make yourself more approachable to the larger community. This speaks once again to the issue of cultural incongruence. Often times African Americans are required to shun their culture in order to fit into the work environment; and
3. Having a thick skin and being able to manage your emotions is critical to surviving as a software development engineer as this will allow you to overcome the biases and prejudices that you will face. The perception is that as an African American you are not smart enough to do the work. As this may infuriate the young African American developer he/she or must learn to control their emotions and not let these biases deter them from reaching the heights they are pursuing.

Based on the results of this study, to equip African American software development engineers with the tools needed to be successful in their careers, the researcher suggests that topics focused on areas such as White supremacy and critical race theory, Black psychology, and the overall history of the African experience in America particularly as it relates to science and technology be discussed. It is imperative that any young African American entering into the workforce have an understanding of what they are dealing with in regard to societal perceptions of who and what they are. These topics are not readily available in workshops, symposiums, or seminars. The best options for learning these lessons or gaining this knowledge will be in the

form of books and/or mentorship from those who have already studied and/or experienced these conditions.

Building a mentorship organization that fosters communication between seasoned African American software development engineers and those who are new to the profession may help develop relationships and transmit the knowledge needed in order for the next generation of African American software development engineers to more easily navigate the terrain of technology companies. This knowledge is not readily accessible via books, seminars, or workshops. This suggestion comes from mentorship being evidenced in the list of themes that emerged from research questions one and five. However, in order for this to work there has to be a willingness by those who have successfully navigated these waters to be open to sharing their experiences and knowledge to those that come behind them. It has been mentioned on several occasions to the researcher during this study that often times this is not the case and that may be part of the reason why only 40% of the participants in this study indicated when responding to IQ9 that they had not received any form of mentorship.

Results for research question three. Research question three asked, How do African American software development engineers measure success in overcoming the challenges of being part of an underrepresented group in the technology sector? To answer this question, a focus was placed on African American software development engineers ability to influence others, maintain longevity in their careers, to continue to improve their compensation packages, as well as how the feel about where they are in their careers. This question also got to the core of whether African American software development engineers are more motivated in their success more from within or from material successes. For example, P6 stated that he measures his success by what he calls his internal barometer of confidence. As a result, these conversations

will highlight the ambitions of new African American software development engineers entering into the corporate technology workspace.

Analysis of research question three. Based on the themes that emerged from this research question, it was determined that the findings from the four interview questions asked did answer research question three. With 14 instances (25%) of it being mentioned, it was evident that money was the key component interview participants listed that African American software development engineers used to effectively measure their success. Interview participants emphasized the importance of having a positive impact on the organization and being able to influence others through their knowledge and work. Throughout their reflective narratives, two aspects of money as a measurement of success stood out from interview participant responses:

1. Most of the other measures that were listed as a measurement of success were ultimately only as an indicator for money. For example, some participants mentioned title as a measure of success, however, only if the title lead to more money. Title was really a measure of money
2. Many of the participants interviewed come from impoverished backgrounds and it was the promise of earning a good salary as a software development engineer that led them to these careers initially.

Results for research question four. Research question four asked, Based on their experiences, what recommendations would African American software development engineers make for future African American software development engineers to be successful as part of an underrepresented group in the technology sector? To answer this question, a focus was placed on African American software development engineers having opportunities for education, research, and training, honing their leadership and interpersonal skills, developing their emotional

intelligence, having opportunities for training and support, overcoming societal perceptions, overcoming cultural differences, studying and researching the corporate workplace as it relates to being African American, studying the technologies of the day, dealing with organizational culture at technology companies, recognizing whether or not technology companies are authentic in their efforts to improve the situation, and creating opportunities for African Americans to pursue careers as software development engineers. For example, P3 emphasized the importance of having a mentor. This is a dilemma for African American software development engineers. Since there are not very many African American software development engineers to choose from many are forced to be mentored by professionals from other ethnic groups. However, the big gain from having a mentor for African American software development engineers is to be shepherded by someone who has already faced the challenges and pitfalls they he or she may encounter. Someone from another ethnic group may not have had these same experiences. Another issue with the needed mentorship is that those who are in position to be excellent mentors to the next generation of African American software development engineers are not always willing to do so.

Analysis of research question four. It was determined that the findings from the six interview questions asked did answer research question four. Primarily, it is imperative for aspiring African American software development engineers to focus their efforts on becoming knowledgeable about the circumstances they may face and work to prepare themselves to be ready to meet these challenges. Areas where African Americans should focus these efforts are (a) an emphasis on technical education particularly math and science, (b) corporate communication skills that allow you to understand what is happening in your environment and being able to communicate your desires and abilities effectively, (c) an awareness of the biases that they may

face and an ability to meet this in a professional manner and not let it take away from the quality of the work, (d) African American communities that have a negative perception of what it means to be a software development engineer and what it takes to become a software developer, and (e) an understanding of the organizational culture at corporate technology companies and how to overcome the isolation and still be able to perform in a way to thrive.

