THE MINORITY IN THE MINORITY,

BLACK WOMEN IN COMPUTER SCIENCE FIELDS: A PHENOMENOLOGICAL STUDY

by

Blanche' De'Ann Anderson

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Philosophy

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APPROVED BY:

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Abstract

The purpose of this transcendental phenomenological study was to describe the lived experiences of Black women with a bachelor's, master's, or doctoral degree in computer science, currently employed in the United States. The theory guiding this study was Krumboltz's social learning theory of career decision-making, as it provides a foundation for understanding how a combination of factors leads to an individual's educational and occupational preferences and skills. This qualitative study answered the following central research question: What are the lived experiences of Black women with a bachelor's, master's, or doctoral degree in computer science, currently employed in the United States? Purposeful criterion sampling was used to select between 12 to 15 participants from the Society of Women Engineers who met the following criteria: a female, Black or African American, with a bachelor's, master's, or doctoral degree in computer science, graduated from an accredited college, university, or vocational program, and currently employed in the United States. Data collection methods included individual interviews, letter writing, and focus groups. Data analysis followed Moustakas modified approach: setting aside personal experiences and prejudgments, organizing data and conducting horizonalization, developing clusters of meaning into common themes, generating and combining textural and structural descriptions, and generating a composite description of the phenomenon experienced by all participants.

Keywords: Black women, computer science, STEM, intersectionality, social learning theory of career decision-making

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Dedication

"I learned a long time ago the wisest thing I can do is be on my own side, be an advocate for myself and others like me, if I do that well enough, then I'll be able to look after someone else -- the children or the husband or the elderly. But I have to look after myself first. I know that some people think that's being selfish, I think that's being self-full."

~Maya Angelou

I dedicate this dissertation to all the women trailblazers in computer science. To the women that suffered greatly and had their work and abilities questioned. To those whose efforts were sabotaged. To those who were overlooked for rewards and promotions due to their race and gender. And to those with the passion and innate ability to get things done but your efforts were misunderstood. Even through all these things, you still persevered. Thank you for all you have done to open the doors and create a path for other women, especially Black women, to pursue educational and occupational opportunities in computer science.

Acknowledgments

First and foremost, I thank Hashem for allowing me to fulfill this dream from years ago. Thank you for the guidance, wisdom, and ability to persevere. Your word always rings true, “Commit your actions to the Lord, and your plans will succeed” (*Holy Bible, New Living Translation*, 1996/2015, Prov 16:3).

Thank you to Liberty University, Dr. Ozolnieks, and Dr. White. Dr. Ozolnieks, I am grateful and blessed to have had you as my chair. Your never-ending smile and words of encouragement kept me going. Even while going through your own life's difficulties, your smile and words of encouragement never faded away. Thank you. Dr. White, it was such a great pleasure to have you as my committee member. It was encouraging to work alongside another Black woman with a doctorate degree. Thank you for providing feedback to extend my thinking and for asking great questions.

A special thank you to my participants for taking the time to participate in this study. I am grateful you shared some of your experiences and stories, as your experiences made this study what it is. I pray that Hashem's never-ending favor overtakes every one of you!

Thank you, Husband! Thank you for your patience and enduring love throughout this entire process. When I started this journey, we hadn't even met yet. However, once you learned about my end goal, you were always there to provide love, encouraging words, and even jokes to lighten the mood. I thank Hashem for us being able to do life together. I love you.

To my mom and dad, thank you for always instilling in us to be great at whatever we decide to put our hands to do. Daddy, you told me right after high school that I should go all the way in my education. I am so glad I listened to you! Mom, you are one of the strongest and smartest women I know. Thank you for the sacrifices you've made for us so that we can be all that Hashem has intended for us to be. I love you dearly.

Thank you, Stister and Brother. Thank you for the love and support and for being my biggest cheerleader. Stister, I am looking forward to catching up on the comics I've missed. Brother, you have always been an inspiration to me; keep excelling. Brother-in-Love, Cammy, Nova Superstar, and Maddy - I love you all and hope I've made you proud.

Lastly, a huge thank you to my friends who have become my extended family and my NTA/Horace Mann family. There are too many names to list everyone, but I appreciate the calls, texts, and emails during this process. Thank you for consistently checking in on me, volunteering as readers, and providing feedback. This journey was long and having support from all of you made the process worth it.

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List of Abbreviations

Associative Learning Experiences (ALEs)

Bureau of Labor Statistics (BLS)

Career Decision-Making (CDM)

Central Research Question (CRQ)

Electronic Numerical Integrator and Computer (ENIAC)

Historically Black Colleges and Universities (HBCUs)

Institutional Review Board (IRB)

Instrumental Learning Experiences (ILEs)

National Academies of Sciences, Engineering, and Medicine (NASEM)

National Aeronautics and Space Administration (NASA)

National Center for Science and Engineering Statistics (NCSES)

National Science Board (NSB)

National Science Foundation (NSF)

Science, Technology, Engineering, and Mathematics (STEM)

Social Learning Theory of Career Decision-Making (SLTCDM)

Society of Women Engineers (SWE)

Stevick-Colaizzi-Keen (SCK) method of data analysis

Sub-Question One (SQ1)

Sub-Question Two (SQ2)

Sub-Question Three (SQ3)

Underrepresented Minority Groups (URM)

CHAPTER ONE: INTRODUCTION

Overview

On July 20, 1969, Commander Neil Armstrong was the first human to walk on the Moon's surface. Upon returning to Earth, there was a massive celebration of this momentous achievement throughout the United States. Neil Armstrong would become a positive role model, inspiring future generations of astronauts and engineers. Young men would continue to have visible images of individuals who looked just like them pursuing great things in careers such as aeronautics, astronautics, and engineering. A pipeline was crafted for career possibilities in the United States science and technological workforce for these young men. Unfortunately, this crafted pipeline did not appear suitable for women or people of color to pursue these types of careers. Chapter One provides an introduction of the framework for this transcendental phenomenological study. The researcher covers the study's groundwork by providing a summary of the relevant literature about the historical, theoretical, and social contexts surrounding the phenomenon of Black women in computer science fields. Not much is known about the process by which Black women establish careers in science, technology, engineering, and mathematics (STEM) fields; much less is known about the career development of Black women in computer science fields. The motivation for conducting this study is presented along with the philosophical assumptions and paradigms that guide the study. The problem and purpose statements provide support for the significance and relevance of conducting this study. The study's theoretical, empirical, and practical significance is provided along with the central research question and sub-questions used to guide the study. Chapter One concludes with a list of important definitions and a summary.

Background

There is a predominant masculine culture in STEM fields that could be preventing more women and women of color from entering these fields (Lewis et al., 2017; McAlear et al., 2018; McGee & Bentley, 2017; Niepel et al., 2019). Therefore, hearing about the experiences of those currently contributing their knowledge, skills, and insights towards evolving technologies may help decrease the inequalities in STEM over time (Blosser, 2019; McAlear et al., 2018). The focus of this study is on the lived experiences of Black women persisting in their STEM education who were able to pursue careers in computer science fields in the United States. By describing their experiences, the researcher will increase the literature on this minority population of women in STEM. To fully understand the experiences of Black women in computer science fields, one must first know the historical, theoretical, and social contexts regarding women and women of color in STEM.

Historical Context

In the United States, career fields in STEM are showing more promise of growth and higher earning potential than non-STEM fields (Collins, 2018; Ma & Liu, 2017). In 2010, computer and math occupations accounted for 3.5 million jobs, with an anticipated 778,000 more jobs by 2020 (Collins, 2018). Technology is so critical to the growth of the United States economy and workforce that in 2017 it was projected there would be one million new jobs in computer and information technology over the next 10 years (Bahr et al., 2017). Regardless of this growth, the current technological workforce does not match the diversity of the United States population, highlighting a lack of representation of women and people of color in STEM (Amon, 2017; Lehman et al., 2016; Ma & Liu, 2017; McAlear et al., 2018; Meschitti & Smith, 2017; Niepel et al., 2019; van Tuijl & van der Molen, 2016). Despite the technological workforce of the United States not matching the current diversity of society, many women and women of color have successfully traversed the STEM pipeline (Cheryan et al., 2017).

Female representation in STEM has not always been considered low. By 1920, the percentage of female STEM graduates was at an all-time high, with women earning 14% of doctoral degrees in physical and biological sciences (Leslie, 2018). During the last portion of the 20th century, there were rising enrollments in STEM disciplines for women and people of color (Charleston et al., 2014). From 1995 to 2007,

> the proportion of science and engineering bachelor's degrees awarded to underrepresented minority groups (URM) increased among Asians/Pacific Islanders (from 8% to 9%), Black students (from 7% to 8%), Hispanic students (from 6% to 8%), and American Indian/Alaska Native students (from 0.5% to 0.7%). (Charleston et al., 2014, p. 167)

The increase of degrees awarded to URM could be due to the government and researchers wanting to improve and diversify the number of students receiving STEM degrees (Charleston et al., 2014; Ireland et al., 2018; Niepel et al., 2019; Snyder & Cudney, 2017), as well as population changes and increased college attendance by URM (National Science Board [NSB], 2010).

According to the National Center for Women Information Technology scorecard, in 2007 the percentage of Black women in computing and math fields was approximately 9.7% (DuBow & Gonzalez, 2020). Over the years, the percentage of Black women in computing and math fields has shifted between 9% and 12%, and to date has remained stable at around 12% (DuBow & Gonzalez, 2020). Existing research has highlighted Black women's STEM experiences, and unfortunately for Black women, marginalization has continued to feed the decline of their representation in these fields (Lewis et al., 2017; Ong et al., 2018; Rice et al., 2019; Yamaguchi

& Burge, 2019). Regardless of marginalization issues, there are still justifications for placing more attention on Black women's status in STEM. These justifications include the

> current demand for professionals to fill the STEM workforce, the benefit of diverse perspectives and ideas to promote STEM innovation and discovery, and the social justice imperative to ensure equity in STEM access and literacy as the society advances technologically. (Ireland et al., 2018, p. 227)

Social Context

STEM education and technological advances have continued to increase in other countries (Alexander & Hermann, 2016; Snyder & Cudney, 2017; Vitores & Gil-Juárez, 2016). However, the United States has seen a decline in individuals coming through the STEM pipeline (Alexander & Hermann, 2016; Crawford et al., 2021; Daniels & Robnett, 2021; Snyder & Cudney, 2017; Vitores & Gil-Juárez, 2016). A continued lack of STEM workers could harm the United States' economy and create global security risks (Alexander & Hermann, 2016; Fong et al., 2021). Fewer individuals going through STEM education and continuing to a STEM career puts the United States at a technological disadvantage compared to other countries (Alexander & Hermann, 2016; Ma & Liu, 2017; McAlear et al., 2018; Snyder & Cudney, 2017; Thébaud & Charles, 2018; Wolf & Terrell, 2016). This disadvantage is evident, especially when the current workforce lacks diversity and representation of women and people of color in STEM (McAlear et al., 2018; Snyder & Cudney, 2017; van Tuijl & van der Molen, 2016).

Women make up only 30% of STEM career fields and represent almost 50% of the United States workforce population (Amon, 2017; Ellis et al., 2016; Snyder & Cudney, 2017; Wang & Degol, 2017). For instance, women account for only 12% of engineering and 26% of the computing workforce, which are small proportions, and the numbers are drastically lower when considering women of color (Snyder & Cudney, 2017). Women and people of color have interests in STEM, and the current workforce is missing out on their added benefits and insights due to lack of diversity (Clark et al., 2021; Ireland et al., 2018; Johnson et al., 2019; King & Pringle, 2019; Lehman et al., 2016; Lewis et al., 2017; McAlear et al., 2018; Snyder & Cudney, 2017; van Tuijl & van der Molen, 2016; Yamaguchi & Burge, 2019).

The pipelines to STEM do not necessarily have issues with the individuals currently flowing through them, but the social values placed on these pipelines have kept certain individuals out (Garcia, 2020; Hicks & Wood, 2016; Ireland et al., 2018; McGee & Bentley, 2017; Vitores & Gil-Juárez, 2016). STEM fields, especially computing, have been treated and perceived as disciplines exclusively for men, mostly White males (Charleston et al., 2014; Cheryan et al., 2017; McGee & Bentley, 2017; Niepel et al., 2019). STEM fields are necessary for the United States to compete with other countries and better its economy (Alexander & Hermann, 2016; Crain & Webber, 2021; Ireland et al., 2018; Ma & Liu, 2017; McAlear et al., 2018; Snyder & Cudney, 2017; Wolf & Terrell, 2016). There is a growing demand for those trained in computer and information technology fields (Cabell et al., 2021; Kim et al., 2021), regardless of their gender; thus, increasing female representation in computer science fields is a valid concern (Ireland et al., 2018; Lehman et al., 2016; Roberts et al., 2018; Sax et al., 2017; van Aalderen-Smeets & Walma van der Molen, 2018). Having more women and women of color in STEM fields can only help further technologies that serve an entire population and not just men (Lehman et al., 2016; Yamaguchi & Burge, 2019).

Images of Black women in computer science fields are few and far between. Researchers know the barriers preventing young Black women from completing their studies in STEM fields like computer science and not pursuing a career (Alexander & Hermann, 2016; Amon, 2017;

Hicks & Wood, 2016; Hu & Ortagus, 2019; Johnson et al., 2019; Lewis et al., 2017; Niepel et al., 2019; Ong et al., 2018; Smith & Gayles, 2018; van Tuijl & van der Molen, 2016; Yamaguchi & Burge, 2019). Black female college students have shown interest, but they describe running into obstacles in STEM related to their racial and gender characteristics (Alexander & Hermann, 2016; Amon, 2017; Hicks & Wood, 2016; Johnson et al., 2019; King & Pringle, 2019; Lewis et al., 2017). Some obstacles include dealing with pervasive racial and gender stereotypes (Collins et al., 2020; King & Pringle, 2019; Shin et al., 2016), instructor bias (Clark et al., 2021; Davenport et al., 2020), presumed incompetence from peers, steering away from rigorous math or science courses in high school (Collins et al., 2020; McGee & Bentley, 2017), lack of family support and role models (Hicks & Wood, 2016; Talafian et al., 2019), and academic isolation (Lee et al., 2020; Watkins & Mensah, 2019). Other difficulties involve stereotyping of Black women, imposter syndrome, no availability of mentors, limited or no access to networking, and the reversal of affirmative action programs (Alexander & Hermann, 2016; Blosser, 2019; Collins et al., 2020; Dung et al., 2019; van Tuijl & van der Molen, 2016; Washington Lockett et al., 2018; Yamaguchi & Burge, 2019). Consequently, there is a gap in the literature regarding the lived experiences of Black women who were motivated and have persisted in their STEM education and their careers in computer science fields (Amon, 2017; Herrmann et al., 2016; Yamaguchi & Burge, 2019).