With regard to African American culture, it is important that the narrative in these communities change. Currently there is a culture that suggests that it is too difficult to become a software development engineer. Moreover, there is also a lack of exposure in these communities of the possibility of being a software development engineer. These communities need to be made aware of the possibilities. The young people in these communities should be afforded the opportunities to explore what it would be like to be a software development engineer. And the notion that the areas of science and technology is only for nerds and geeks needs to be removed or at the very least replaced with an image of the African American software development engineer as someone who is culturally relevant to the African American community.

Being ready to face the biases as an African American software development engineer is a crucial component in being successful. As young African Americans come into this career they need to have an understanding that whether or not they are promoted or given credit for their work is not always based solely on the quality of their work. There must be a mental muscle that is developed that allows you to not only focus on the work that you are doing but not to become frustrated with the situation that you are in. It is very difficult to be creative and stressed at the same time. African American software developers can't let these conditions discourage them if they are going to be successful. It is important to understand that in most cases these biases are not personal and are based on ignorance and as you continue to do quality work and prove the

stereotypes wrong these types of barriers will dissolve. This is a skill that must be developed. The best way for aspiring African Americans to acquire this skill is by working with a mentor. Another way to learn how to handle these biases is to read the memoirs of famous African Americans in technology and read how they described how they overcame this issue. One of the best books on this subject, which was listed in responses to RQ4 *Brainwashed* by Tom Burrell. It is critical that aspiring African American software development engineers understand that they not only need a superior technical education but they must also be educated on the historical and social context of the challenges they will face and how to overcome them.

Implications of the Study

As the study began to conclude, it was evident that many implications from it will benefit aspiring or current African American software development engineers. In addition, it can offer guidelines for corporate information technology departments to consider in determining how to best recruit and retain African American software development engineering talent to their organizations.

- *Be World Class:* "You have to tinker. And you have to read the absolute best people on the subject. Don't read people who are bozos or just secondary. Read world class people and tinker, that's it" (P1, personal communication, March 10, 2016). This practice can be in form of subscribing to blogs of those who are known to be world class. These blogs provide knowledge about the craft of software development and/or the technology that the aspiring individual aspires to master. The benefit here is that you are learning from the primary source and not getting an interpretation from those who may or may not be reading from the primary source. The learning should be accelerated.

- *Create your own:* “I think that individuals can build tech companies to solve problems in their environment. Anything that they can do, we have the ability to win gold in” (P14, personal communication, March 25, 2016).
- *Be prepared:* “Pay attention not just to what is happening in your technology, but pay attention to what is happening in the industry. You have to be able to learn the new technology as the industry is transitioning toward it in order to remain relevant” (P2, personal communication, March 10, 2016).
- *Do for self:* “We cannot wait for corporate America to accept us” (P2, personal communication, March 10, 2016).
- *Learn the craft of software development:* “Learn your craft, learn your craft, learn your craft” (P2, personal communication, March 10, 2016).
- *Get a good mentor:* “Get yourself a good mentor, whether he is Black, White or otherwise. Pick up on his code base. Look at what he’s done. Get someone that’s good. See if you can get access to some of his old code and see how he does things and mimic that and that will start giving you your own style” (P3, personal communication, March 14, 2016).
- *Be passionate:* “Don’t look at this as I’m doing this for money. That’s the wrong way to look at it. Because if you don’t like doing it and you can’t make yourself like doing it, then money ain’t going to mean nothing. You have to have a love for this type of stuff. If you are good at it the money will come” (P3, personal communication, March 14, 2016).
- *Don’t do it for money:* “Don’t go for money early, don’t worry about how much you’re going to make early when you’re first getting your feet wet, get you some

good experience. Go find a good company to work for that is going to actually let you do work. Not just let you sit there and support somebody else, but is going to actually let you get into some code. That will allow to be creative on your own" (P3, personal communication, March 14, 2016).

- *Start early:* "Start before you get out of high school. By the time you get out of high school you should already have a couple of years of experience. Don't waste time learning any of the older languages like Visual Basic. Go ahead and start to learn languages that are fresh now" (P3, personal communication, March 14, 2016).
- *Be creative and challenge yourself:* "Don't try to do things just because they are easy. Do something challenging" (P3, personal communication, March 14, 2016).
- *Thick skin*: "You definitely going to have to have thick skin. This game can be really cut throat and that's another reason why you have to kind of control your emotions" (P4, personal communication, March 13, 2016).
- *Build your own*: "Build your own and you don't have to deal 99% of the stuff we have been talking about, even though, that's difficult, that's not easy to do" (P4, personal communication, March 14, 2016).
- *Be on your game:* "You have to be better and it's not right but it's reality, you have to better than your counterparts in order for you to be equal. That is in a lot of things but it is very relevant and prevalent when you talk about computer science because one look at you and automatically and unfortunately should you be here as an African American. You don't look like what they feel you should look like and you have to be, that being the case, really be on your game" (P7, personal communication, March 25, 2016).