Increasing the visibility of Black women in computer science fields may contribute to an increased sense of belonging and retention among Black women (Cheryan et al., 2017; Dung et al., 2019; Niepel et al., 2019). Hearing about the experiences of Black women who were motivated and persisted in a computer science field could also increase representation. Black women who have faced barriers and have persevered can serve as role models for other Black women (Cheryan et al., 2017; Pietri et al., 2018). Thus, there is a need for continuous incorporation of real-world examples of successful Black women in computer science fields so that others can feel inspired and have someone to look up to and relate to their experiences (Cheryan et al., 2017).

Inspiration, motivation, and a sense of belonging are increased for those wondering if computing fields are obtainable for Black women when there is heightened visibility of those who have been successful (Dung et al., 2019; Johnson et al., 2019; Niepel et al., 2019; Ong et al., 2018; Pietri et al., 2018; Vitores & Gil-Juárez, 2016). Individuals sharing a common racial identity can serve as effective role models (Alexander & Hermann, 2016; Johnson et al., 2019). Since Black women are more aware of race and gender and the intersections of the two, they are more likely to relate to successful Black women as role models (Herrmann et al., 2016; Johnson et al., 2019). They need role models who are credible, reasonably successful, and display appropriate behaviors for navigating the STEM pipeline (Horsburgh & Ippolito, 2018; Vitores & Gil-Juárez, 2016). Increased motivation for future Black women may occur when they perceive they are like other successful Black women in computer science fields.

Theoretical Context

Computer science and other computing-related fields have consistently been male-dominated. The underrepresentation of Black women alone is enough to prevent others from even considering a career in these fields (Charleston et al., 2014; McAlear et al., 2018; Niepel et al., 2019). Despite the low representation of Black women in computing fields, some Black women have thriving careers. Krumboltz's (1979) social learning theory of career decision-making (SLTCDM) provides a lens through which to view these experiences and a framework to understand the phenomenon better. The unique experiences of Black women have influenced their decisions to pursue careers in computer science or other computing-related fields. Krumboltz's SLTCDM identifies four factors that influence the nature of career decision-making (CDM): genetic endowment and special abilities, environmental conditions and events, learning experiences, and task approach skills (Krumboltz, 1979; Krumboltz et al., 1976; Krumboltz & Worthington, 1999). This study will utilize three of the four factors, genetic endowment and special abilities, environmental conditions and events, and learning experiences, since task approach skills is a combination of the first three.

Genetic endowment and special abilities are the inherited traits with which an individual is born, including race, gender, physical appearance, and characteristics (Krumboltz, 1979; Krumboltz et al., 1976). The situations people are born into can either help or hinder their educational and occupational opportunities, and special abilities are not learned (Krumboltz, 1979; Krumboltz et al., 1976). How individuals view their own mathematical and science abilities, as it relates to STEM, is a crucial predictor of their desire to pursue careers in STEM (Clark et al., 2021; Jaeger et al., 2017; Mau & Li, 2018; Niepel et al., 2019; Stearns et al., 2020; Talafian et al., 2019). Black women could have had limitations on their ability to pursue careers in computer science fields early in their lives. For example, some Black girls who love math and science may never be exposed to other women in STEM fields (Blosser, 2019; Talley & Martinez Ortiz, 2017). Other limitations could include no sense of belonging, weak mathematical skills, a lack of interest in technology, or exposure to high quality instruction or technologies related explicitly to computing fields (Cabell et al., 2021; Lee, 2020; Talafian et al., 2019; Wang & Degol, 2017). Alternatively, some Black women may not have had any limitations on their abilities to pursue careers in computer science. They may have had strong mathematical skills, heightened interest in technology as children, or even early exposure to technology within their homes and community.

Environmental conditions and events influence career decision-making through factors (human action or natural forces) outside the control of the individual (Krumboltz, 1979; Krumboltz et al., 1976). For instance, a factor could be the number of job opportunities in computer science fields, specifically for Black women pursuing these careers. The U.S. Bureau of Labor Statistics projects employment in computing fields (e.g., computer scientists, computer network architects, computer programmers, computer support specialists, database administrators) will grow 11% from 2019 to 2029, much faster than the average for all occupations (Bureau of Labor Statistics, 2021). Even though most female representation in computing is White women, the computing workforce is gradually becoming more diverse and inclusive (DuBow & Gonzalez, 2020). In 2019, the percentages by race and ethnicity of women in computing and mathematical occupations (employed and experienced unemployed) were 56.1% (White), 11.4% (Black/African American), 24.3% (Asian/Pacific Islander), and 8.2% (Latina/Hispanic), compared to 67.2% (White), 12.5% (Black/African American), 20.7% (Asian/Pacific Islander), and 6.9% (Latina/Hispanic) in 2015 and 68% (White), 9.7% (Black/African American), 17.6% (Asian/Pacific Islander), and 4.6% (Latina/Hispanic) in 2007 (DuBow & Gonzalez, 2020).

Learning experiences influence an individual's skills, interests, beliefs, values, and work habits, and these experiences guide educational and occupational pursuits (Krumboltz & Worthington, 1999; Smith et al., 2019). The SLTCDM (Krumboltz, 1979) identifies two basic types of learning experiences: Instrumental Learning Experiences (ILEs) and Associative Learning Experiences (ALEs; Krumboltz, 1979; Krumboltz et al., 1976). Learning experiences that happen through reinforcements or punishments of an action or skill are called instrumental learning experiences (Krumboltz, 1979; Krumboltz et al., 1976; Krumboltz & Worthington, 1999). Associative learning experiences happen when an emotional experience is associated with a previously neutral event (Krumboltz, 1979; Krumboltz et al., 1976; Krumboltz & Worthington, 1999). ILEs and ALEs change the trajectories of CDM of Black women considering STEM fields (Collins, 2018; Lewis et al., 2017). Black women deciding to pursue careers in computer science fields would consider their prior learning experiences and other factors that influence those experiences (Collins, 2018; Jaeger et al., 2017). Also, their previous educational and social learning experiences would have informed how they saw themselves (i.e., attitudes, behaviors, STEM identity) pursuing a career in a STEM field (Collins, 2018; Jaeger et al., 2017; King & Pringle, 2019; Talafian et al., 2019).

Problem Statement

The problem is that Black women who persist in computer science fields and their experiences are scarce and often undocumented (Amon, 2017; Herrmann et al., 2016; Yamaguchi & Burge, 2019). The deficiency in the documented experiences of Black women who persist in computer science fields leads to a lack of relatable, positive real-world examples to encourage participation and increase retention (Herrmann et al., 2016; Shin et al., 2016; Yamaguchi & Burge, 2019). Research shows that having diversity in STEM, notably minority women, drives innovation in technology (Ireland et al., 2018; Snyder & Cudney, 2017; Yamaguchi & Burge, 2019). Unfortunately, Black women are among the least represented groups in STEM, especially in the computer science fields, even though many show interest (Ireland et al., 2018; Johnson et al., 2019; Lehman et al., 2016; Lewis et al., 2017; Nix & Perez-Felkner, 2019; Yamaguchi & Burge, 2019).

Black women represent approximately 7% of the United States workforce, yet they are disproportionately underrepresented in most STEM fields (Ireland et al., 2018; Johnson et al., 2019). The lack of Black female representation in STEM fields is disheartening and is presumably one of the reasons young Black women are discouraged from pursuing careers in STEM (Lewis et al., 2017; McAlear et al., 2018; van Tuijl & van der Molen, 2016). Young Black women are not seeing other women who look like them and who have also impacted the world in computer science fields (Ireland et al., 2018; Johnson et al., 2019; McAlear et al., 2018). There is growing evidence suggesting that exposure to other Black women who are relatable would increase interest, participation, and retention in STEM fields (Herrmann et al., 2016; Ireland et al., 2018; Johnson et al., 2019; McAlear et al., 2018; Niepel et al., 2019; Phume & Bosch, 2020). The lack of representation prevents the knowledge, skills, and insights of Black women from contributing to emerging technologies (Alexander & Hermann, 2016; Lehman et al., 2016; Meschitti & Smith, 2017; Sax et al., 2017).

Purpose Statement

The purpose of this transcendental phenomenological study is to describe the lived experiences of Black women with a bachelor's, master's, or doctoral degree in computer science, currently employed in the United States. At this stage in the research, Black women with a degree in computer science are generally defined as those who graduated with a bachelor's, master's, or doctoral degree in a computer science field (e.g., computer engineering, computer science, cybersecurity, data science, information systems, information technology, software engineering) from an accredited college, university, or vocational program who are currently employed in the United States. Guiding this study is Krumboltz's (1979) SLTCDM. The

SLTCDM provides a foundation for understanding how a combination of factors leads to an individual's educational and occupational preferences and skills.

Significance of the Study

This study seeks to describe the lived experiences of Black women with a bachelor's, master's, or doctoral degree in computer science, currently employed in the United States. This topic is worth exploring to bring visible, relatable, and positive representations of Black women in computer science fields through the details of their experiences. This study contributes to the existing knowledge base by showing its theoretical, empirical, and practical significance.

The theoretical significance of this study is that it provides a new application of John D. Krumboltz's (1979) SLTCDM. According to Krumboltz (1979), four factors influence career choices: genetic endowment and special abilities, environmental conditions and events, learning experiences, and task approach skills. Combining these factors can result in right or wrong generalizations about self, careers, society, beliefs, and stereotypes (Krumboltz, 1979; Krumboltz et al., 1976). Traditionally, the SLTCDM is used in research regarding counseling psychology (e.g., career counseling, career development; Scheel et al., 2018; Uyanik et al., 2017), and a few research studies apply the theory to culturally diverse populations in STEM (Evans et al., 2020; Jaeger et al., 2017). This study provides a new application of the SLTCDM (Krumboltz, 1979) to a minority group of women in STEM. The researcher utilizes the theory to support researching Black women in computer science fields and documenting their experiences. Black women's lived experiences in computer science fields are legitimate, and their voices need to be heard to uplift and empower other Black women in STEM fields (Ong et al., 2018; Rice et al., 2019; Yamaguchi & Burge, 2019).

The empirical significance of this study is that it fills an existing gap in the literature and contributes new empirical research on Black women in computer science fields. Black women have always shown interest in computing fields and have also faced obstacles while pursuing academics or careers in computing (Alexander & Hermann, 2016; Johnson et al., 2019; McGee & Bentley, 2017; Washington Lockett et al., 2018). Some Black women have persisted in their STEM education and have successful careers in computing fields (Cheryan et al., 2017). Research on women and women of color in STEM is available; however, there is a lack of empirical research on Black women in computer science fields and their motivation to persist over time (Amon, 2017; Collins et al., 2020; Herrmann et al., 2016; Yamaguchi & Burge, 2019). This study also presents an opportunity to encourage other researchers to identify more balanced (e.g., both positive and negative) experiences that could increase Black female representation in computer science fields.

The practical significance of this study consists of its importance and usefulness in the real world. This study provides beneficial information for Black women looking to start academic studies or pursue lifelong careers in computer science fields. Increasing the number of Black women in computing is advantageous for technology in the United States (Crain & Webber, 2021; Crawford et al., 2021; Fong et al., 2021). For businesses to excel, push innovation and discovery, and promote diverse perspectives and ideas, they should consider maximizing the talents of more women in the workplace (Ireland et al., 2018; Ong et al., 2018; Yamaguchi & Burge, 2019). Illuminating and sharing the experiences of successful Black women in computer science fields is crucial to the expansion, growth, promotion, and support for more Black women entering or desiring to enter this field (Ong et al., 2018; Rice et al., 2019; Vitores & Gil-Juárez, 2016; Yamaguchi & Burge, 2019). The lack of visible role models contributes to a lowered sense of belonging and retention among Black women in STEM fields (Clark et al., 2021; Dung et al., 2019; Lewis et al., 2017; Niepel et al., 2019). Even though it is known there are social injustices and underrepresentation present in computer science fields for Black women (Ong et al., 2018; Rice et al., 2019; van Tuijl & van der Molen, 2016; Yamaguchi & Burge, 2019), this study will focus on a balanced view of Black women's experiences of success in computer science fields. This study will describe real-life experiences and success stories, as well as uncover examples of success strategies for other Black women considering computer science fields both academically and as a career in the future.

Research Questions

Research questions should provide direction for the study and bring attention to meaning, thus stirring more interest in studying the phenomenon (Moustakas, 1994; Patton, 2015). Phenomenological research questions should be open-ended, evolving and nondirectional, must always be about the lived experiences, and be free from assumptions (Creswell & Poth, 2018; Peoples, 2021). The following central research question and sub-questions allow for further exploration into the lived experiences of Black women with a bachelor's, master's, or doctoral degree in computer science, currently employed in the United States.

Central Research Question

The central research question for this phenomenological study follows Moustakas's (1994) recommendation to ask questions about the participants' experiences and the context in which they experienced the phenomenon. What are the lived experiences of Black women with a bachelor's, master's, or doctoral degree in computer science, currently employed in the United States? Deficient within current research are the voices and life experiences that have contributed to the motivation and persistence of Black women in STEM career fields (Alexander &

Hermann, 2016; Amon, 2017; Collins et al., 2020; Lehman et al., 2016; Ong et al., 2018; Vitores & Gil-Juárez, 2016; Yamaguchi & Burge, 2019). It is also critical to hear and learn about the experiences of Black women in computing fields to promote inclusiveness in computer science fields and the technological workforce (Alexander & Hermann, 2016; Ong et al., 2018; Yamaguchi & Burge, 2019).

The following sub-questions follow Krumboltz's (1979) SLTCDM by addressing three of the following factors that influence CDM: genetic endowment and special abilities, environmental conditions and events, and learning experiences.

Sub-Question One

How do Black women in computer science fields describe the impact of race and gender on their career decision-making? This first sub-question aligns with Krumboltz's (1979) first factor influencing CDM: genetic endowment and special abilities. According to Krumboltz (1979), certain inherited qualities (e.g., race, gender, nationality, ethnicity, physical appearance, characteristics, handicaps) may set limitations on educational and occupational preferences, skills, and selections.

Computer science fields are typically considered male-dominated fields (Charleston et al., 2014; McAlear et al., 2018; Niepel et al., 2019; Vitores & Gil-Juárez, 2016). Black women who have had success in obtaining careers in computer science fields can offer a different perspective concerning women of color in STEM (Ahn et al., 2020; Blosser, 2019). There must first be an acknowledgment of the differences in experiences of Black women from other groups of individuals to increase the participation of Black women in computer science fields (Crenshaw, 1989; Yamaguchi & Burge, 2019).

Sub-Question Two

How do Black women in computer science fields describe any environmental factors or circumstances that influenced their career decision-making? This second sub-question aligns with Krumboltz's (1979) second factor influencing CDM: environmental conditions and events. Educational and occupational decision-making is influenced by several factors outside of a person's control (Krumboltz, 1979; Krumboltz et al., 1976).

Factors include family training experiences and resources, neighborhood and community influences, and educational systems (Krumboltz, 1979; Krumboltz et al., 1976). Families adopt specific values and provide resources that communicate expectations to their children (Krumboltz, 1979; Krumboltz et al., 1976; Puccia et al., 2021). Depending on the neighborhood and community, a person's career preference can be influenced by the availability of individuals seen working in different occupations (Krumboltz, 1979; Krumboltz et al., 1976). Educational organizations, administrative policies, and educators can significantly impact the skills learned and the degree to which a person strives to excel in various endeavors (Krumboltz, 1979; Krumboltz et al., 1976).