- *Sticktoitiveness*: “Stick with it because the hardest time is in the beginning, just know that it gets easier, when you are new to this you’re scared to even touch code at first, you see a problem you get anxiety from that you see a problem, you don’t want to break stuff, you don’t want to touch it, that anxiety to solve the problem makes your job harder, just know that you are not going to have this stress as time goes on” (P9, personal communication, March 22, 2016).
- *Ask questions:* “Never hesitate to ask questions. I don’t want to look dumb. I am supposed to know this” (P9, personal communication, March 22, 2016).
- *Confidence:* “Don’t let anyone tell you that you can’t do it” (P10, personal communication, March 22, 2016). “Moreover, you have to learn how to not downplay your brilliance and force people to recognize you as the expert that you are” (P13, personal communication, March 25, 2016).
- *Networking:* “You gotta network and get with your peers in the field and do the study sessions. Getting with your peers to make yourself better, but also to make them better” (P15, personal communication, March 26, 2016).
- *Continuing education:* “Having that fundamental core knowledge is something that you can’t get around it. I think it is key. The fundamental core computer science knowledge is key. Constantly educating yourself on what’s new, technology changes every eighteen months, therefore constantly I am reading something every day, I am educating myself every day, and then every few years I am dropping some major cash to really get up to speed” (P15, personal communication, March 26, 2016).

Study Conclusion

Considering the stated implications for African American software development engineers, it is important to reflect on the diversity problem that currently exists in the technology sector and the potential solutions to consider in rectifying this problem. It is predicted that by the year 2050, that the population of the United States will grow by 50%. People of color are projected to make up approximately half of the population. It is believed that immigration will be responsible for nearly two-thirds of the nation's population growth; 25% of all Americans will be of Hispanic origin. Additionally, nearly one in 10 Americans will be of Pacific Islander or Asian heritage. More people with disabilities as well as more women will become a part of the workforce. The U.S. population is expected to follow a similar pattern, becoming majority-minority by the year 2044. The minority population is expected to rise to 56% of the total in 2060, compared with 38% in 2014 (U.S. Census Bureau, 2015).

The technology sector has recently started to deal with this issue. Some ethnic minority groups such as Hispanics and African Americans are severely underrepresented in the technology sector. Technology organizations need to make diversity a priority and develop strategies to become more inclusive, however for a tech sector accustomed to hacking its way out of problems, making its workforce more diverse has emerged as a major challenge. Many attribute the situation to the talent pipeline as one of the main reasons. Companies would hire more diverse employees if they were available. However, the problem is not enough Black and Hispanic students are pursuing computer science degrees (Kang & Frankel, 2015). There is a shortage of diverse STEM talent (Chubin & Malcolm, 2008). Exploration of those untapped markets is where America must search for its next generation of technical talent. It is from those ethnic groups that will make up half of the population of the U.S by the year 2050, those that are

the most severely underrepresented in the technology sector today, these are the groups where talent must be harvested in order for America avoid an impending talent shortage (ACT, 2006). The best way to remedy this situation would be to tap into those groups that have been historically underrepresented in STEM (Margolis, 2008). The implication is that the future financial success of America is to some degree dependent on the effectiveness of the country to persuade more African-American students to pursue careers in technology.

Therefore, for African Americans to become more attracted to the field of software development and to be successful in corporate America once they have become software development engineers there must be an identification of the factors that are keeping young African Americans from entering the field as well as retaining those who have made it on to corporate software development engineering teams. As such, from this study, below are eight aspects that should be considered in preparing African Americans to become successful software development engineers:

1. Understanding the built in bias against you as African American software development engineer,
2. Possessing unwavering confidence,
3. Effectively communicating your skills and abilities,
4. Need for a more welcoming organizational culture at tech companies,
5. Being a life-long learner,
6. Being adept at emotional intelligence and skillfully using and controlling your emotions,
7. Building relationships and networking as a African American software development engineer,

8. Work to change the image of computer science in the African American community.

Recommendations for Future Research

Although this research has divulged and contributed valuable knowledge to the field of diversity in technology, there are still opportunities available for future research focused on this topic. Based on the research findings, listed subsequently are recommendations for future study regarding African American software development engineers.

1. Conduct a similar study, but consider including African American software development engineers who run their own software development shops.
2. Conduct a similar study, but consider including African American software development engineers who work internationally.
3. Expand the population to include software development engineers who are Black, but are not African American and compare/contrast the themes that emerge from both.
4. Conduct a similar study, but examine the setting from a quantitative viewpoint.
5. Focus on women African American software development engineers and compare/contrast the themes that emerge from both.

Author's Observations

This study was of particular interest as the researcher has been a part of many corporate technology groups as a software developer and has often been the only African American and left to wonder why there are so few African Americans in this role. Additionally, as stated in the findings African American software development engineers face many challenges that are unique to developers who are African American and it is important to illuminate these issues as in order to be successful as an African American software development engineer requires much more than simply mastering the technical skills.

In this field, African Americans spend a great deal of time honing their technical skills and this is critical. However it is not enough. Most of the practitioners in this study acknowledge that the environment that they came into after completing a very difficult degree was not what they were expecting and having to recognize and Figure out these obstacles on the fly proved to be quite challenging, and for some not worth it as they left the field. The information brought to life in this study would have been valuable to those who left, not to mention those who are currently aspiring to become software development engineers. The author's biggest takeaway is that aptitude does not seem to be an issue with the dearth of African-American software development engineers in the technology sector. Although the findings suggest that it is crucial that African Americans master the techniques needed to be successful in this field, what stands out is that the social factors are what determine whether they choose and/or remain in the field of software development.

Currently, there are a number of organizations working to improve the number of African American software development engineers. Although I applaud their efforts, as a result of this research, it is clear that efforts to expose young African-Americans to technology is not the best path to solving this problem. Organizations such as Black Girls Code and Code2040 whose efforts seem centered on creating opportunities in technology and exposing young people of color to the skills needed to be successful in this field. There is no shortage of places where young African Americans can learn the skills needed to become successful software developer engineers. As discussed in IQ14 (What is the best path to becoming to a software development engineer today?), there are a multitude of options that one can pursue, however, the findings of this study indicate that skills and aptitude should not be the focus in efforts to solve the underrepresentation of African-Americans in software development.

In this study, experienced African-American software development engineers repeatedly pointed to the social issues that they believe are the reasons why there are so few African-Americans pursuing careers in software development. This leads the author to conclude that what organizations that seek to solve this problem should do is focus on the societal factors that may be the true culprit. These factors such as societal perceptions, emotional intelligence, communication tactics, self-confidence, and cultural barriers. It would be beneficial for aspiring African-American software development engineers to prepare themselves for the environment that they will be walking into in the workplace. This is where the focus should be. Those that are entering into the technology sector as software development engineers or in other technical roles need to be prepared emotionally, socially, spiritually, and technically in order to deal with the challenges they will face as outlined in the study. Again, these aspirants are able to attend a plethora of courses online and elsewhere if they need to learn how to program in C#, but where do they turn to learn the skills needed to combat the stereotypes that they may face in their new roles? Where do they learn how to handle being the only African-American on the team and feeling that colleagues on your team feel that you are not qualified to do your job? These are some of the facts that have emerged from this study that need to be addressed and the efforts that are currently taking place are not doing that. There are organizations that have been in place for nearly 40 years to solve this problem and the needle has not moved with regard to the number of African-Americans who pursue careers in technology. Their solutions are not working. Perhaps it is time for a new approach, or at the very least there needs be a more comprehensive solution that takes more into account than simple aptitude or technical skills.

Perhaps workshops and training could be developed in conjunction with the technical skills at least until these conditions can be ameliorated in the corporate culture. Due to a passion

for this area, it is anticipated that the researcher will conduct future expanded studies on this topic to continue contributing literature and best practice initiatives to the field of computing in an attempt to increase the number of African American software development engineers. These studies will be aimed particularly at those who are often overlooked, but never forgotten: African Americans.

Thank you to all interview participants who took part in this study to contribute to making it successful. The inestimable information culled from the honest reflections of all the respondents will serve to contribute to the literature regarding diversity in technology as it relates to African American software development engineers for posterity.

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APPENDIX A

Protecting Human Resource Certificate of Completion

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)

COURSEWORK REQUIREMENTS REPORT*

* NOTE: Scores on this Requirements Report reflect quiz completions at the time all requirements for the course were met. See list below for details. See separate Transcript Report for more recent quiz scores, including those on optional (supplemental) course elements.

- **Name:** [redacted]
- **Email:**
- **Institution Affiliation:**
- **Institution Unit:**
- **Phone:**

- **Curriculum Group:** Graduate & Professional Schools HSR
- **Course Learner Group:** Graduate & Professional Schools - Psychology Division Human Subjects Training
- **Stage:** Stage 1 - Basic Course
- **Description:** Choose this group to satisfy CITI training requirements for Investigators and staff involved primarily in Social/Behavioral Research with human subjects.