Sub-Question Three

How do Black women in computer science fields describe the various learning experiences that influenced their career decision-making? This third sub-question aligns with Krumboltz's (1979) third factor influencing CDM: learning experiences. An individual's past learning experiences can also influence educational and occupational decision-making (Krumboltz, 1979; Krumboltz et al., 1976).

Giving these unique experiences, this study may help identify strategies and provide positive visible images to encourage other Black women to pursue and persist in STEM fields

(Ong et al., 2018; Rice et al., 2019; Yamaguchi & Burge, 2019). Learning from the experiences of others can provide social, academic, and emotional support for Black women in computer science fields (Ireland et al., 2018; Ong et al., 2018). Black women can then recognize their experiences as being shared with others as they work towards a common goal of success in their respective fields (Ireland et al., 2018; Ong et al., 2018).

Definitions

1. *Associative Learning Experiences (ALEs)* – A type of continuous learning experience where an individual's response is determined by an external stimulus within a certain cultural context (Krumboltz, 1979; Krumboltz et al., 1976). ALEs happen through observing, listening, or reading about others (Krumboltz, 1979; Krumboltz et al., 1976).
2. *Career Decision-Making (CDM)* – The process by which educational and occupational preferences and skills are used to help with the selection of occupations and fields of work (Krumboltz, 1979; Krumboltz et al., 1976).
3. *Instrumental Learning Experiences (ILEs)* – A type of continuous learning experience where an individual performs certain actions and observes the consequences of those actions (Krumboltz, 1979; Krumboltz et al., 1976).
4. *Intersectionality* – Term developed by Kimberlé Williams Crenshaw (1989) to define how individuals' experiences are shaped by their social and political identities, not limited to the intersections of race, gender, sex, class, religion, physical characteristics, or disability (Crenshaw, 1989).
5. *Social Learning Theory* – Theory developed by Albert Bandura (1977) that states learning is a process that occurs by observing and imitating the behaviors of others while

also observing the rewards and punishments for those behaviors (Bandura, 1977; Bandura et al., 1963).

6. *Social Learning Theory of Career Decision-Making (SLTCDM)* – Theory developed by John D. Krumboltz (1979) to explain why individuals make certain career decisions and how those decisions are made through continuous learning experiences (Krumboltz, 1979; Krumboltz et al., 1976).
7. *Underrepresented Minority groups (URM)* – Black or African American, Latinos or Hispanics, Asians or Pacific Islanders, and American Indian or Alaska Natives (NSB, 2020). Regarding STEM, women are also considered a minority group (Amon, 2017; Ellis et al., 2016; Snyder & Cudney, 2017; Wang et al., 2017).

Summary

The problem is that Black women who persist in computer science fields and their experiences are scarce and often undocumented. Existing research lacks positive relatable real-world experiences of Black women in STEM fields, specifically computer science fields. The purpose of this transcendental phenomenological study is to describe the lived experiences of Black women with a bachelor's, master's, or doctoral degree in computer science, currently employed in the United States. The motivation for conducting this study is to bring prominence to other Black women's voices in computer science fields. Hearing the experiences of other Black women who were motivated and persisted in a computer science field could increase representation. This topic is also worth exploring to gain a deeper understanding of the lived experiences of Black women in computer science fields, thus uncovering the grit, commitment, and willingness of these Black women to overcome obstacles and pursue careers in STEM fields.

CHAPTER TWO: LITERATURE REVIEW

Overview

Chapter Two provides context for the study through a comprehensive review of the existing literature on the research topic and supports the need for the study. First, the theoretical framework underpinning the study is presented. Second, a review of the related literature is given to justify the necessity and importance of conducting this research study. Lastly, Chapter Two concludes with a summary identifying how this study fills gaps in the existing literature and demonstrates practical significance.

Theoretical Framework

Studying a phenomenon through the lens of different perspectives helps the researcher focus the study and better understand the phenomenon (Peoples, 2021). The following theory will help focus the research on the lived experiences of Black women with a bachelor's, master's, or doctoral degree in computer science, currently employed in the United States and provide a theoretical framework. Krumboltz's (1979) social learning theory of career decision-making (SLTCDM) provides a foundation for understanding how a combination of factors leads to an individual's educational and occupational preferences and skills. Through an individual's experiences, their skills, interests, beliefs, values, and work ethics are influenced by what they learn (Krumboltz & Worthington, 1999). The SLTCDM (Krumboltz, 1979) serves as the primary lens to frame this study and through which the researcher will describe the experiences of Black women with a bachelor's, master's, or doctoral degree in computer science, currently employed in the United States.

Social Learning Theory of Career Decision-Making

There are theories of learning that suggest learning is the result of conditioning, reinforcements, and punishments (Miller & Dollard, 1941), or that learning occurs by observing the actions of others, and new behaviors are thus developed by observing, imitating, and modeling other people (Bandura, 1977; Bandura et al., 1963). Krumboltz's (1979) SLTCDM is rooted in Bandura's (1977) social learning theory and extends Bandura's work by describing how learning experiences influence an individual's career path (Krumboltz, 1979; Krumboltz et al., 1976). In particular, the SLTCDM helps explain how individuals choose their educational and occupational preferences and acquire specific skills, as well as how academic, occupation, and field of work selections are made (Krumboltz, 1979; Krumboltz et al., 1976; Krumboltz & Worthington, 1999; "Krumboltz's Social Learning Theory," 2008). According to SLTCDM, four factors influence the nature of career decision-making (CDM): (1) genetic endowment and special abilities, (2) environmental conditions and events, (3) learning experiences, and (4) task approach skills (Krumboltz, 1979; Krumboltz et al., 1976). The combination and interaction of these four factors produce unique choices as individuals move along one career path or another (Krumboltz, 1979; Krumboltz et al., 1976). The first three factors (genetic endowment and special abilities, environmental conditions and events, and learning experiences) will be used to guide this study.

Genetic Endowment and Special Abilities

Genetic endowment and special abilities refer to the "inherited qualities that may set limits on that individual's education and occupational preferences, skills, and selections" (Krumboltz et al., 1976, p. 71). According to the SLTCDM, inherited qualities could involve race, sex, physical appearance, characteristics, physical defects, and handicaps (Krumboltz, 1979; Krumboltz et al., 1976). Thus, these special abilities are innate or inherited traits rather than learned (Krumboltz et al., 1976; “Krumboltz’s Social Learning Theory,” 2008). Individuals are born into situations that can either enhance or hinder their educational and occupational preferences and opportunities (Krumboltz, 1979; Krumboltz et al., 1976; “Krumboltz’s Social Learning Theory,” 2008). For instance, some individuals are born with special abilities to draw, sing, have musical talent, or perform well at sports (“Krumboltz’s Social Learning Theory,” 2008). Internal and external influences shape their environment, the number of opportunities, and how they respond to their options (Krumboltz, 1979; Krumboltz et al., 1976).

Environmental Conditions and Events

Environmental conditions and events produce external factors that influence CDM, and these factors are usually out of the individual’s control (Krumboltz, 1979; Krumboltz et al., 1976). These events can be planned or unplanned and could be due to human actions (social, cultural, political, or economic) or natural forces (natural resources, natural disasters, climate, or geography; Krumboltz, 1979; Krumboltz et al., 1976; “Krumboltz’s Social Learning Theory,” 2008). Some examples of environmental conditions or events that can influence CDM include the number and nature of job and training opportunities, the rate of return for various occupations, labor laws, union rules, technological developments, changes in social organization, family experiences and resources, educational systems, and neighborhood and community influences (Krumboltz, 1979; Krumboltz et al., 1976).

Learning Experiences

An individual’s past learning experiences have a strong influence on CDM, and each learning experience is unique to that individual (Krumboltz, 1979; Krumboltz et al., 1976; “Krumboltz’s Social Learning Theory,” 2008). There are an infinite number of variations of learning experiences that can influence career preferences, career selections, and the development of specific skillsets (Krumboltz, 1979; Krumboltz et al., 1976). According to the SLTCDM, two basic types of learning experiences can impact CDM: instrumental learning experiences and associative learning experiences (Krumboltz, 1979; Krumboltz et al., 1976; Krumboltz & Worthington, 1999).

Instrumental Learning Experiences (ILEs). ILEs are those experiences where actions are taken, and the consequences of those actions are observed (Krumboltz, 1979; Krumboltz et al., 1976; Krumboltz & Worthington, 1999). Whether the outcomes are positive or negative, learning is taking place, and future decision-making is affected (Krumboltz & Worthington, 1999). For instance, positive results produce positive changes in behavior and increase the likelihood of repeating the behavior (Krumboltz et al., 1976). Likewise, negative results would decrease the possibility of repeating the behavior (Krumboltz et al., 1976). ILEs consist of three general components: antecedents (the four factors that influence CDM), behaviors (cognitive and emotional responses and overt actions), and consequences (direct effects of the actions and mental and emotional reactions experienced by the individual; Krumboltz, 1979; Krumboltz et al., 1976). For CDM, ILEs are successive learning experiences that help individuals develop the necessary skills for successful career planning, development, and educational or occupational performance (Krumboltz, 1979; Krumboltz et al., 1976; "Krumboltz's Social Learning Theory," 2008).

Associative Learning Experiences (ALEs). ALEs are those experiences where observational learning occurs, which produces positive and negative generalizations (Krumboltz, 1979; Krumboltz et al., 1976). The pairing of two events in time or location once considered a neutral situation is now associated with a positive or negative outcome (Krumboltz, 1979;

Krumboltz et al., 1976; Krumboltz & Worthington, 1999; "Krumboltz's Social Learning Theory," 2008). For CDM, these associations can be formed by words spoken, images on film, reading, observing others, and direct experiences (Krumboltz, 1979; Krumboltz et al., 1976). From these associations, stereotypes regarding occupations can influence how attractive or unattractive professions are to certain individuals (Krumboltz, 1979; Krumboltz et al., 1976). Individuals tend to form generalizations regarding entire occupations from the limited examples they observe, and the initial impressions formed are usually the lasting ones (Krumboltz, 1979; Krumboltz et al., 1976). Thus, how individuals build associations regarding occupations is essential for the CDM process.

In summary, Krumboltz's (1979) SLTCDM can serve as a framework for this study to describe the lived experiences of Black women with a bachelor's, master's, or doctoral degree in computer science, currently employed in the United States. This study will expand the SLTCDM to Black women in computer science fields and utilize the theory to support researching the experiences of Black women who have persisted in other science, technology, engineering, and mathematics (STEM) career fields. For this study, the researcher will focus on three of the four factors of SLTCDM: genetic endowment and special abilities, environmental conditions and events, and learning experiences. Genetic endowment and special abilities influence CDM because situations individuals are born into either help or hinder educational and occupation opportunities (Krumboltz, 1979). Biological influences such as genetics, hereditary factors, and physical appearance play a significant role in whether Black women pursue STEM occupations (Cheryan et al., 2017; Jaeger et al., 2017). Also, Black women's math and science abilities are shaped by exposure to cultural beliefs and stereotypes regarding a woman's capacity for STEM fields (Ehrlinger et al., 2018; Jaeger et al., 2017; Lee, 2020; Thébaud & Charles, 2018).

Environmental conditions and events influence CDM through human actions and natural forces outside of an individual's control (Krumboltz, 1979). Society, culture, and political, economic, and environmental factors all play a role in whether Black women pursue STEM occupations (Cheryan et al., 2017; Dekelaita-Mullet et al., 2021; Jaeger et al., 2017; Yamaguchi & Burge, 2019). Learning experiences influence CDM because skills, interests, beliefs, values, and work habits are learned and developed over time to support educational and occupational opportunities (Krumboltz & Worthington, 1999). Also, ILEs and ALEs are powerful at changing the trajectories of CDM of Black women regarding STEM fields Collins, 2018; Jaeger et al., 2017; Lewis et al., 2017). By providing a platform for the unheard lived experiences of Black women with degrees in computer science fields, the hope is these experiences would increase the retention and motivation for young Black women to pursue academics and professional careers in these fields (Amon, 2017; Johnson et al., 2019).

Related Literature

To initially believe all individuals are treated equally and considered part of the majority is normal. Not until questions are asked about others' experiences is there a realization that all voices are not in the majority. For instance, within STEM education and career fields, the marginalization of groups of individuals is created by focusing solely on the voices of the majority while ignoring other minority groups (Collins, 2018; Crenshaw, 1989; McAlear et al., 2018; Meschitti & Smith, 2017; Ong et al., 2018; Rice et al., 2019; Yamaguchi & Burge, 2019). For Black women, the lack of attention given to their experiences in STEM fields has continued to feed the narrative of their underrepresentation in STEM (Collins, 2018; Ireland et al., 2018; Lewis et al., 2017; Ong et al., 2018; Watkins & Mensah, 2019). Emphasizing Black women's lived experiences in STEM and the factors contributing to their motivation and persistence, specifically in computer science fields, is lacking in current research (Alexander & Hermann, 2016; Amon, 2017; Collins et al., 2020; Lehman et al., 2016; Ong et al., 2018; Vitores & Gil-Juárez, 2016; Yamaguchi & Burge, 2019).

The Foundation of Computing

For the last few decades, computing and other STEM fields have been perceived as exclusively open to White males (Charleston et al., 2014; Collins et al., 2020; McGee & Bentley, 2017; Niepel et al., 2019; Shin et al., 2016). However, this exclusivity in computing for White males has not always been the case. Initially, programming was considered a low-status clerical position (Dick, 2016; Light, 1999; Vogel, 2017) and determined by men to be "pink collar" work (Dick, 2016; Duffy & Schwartz, 2018; Dung et al., 2019; Reid & Mason, 2017). Programming computer "software" was associated with feminine characteristics, while building and maintaining computer "hardware" was associated with masculine traits (Chun, 2011; Dick, 2016).

The Pink Ghetto

The "pink ghetto" is a term used to describe the industry of jobs occupied mainly by women (Allen et al., 2019; Duffy & Schwartz, 2018; Reid & Mason, 2017). Louise Kapp Howe (1978) introduced the term "pink collar" work to refer to those jobs traditionally held by women. During the late 20th century, these jobs included cooking and cleaning (e.g., homemaker), doing hair (e.g., beautician), and serving others (e.g., waitress; Duffy & Schwartz, 2018; Howe, 1978). Post-Civil War, "pink collar" jobs grew to include broader categories of clerical and office-type occupations (Allen et al., 2019) such as stenographers, typists and secretaries, shipping and receiving clerks, clerical and kindred workers, office machine operators, bookkeepers, accountants, cashiers, telephone operators, sales workers, salespersons, sales demonstrators, and real estate salespersons (Bremner, 1992).