- **Report ID:** 18637419
- **Completion Date:** 02/08/2016
- **Expiration Date:** 02/07/2019
- **Minimum Passing:** 80
- **Reported Score*:** 100

REQUIRED AND ELECTIVE MODULES ONLY	DATE COMPLETED	SCORE
Belmont Report and CITI Course Introduction (ID: 1127)	02/06/16	3/3 (100%)
History and Ethical Principles - SBE (ID: 490)	02/06/16	5/5 (100%)
Defining Research with Human Subjects - SBE (ID: 491)	02/06/16	5/5 (100%)
The Federal Regulations - SBE (ID: 502)	02/07/16	5/5 (100%)
Assessing Risk - SBE (ID: 503)	02/07/16	5/5 (100%)
Informed Consent - SBE (ID: 504)	02/07/16	5/5 (100%)
Privacy and Confidentiality - SBE (ID: 505)	02/07/16	5/5 (100%)
Conflicts of Interest in Research Involving Human Subjects (ID: 488)	02/08/16	5/5 (100%)
Cultural Competence in Research (ID: 15166)	02/08/16	5/5 (100%)

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

CITI Program
Email: citisupport@miami.edu
Phone: 305-243-7970
Web: https://www.citiprogram.org

APPENDIX B

Recruitment Letter

Dear Potential Research Participant,

I am an African American and a career software developer with 25+ years of experience in information technology, and am entering into the research phase of my doctoral program in Educational Technology at Pepperdine University. My research is in partial fulfillment of the requirements for the dissertation, titled *Coding While Black: A Descriptive, Phenomenological Study of African American Software Development Engineers*.

The purpose of my research is to examine strategies, best practices, and challenges experienced by African American software development engineers who have been successful despite being part of the underrepresented ethnic groups in the technology sector.

Your participation in this research study will take the form of a one-hour interview. The interview may take place in person or facilitated through technological means. During the interview, you will be asked a series of questions pertaining to your experience as an African American software development engineer in corporate America.

Please contact me directly, within the next week expressing your willingness to participate in this research study. Thank you, in advance, for the consideration.

Respectfully,
Kai Ajala Dupe

APPENDIX C

IRB Approval Letter

PEPPERDINE

Pepperdine University
24255 Pacific Coast Highway
Malibu, CA 90263
TEL: 310-506-4000

NOTICE OF APPROVAL FOR HUMAN RESEARCH

Date: February 25, 2016

Protocol Investigator Name: Kai Dupe

Protocol #: 16-02-201

Project Title: Success Strategies of African American Software Development Engineers

School: Graduate School of Education and Psychology

Dear Kai Dupe:

Thank you for submitting your application for exempt review to Pepperdine University's Institutional Review Board (IRB). We appreciate the work you have done on your proposal. The IRB has reviewed your submitted IRB application and all ancillary materials. Upon review, the IRB has determined that the above entitled project meets the requirements for exemption under the federal regulations 45 CFR 46.101 that govern the protections of human subjects.

Your research must be conducted according to the proposal that was submitted to the IRB. If changes to the approved protocol occur, a revised protocol must be reviewed and approved by the IRB before implementation. For any proposed changes in your research protocol, please submit an amendment to the IRB. Since your study falls under exemption, there is no requirement for continuing IRB review of your project. Please be aware that changes to your protocol may prevent the research from qualifying for exemption from 45 CFR 46.101 and require submission of a new IRB application or other materials to the IRB.

A goal of the IRB is to prevent negative occurrences during any research study. However, despite the best intent, unforeseen circumstances or events may arise during the research. If an unexpected situation or adverse event happens during your investigation, please notify the IRB as soon as possible. We will ask for a complete written explanation of the event and your written response. Other actions also may be required depending on the nature of the event. Details regarding the timeframe in which adverse events must be reported to the IRB and documenting the adverse event can be found in the *Pepperdine University Protection of Human Participants in Research: Policies and Procedures Manual* at community.pepperdine.edu/irb.

Please refer to the protocol number denoted above in all communication or correspondence related to your application and this approval. Should you have additional questions or require clarification of the contents of this letter, please contact the IRB Office. On behalf of the IRB, I wish you success in this scholarly pursuit.