Computing became a profession during World War II, and those involved in this profession were called human computers (Dick, 2016; Grier, 2001; Light, 1999). During World War II, the United States government recruited men to fight in the war, and the government also encouraged women to take on jobs previously occupied by men (Light, 1999; Little, 2017). Therefore, most human computers were women, and many were college-educated (Dick, 2016; Grier, 2001; Light, 1999). Thus, the list of "pink collar" jobs soon included computing, as it was seen as a low-status clerical position for women (Dick, 2016; Light, 1999; Vogel, 2017). It was not until the 1950s and 1960s that specializing in computing became increasingly male-dominated (Dick, 2016), and there were efforts to establish computing accordingly as a high-status white-collar profession (Vogel, 2017). Thus, the transformation of coding from feminine clerical work to highly masculine work disassociated computing from its origins (Amon, 2017; Dick, 2016; Light, 1999; Vogel, 2017).

"She" Was the Computer

Until about 1945, "computers" referred to those individuals who could perform complex calculations (Chun, 2011; Dick, 2016; Grier, 2001; Light, 1999; Poster, 2018). These "computers" were tasked with producing calculation tables to assist military personnel and others in looking up solutions for various numerical problems (Dick, 2016; Light, 1999). These calculation tables were created for bombing and ballistics trajectories and atomic weapons (Dick, 2016; Grier, 2001; Poster, 2018). Most of these calculations were performed by hand, most commonly by women (Dick, 2016; Light, 1999; Little, 2017). The tasks of human "computers" were eventually transferred to machine computers, and women were some of the first operators of those machines (Abbate, 2012; Dick, 2016; Poster, 2018).

Built during World War II between 1943 and 1945, the Electronic Numerical Integrator and Computer (ENIAC) was the first electronic, general-purpose, large-scale digital computer (Dick, 2016; Little, 2017; Spinellis, 2017). The ENIAC was developed by the Moore School of Engineering at the University of Pennsylvania and was designed to calculate bombing and ballistic trajectories (Dick, 2016; Light, 1999; Poster, 2018)—the same bombing and ballistic trajectories and calculations nearly 200 women as human computers had previously done by hand (Dick, 2016; Light, 1999; Poster, 2018).

Super Heroines of the ENIAC

Six women considered the best human "computers" were selected as programmers to learn how to program the ENIAC in July 1945 (Light, 1999; Little, 2017). These six women are credited with being the first ENIAC programmers: Kathleen McNulty, Frances Bilas, Betty Jean Jennings, Ruth Lichterman, Elizabeth Snyder, and Marlyn Wescoff (Chun, 2011; Dick, 2016; Light, 1999; Little, 2017). These women not only understood how to program the ENIAC, but also understood intimately how the machine worked (Chun, 2011; Dick, 2016; Light, 1999; Little, 2017).

The ENIAC women coders were credited with displaying mastery and extensive knowledge of the ENIAC and played a significant role in shaping and making the machine functional (Chun, 2011; Light, 1999; Little, 2017). Unfortunately, in 1946, the success of the ENIAC was deliberately attributed to the designers of the machine, and the contributions of the women involved were not credited (Light, 1999; Little, 2017). This statement was published in the *New York Times* on February 15, 1946: "The ENIAC was then told to solve a difficult problem that would have required several weeks' work by a trained man. The ENIAC did it in exactly 15 seconds" (as cited in Light, 1999, p. 474), thus ignoring the fact that the only reason the ENIAC could complete these calculations in 15 seconds was due to the massive amount of time women had spent programming the machine (Light, 1999).

Contributions of Black Women

Black women have made many significant contributions to STEM professions that have impacted the world (Brown, 2011). Alice Augusta Ball was a pharmaceutical chemist who developed a treatment for Hansen's disease (also known as leprosy) in 1915; she was only 23 years old at the time (Brown, 2011). The treatment became known as the "Ball Method" and has been used to treat patients worldwide. Ms. Ball was also the first Black woman to graduate with a Master of Science degree in chemistry from the College of Hawaii (Brown, 2011).

During World War II, there was a great need for scientists, so Marie Maynard Daly obtained a fellowship from Columbia University for her doctoral studies (Brown, 2011). As a result, she became the first Black woman to receive a doctoral degree in chemistry (Brown, 2011). Dr. Daly is also credited with discovering the role cholesterol plays in heart problems and how sugar and smoking affect the heart (Brown, 2011).

Katherine Coleman Johnson was one of many Black women who were instrumental individuals at the National Aeronautics and Space Administration (NASA; Condon, 2018; Warren, 1999). In 1937, she earned her Bachelor of Science degree in mathematics and French, and she taught mathematics in the classroom until 1953 (Warren, 1999). While working at NASA, her mathematical computations were used to track the trajectories of two astronauts, the 1961 Mercury flight of Alan Shepard and the 1962 Mercury flight of John Glenn (Warren, 1999). Johnson is also credited with providing the trajectories for the Apollo moon landing project at NASA (Warren, 1999). Real-world examples like these could help limit the real difficulties of succeeding in STEM while increasing a sense of drive and determination in Black women (Amon, 2017; Niepel et al., 2019; Ong et al., 2018; Pietri et al., 2018; Vitores & Gil-Juárez, 2016).

Examination of Race and Gender

Over the last decade, the United States has seen an increase in the need for individuals majoring in STEM fields (Ellis et al., 2016; Roberts et al., 2018; Snyder & Cudney, 2017). STEM fields provide opportunities for individuals to impact the entire economy (Ireland et al., 2018; McAlear et al., 2018). STEM education and employment are continuously increasing in other countries, while here in the United States, STEM appears to be on the decline and lacks diversity (Alexander & Hermann, 2016; Ma & Liu, 2017; Pascale et al., 2021; Snyder & Cudney, 2017; Thébaud & Charles, 2018). For the United States to compete with other countries, ensure the strength of the economy, and maintain its economic leadership nationally, growth in STEM fields is necessary (Alexander & Hermann, 2016; Bahr et al., 2017; Crain & Webber, 2021; Ireland et al., 2018; Ma & Liu, 2017; McAlear et al., 2018; Snyder & Cudney, 2017; Wolf & Terrell, 2016). Without an increase in STEM workers from diverse backgrounds and with unique expertise, there is a possibility of negative repercussions for the United States economy and international security risks (Alexander & Hermann, 2016; Collins, 2018; Ireland et al., 2018; Ma & Liu, 2017; McAlear et al., 2018; Ong et al., 2018; Poster, 2018).

Diversity and Inclusion

In the United States, diversity in STEM continues to be a primary concern (National Center for Science and Engineering Statistics [NCSES], 2021). Diversity and inclusion are known to contribute to positive learning experiences and mental growth in STEM education

(Lawson et al., 2018; Niepel et al., 2019; Ong et al., 2018). Likewise, diversity and inclusion in STEM gives women and people of color the opportunity to see others who look like them in STEM fields (Niepel et al., 2019; Ong et al., 2018). Gender, racial, and ethnic discrimination, negative racial stereotypes perpetuated in the workplace and educational environments, and minorities experiencing microaggressions and isolation from White peers (e.g., structural racism) are some of the negative factors influencing the lack of diversity and inclusion in STEM (Ahn et al., 2020; Alexander & Hermann, 2016; Clark et al., 2021; Daniels & Robnett, 2021; Herrmann et al., 2016; Lee et al., 2020; McGee & Bentley, 2017; Ong et al., 2018; Sax et al., 2017; Smith & Gayles, 2018; van Tuijl & van der Molen, 2016; Warren, 1999). A valid argument for diversity in STEM fields is that the current workforce should mirror the current population if the United States desires to continue competing with other countries (Alexander & Hermann, 2016; Fong et al., 2021; Ma & Liu, 2017; McAlear et al., 2018; Snyder & Cudney, 2017; Wolf & Terrell, 2016;). A diverse national STEM workforce is essential to ensure the future economic growth and prosperity of the United States (Alexander & Hermann, 2016; Evans et al., 2020; Lawson et al., 2018; McAlear et al., 2018; Smith & Gayles, 2018; Snyder & Cudney, 2017). In addition, the continued lack of gender and racial/ethnic diversity promotes the prevailing masculine culture in STEM fields, keeping women and people of color from seeing how they fit in STEM (Cheryan et al., 2017; Niepel et al., 2019; Pietri et al., 2018; Snyder & Cudney, 2017; Poster, 2018). Unfortunately, attitudes within the scientific community towards diversification have followed society's same pattern of associating masculinity with STEM while trying to exclude specific individuals (Garcia, 2020; Manning, 1991; NASEM, 2020; Niepel et al., 2019; Pietri et al., 2018).