Sincerely,

Judy Ho, Ph.D., IRB Chairperson

cc: Dr. Lee Kats, Vice Provost for Research and Strategic Initiatives

APPENDIX D

Informed Consent

PEPPERDINE UNIVERSITY

Graduate School of Education and Psychology

INFORMED CONSENT FOR PARTICIPATION IN RESEARCH ACTIVITIES

CODING WHILE BLACK:
A DESCRIPTIVE, PHENOMENOLOGICAL STUDY OF AFRICAN AMERICAN SOFTWARE DEVELOPMENT ENGINEERS

You are invited to participate in a research study conducted by Kai Dupe, M.Ed., and Farzin Majidi, Ed.D at Pepperdine University, because you are a professional African American software development engineer who works in a corporate information technology department and you have been in your role for at least 5 years. Also you have earned at least a Bachelor's degree in computer science or a related area. Your participation is voluntary. You should read the information below, and ask questions about anything that you do not understand, before deciding whether to participate. Please take as much time as you need to read the consent form. You may also decide to discuss participation with your family or friends. If you decide to participate, you will be asked to sign this form. You will also be given a copy of this form for you records.

PURPOSE OF THE STUDY

The purpose of this study is to determine what strategies and practices are employed by African American software development engineers, to determine what challenges are faced by African American software development engineers, to determine how African American software development engineers measure success, and what recommendations would African American software development engineers make for future African American software development engineers.

STUDY PROCEDURES

If you volunteer to participate in this study, you will be asked to sign an informed consent document. After the informed consent form was is received and accepted, a copy of the semi-structured interview questions will be sent to the participant. If the researcher failed to connect with one of the chosen software development engineers, a request will be made on various social media outlets and after confirming e-mail contact address, a follow-up e-mail will be sent. Prospective interviewees that agreed to take part in the study received a follow-up e-mail from

the researcher to thank them for their participation. The follow-up message included an explanation of the subsequent steps in the process. At this point, it was communicated to the participant that their full contact information will be requested and the researcher will arrange for the interview to take place during the month of March, 2016

Data was collected during the month of March 2016. The researcher used a 19 question open-ended interview instrument. This interview was conducted in person by the researcher. The researcher met the interviewee based on their availability and schedule and the site of their choosing. In the event that an in person interview was not possible for whatever reason the researcher arranged to conduct the interview using VOIP software such as Skype or FaceTime. The researcher setup the software and provided the interviewee with the necessary technology assistance needed in order to use the software to produce a successful interview without requiring any extra work on the part of the participant. The interview is scheduled to last 1 hour and it was scheduled at the convenience of the participant and transcribed using transcription software.

Participants were given the interview questions prior to the interview so they would have an opportunity to reflect on their experiences and provide the best, most accurate and thoughtful answers to the questions. The researcher will arrive 30 minutes before the scheduled interview time. Upon arrival the researcher will review the informed consent form with the participant. The researcher will bring two digital audio recorders to record the interview. The second recorder is a precaution any case there are any issues recording the interview.

POTENTIAL RISKS AND DISCOMFORTS

There are no foreseeable risks to the participants

POTENTIAL BENEFITS TO PARTICIPANTS AND/OR TO SOCIETY

While there are no direct benefits to the study participants, there are several anticipated benefits to society which include:

1.) An understanding the strategies and practices that are employed by African American software development engineers can help corporations and organizations adjust recruitment and hiring strategies.
2.) It can help colleges and universities modify their curriculum in ways that will attract more African Americans to careers in software development.
3.) Researchers have studied the need to have more minorities represented in the computing fields, but there is not much focus in the literature as to why African Americans are so underrepresented in computing in academia and in the workplace. It is anticipated that study adds to the existing literature.

CONFIDENTIALITY

Your records for this study will be kept confidential as far as permitted by law. However, if I am required to do so by law, I may be required to disclose information collected about you. Examples of the types of issues that would require me to break confidentiality are if you tell me about instances of child abuse and elder abuse. Pepperdine's University's Human Subjects Protection Program (HSPP) may also access the data collected. The HSPP occasionally reviews and monitors research studies to protect the rights and welfare of research subjects. There will be no identifiable information obtained in connection with this study. Your name, address or other identifiable information will not be collected. The data will be stored on a password protected computer in the principal investigators place of residence. The data will be stored for a minimum of three years. Data was collected during the month of March 2016. The researcher used a 19 question open-ended interview instrument. This interview was conducted in person by the researcher. The researcher met the interviewee based on their availability and schedule and the site of their choosing. In the event that an in person interview was not possible for whatever reason the researcher arranged to conduct the interview using VOIP software such as Skype or FaceTime. The researcher setup the software and provided the interviewee with the necessary technology assistance needed in order to use the software to produce a successful interview without requiring any extra work on the part of the participant. The interview was scheduled to last 1 hour and it was scheduled at the convenience of the participant and transcribed using transcription software.

Participants were given the interview questions prior to the interview so they would have an opportunity to reflect on their experiences and provide the best, most accurate and thoughtful answers to the questions. The researcher will arrive 30 minutes before the scheduled interview time. Upon arrival the researcher will review the informed consent form with the participant. The researcher will bring two digital audio recorders to record the interview. The second recorder is a precaution any case there are any issues recording the interview. The researcher used 2 digital audio recorders and 1 LiveScribe Echo Smartpen and pad to record the interviews simultaneously. Also, the researcher was prepared to pause the recording upon request if the interviewee decided to share information that he or she did not want to be part of the research record. Interviews are expected to last 60 minutes. The researcher arrived at the interview location on the scheduled day 30 minutes before the start of the interview. The researcher arrived with a Live Scribe Echo Smartpen recording audio pen as well as two Tascam DR-05 portable digital audio recorders. The researcher also employed a backup recorder to ensure the quality of the interview for transcription, with fresh batteries and a supply of extra batteries to finish the interview. The researcher informed the participant that they would receive a copy of their responses to verify for accuracy. Also, the researcher confirmed that the participant would be open to being contacted for questions of clarity. Two weeks after the interview was conducted the researcher provided the participant with a duplicate of the transcribed interview for the participant to review. This steps gives the participant an opportunity to clarify and/or correct the information provided during their interview session.

The data collected will be coded, de-identified, identifiable, and transcribed. The data will be stored on the researchers personal laptop which is password protected.

PARTICIPATION AND WITHDRAWAL

Your participation is voluntary. Your refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study.

ALTERNATIVES TO FULL PARTICIPATION

Your alternative is to not participate. Your relationship with your employer will not be affected whether you participate or not in this study.

EMERGENCY CARE AND COMPENSATION FOR INJURY

If you are injured as a direct result of research procedures you will receive medical treatment; however, you or your insurance will be responsible for the cost. Pepperdine University does not provide any monetary compensation for injury

INVESTIGATOR'S CONTACT INFORMATION

I understand that the investigator is willing to answer any inquiries I may have concerning the research herein described. I understand that I may contact Kai Dupe via phone at [redacted] or via e-mail at [redacted] Additionally, I may contact the faculty advisor Farzin Madjidi via phone at [redacted] if I have any other questions or concerns about this research.

RIGHTS OF RESEARCH PARTICIPANT – IRB CONTACT INFORMATION

If you have questions, concerns or complaints about your rights as a research participant or research in general please contact Dr. Judy Ho, Chairperson of the Graduate & Professional Schools Institutional Review Board at Pepperdine University 6100 Center Drive Suite 500 Los Angeles, CA 90045, 310-568-5753 or gpsirb@pepperdine.edu.

SUMMARY (Revised Risk, Revised Maintenance of Data Security Information

Revised Risk:
The participants of this study will be exposed to minimal risk. By minimal risk, this includes risks that a person is likely to encounter in daily life activities. The following is a list of those risks:
The participants may feel uncomfortable answering certain questions
The participants may feel uncomfortable having to relive certain experiences
The participants may experience boredom during the interview
The participants may experiences feeling of anguish or apprehension about participating in an interview centering on such a controversial topic
The participants may fear repercussions with regard to employment opportunities in the industry as a result of their participation in the study

Revised Maintenance of Data Security Information:
The confidentiality of the data collected will be maintained by de-identifying the information. The participant's name and other personal information such as where they are employed and other pieces of information that can be used to identify participants will be removed from the data set. In order to preserve the confidentiality of the participants none of the participants were referenced by name and no other information that may tie the research to the participant was given. Each participant received a code to keep the obtained data confidential. The researcher will keep the participants' names and addresses, information, consent letters, and other data such as tapes, notes, and transcriptions in a locked file for 5 years for confidentiality protection. The researcher will be the only person who has access to the locked file. The data will be destroyed after the 5 years and it will be destroyed by using a document shredder. The audio files will be stored on a personal external hard drive that will only be used by the principal researcher. All electronic files such as interview notes and audio recordings will be password protected on this drive and the notes and transcriptions from the interviews will be encrypted using AES-256 bit encryption.

SIGNATURE OF RESEARCH PARTICIPANT

I have read the information provided above. I have been given a chance to ask questions. My questions have been answered to my satisfaction and I agree to participate in this study. I have been given a copy of this form.

AUDIO-RECORDED

□ *I agree to be audio recorded.*

□ *I do not want to be audio-recorded.*

_____
Name of Participant

_____ _____
Signature of Participant Date

SIGNATURE OF INVESTIGATOR

I have explained the research to the participants and answered all of his/her questions. In my judgment the participants are knowingly, willingly and intelligently agreeing to participate in this study. They have the legal capacity to give informed consent to participate in this research study and all of the various components. They also have been informed participation is voluntarily and that they may discontinue their participation in the study at any time, for any reason.

_____

Name of Person Obtaining Consent

_____ _____

Signature of Person Obtaining Consent Date

APPENDIX E

Letter of Intent

Dear [Participant],
Thank you for your response to my request for participation. I am a career software development engineer with over 25 years of experience, and am entering into the research phase of my doctoral program in Educational Technology at Pepperdine University. My research is in partial fulfillment of the requirements for the dissertation, titled *Coding While Black: A Descriptive, Phenomenological Study of African American Software Development Engineers*.

The purpose of my research is to examine strategies, best practices, and challenges experienced by African American software development engineers who have been successful despite being part of the underrepresented ethnic groups in the information technology sector.

Your participation in this research study will take the form of a one-hour interview. With your permission, the interview audio will be recorded. Immediately following the interview, the conversation will be transcribed to ensure that inadvertent references made to your name or institution are redacted. The transcribed file will not be named, to ensure additional confidentiality, and the associated audio file will be immediately destroyed. The information shared in the interview will be confidential, and to further ensure confidentiality, reporting of the data will be done in aggregate and only themes will be disclosed as part of the research study.

The interview may take place in person or facilitated through technological means. During the interview, you will be asked a series of questions pertaining to your experience in higher education policy development and implementation. Potential risks subjects may be exposed to include fatigue, boredom, or feeling uncomfortable with certain questions. Other risks may include disclosures of internal policies and procedures in reference to participant's role at their relative place of employment, which may impact their relationship with their employer. Your participation in this study is completely voluntary, and you may elect to withdraw at any point and time during the study. The results of the study will be used to increase the body of knowledge with regard to being an African American in the information technology software development engineering field and why such groups are underrepresented in the field. Attached you will find an *Informed Consent* form, which will provide additional details of the study.

Thank you again for your expressed willingness to participate in this research study.

Respectfully,
Kai Ajala Dupe

APPENDIX F

Nondisclosure and Review Form for Inter-Rater Reliability

PEPPERDINE UNIVERSITY

INTER-RATER PEER REVIEWER NONDISCLOSURE

Reviewer will protect the information related to participant interview data and the review associated with the dissertation entitled *Coding While Black: A Descriptive, Phenomenological Study of African American Software Development Engineers*.

The reviewer will be privy to notes, transcripts, and coding associated with participant interviews. As such, the reviewer shall treat all interview data as protected information, regardless of the format (e.g., electronic, paper, oral). Additionally, the reviewer agrees to not use, share, or disclose the interview data with anyone other than the researcher. Though the interview files will only contain redacted information and participant codes, this form serves as an additional level of confidentiality.

SIGNATURE OF PEER REVIEWER

I have read the information provided above, and have been given a chance to ask questions. My questions have been answered to my satisfaction and I agree to the terms and conditions outlined herein. I have been given a copy of this form.

_____

Name of Reviewer

_____ _____

Signature of Reviewer Date

APPENDIX G

Interview Questions

Research Questions	Corresponding Interview Questions
RQ1: What professional and career challenges have you faced as an African American software development engineer?	Interview Question 1: Do you believe you have faced unique challenges as an African American software development engineer? Interview Question 2: What specific obstacles have you faced? Interview Question 3: To what extent do you believe these obstacles have hampered your professional and career growth? Interview Question 4: What are your keys to success for becoming a software development engineer? Interview Question 5: Would you have done anything differently?
RQ2: What strategies and practices have you employed to overcome your professional and career challenges as an African American software development engineer?	Interview Question 6: What strategies and practices did you use to overcome the obstacles you have faced to become a successful software development engineer? Interview Question 7: What was the most important strategy or practice that you employed in helping you to overcome these challenges? Interview Question 8: Did you join any organizations? Interview Question 9: Did you receive any mentoring?
RQ3: How do African American software development engineers measure success in overcoming the challenges of being	Interview Question 10: How do you measure success in your career as a software development engineer?

part of an underrepresented group in the technology sector?	Interview Question 11: Have you achieved any of these measures of success? Interview Question 12: If you have not, why do you think you have not, if you have what would you say contribute to your success? Interview Question 13: What factors influenced how you measure your success?
RQ4: Based on their experiences, what recommendations would African American software development engineers make for future African American software development engineers to be successful as part of an underrepresented group in the technology sector?	Interview Question 14: What is the best path to becoming a software development engineer today? Interview Question 15: What advice do you have for African Americans who aspire to become software development engineers? Interview Question 16: Why do you feel there are so few African American in software development engineers? Interview Question 17: What book or article on leadership would you recommend to a new software development engineer? Interview Question 18: Do you see any changes taking place that will make it easier for the next generation of African American software development engineers? Interview Question 19: What can companies do to solve the diversity issue in the technology sector?