Since there is plenty of research on success strategies to promote diversity and inclusion and encourage participation, there is no reason for STEM fields to lack diversity (Lawson et al., 2018; Niepel et al., 2019; Sax et al., 2017; Yamaguchi & Burge, 2019). A few success strategies include STEM diversity conferences, seminars, and clubs, camps, or groups (e.g., code.org, Girls Who Code, Black Girls Code, Google's "Made With Code" campaign, and TECHNOLOchicas) to encourage participation and bring together individuals in STEM to meet and support each other (Alexander & Hermann, 2016; Cheryan et al., 2017; NASEM, 2020; Niepel et al., 2019; Ong et al., 2018; Poster, 2018; Sax et al., 2017; Smith et al., 2019). People consider diversity conferences in STEM fields as rare opportunities for all racial/ethnic groups to be represented in STEM (Ong et al., 2018; Poster, 2018). Seminars and conferences provided through educational institutions and professional organizations offer a means to pursue diversification and integration within STEM (Ong et al., 2018; Poster, 2018). STEM departments within educational institutions can increase the visibility of gender and racial/ethnic diversities through social events (e.g., career fairs, mentoring programs, STEM clubs) and printed materials (e.g., department newsletters, inspiring faculty) featuring women and students of color (Alexander & Hermann, 2016; Niepel et al., 2019; Ong et al., 2018; Poster, 2018). In the workplace and institutions of higher learning, organizations should seek to value diverse perspectives and contributions more within their STEM areas (Amon, 2017; Niepel et al., 2019; Poster, 2018; Smith & Gayles, 2018; Snyder & Cudney, 2017).

Female Representation in STEM

Although women make up about half of the workforce in the United States, they only account for approximately 30% of the STEM career fields (Amon, 2017; Bahr et al., 2017; Cabell et al., 2021; Ellis et al., 2016; Snyder & Cudney, 2017; Wang & Degol, 2017), mirroring the same patterns of low representation in STEM education (Cheryan et al., 2017; Dekelaita-Mullet et al., 2021; Sax et al., 2017). For instance, STEM fields such as computer science, engineering, and physics have a low representation of women (Cheryan et al., 2017; Ehrlinger et al., 2018; Evans et al., 2020; National Academies of Sciences, Engineering, and Medicine [NASEM], 2020; Pew Research Center, 2021; Sax et al., 2017; Smith & Gayles, 2018). In 2017, women accounted for 27% of computer scientists, 16% of engineers, and 29% of physical scientists, compared to 50% of the workforce in life sciences, psychology, and social sciences (NSB, 2020). Female students are also among the minority group of students earning STEM degrees in various computing fields in the United States (Alexander & Hermann, 2016; Evans et al., 2020; Lewis et al., 2017; Pew Research Center, 2021; Poster, 2018; Roberts et al., 2018; Sax et al., 2017; van Tuijl & van der Molen, 2016; Wang et al., 2017; Washington Lockett et al., 2018). For instance, between 2000 and 2017, women's share of bachelor's degrees in computer science declined from 28% to 19%, and in mathematics and statistics declined from 48% to 42% (NSB, 2019). In 2017, although women earned many of the degrees awarded at all degree levels in STEM fields, participation in areas such as computer science, engineering, physics, mathematics and statistics, and earth, atmospheric, and ocean sciences still varied and remain historically low (NSB, 2019). Unlike STEM bachelor's degrees received by women, doctoral degrees increased from 39% in 2000 to 45% in 2017 across all STEM fields (NSB, 2019). In 2017, women earned one quarter of doctoral degrees in engineering, an increase from 16% in 2000, but computer sciences (23%) and mathematics and statistics (27%) postgraduate degrees remained relatively low (NSB, 2019).

The concern that women are not represented well in STEM careers across the United States is warranted (Alexander & Hermann, 2016; Daniels & Robnett, 2021; King & Pringle, 2019; Lehman et al., 2016; Meschitti & Smith, 2017; Pew Research Center, 2021; Pietri et al., 2018; Sax et al., 2017; van Aalderen-Smeets & Walma van der Molen, 2018; Washington Lockett et al., 2018). Lack of representation means fewer women can contribute their knowledge, skills, and insights towards emerging technologies (Alexander & Hermann, 2016; Ireland et al., 2018; Lehman et al., 2016; Sax et al., 2017). The lack of women in STEM also reduces the number of qualified individuals in high demand in STEM fields (Alexander & Hermann, 2016; Ireland et al., 2018; Poster, 2018; Sax et al., 2017). Diversity and inclusion in STEM are societal needs (Lawson et al., 2018; Lee et al., 2020; Niepel et al., 2019), but some argue diversity may not be enough to shift the STEM workforce (Pew Research Center, 2021). Others believe improving equity and diversity in STEM should improve representation for women and people of color (Lee et al., 2020; NASEM, 2020; Ong et al., 2018; Snyder & Cudney, 2017). Until there is more visible representation of women and minorities in STEM fields, women and people of color may have limitations on deciding whether to pursue a STEM career (Amon, 2017; Dung et al., 2019; McGee & Bentley, 2017; Niepel et al., 2019; Poster, 2018). The strategies implemented to diversify STEM thus far have focused on race and gender as separate issues (e.g., being Black or a woman) while overlooking strategies that could support unique experiences involving the intersections of race and gender (e.g., being a Black woman; Blosser, 2019; Charleston et al., 2014; Crenshaw, 1989; Johnson et al., 2019; McAlear et al., 2018; Nix & Perez-Felkner, 2019; Rankin & Thomas, 2020; Rice et al., 2019; Wang et al., 2017; Yamaguchi & Burge, 2019).

Intersectionality. Intersectionality refers to how people's experiences are shaped based on their social and political identities (Crenshaw, 1989; Rankin & Thomas, 2020; Rice et al., 2019; Yamaguchi & Burge, 2019). These social and political identities include but are not limited to the intersections of race, gender, sex, class, religion, physical characteristics, or disability (Blosser, 2019; Crenshaw, 1989; Johnson et al., 2019; McAlear et al., 2018; Ong et al., 2018; Rankin & Thomas, 2020; Rice et al., 2019). In 1989, Kimberlé Williams Crenshaw was the first person to define intersectionality as she delved into the oppression of women of color in society (Crenshaw, 1989; Rankin & Thomas, 2020; Rice et al., 2019). She used intersectionality as a concept to help others understand the injustice, oppression, and marginalization against women of color (Crenshaw, 1989; Rice et al., 2019; Yamaguchi & Burge, 2019). Crenshaw (1989) believed current research lacked a transformative theory to explain and highlight the issues women of color experience because of the intersections of identities such as race and gender. Her goal in defining intersectionality was to support ending the disproportionate social positions of women of color, namely Black women, in academics, the workplace, and society (Blosser, 2019; Creswell & Poth, 2018; Johnson et al., 2019).

Representation of Women of Color

The diversity and inclusion issues in STEM go far beyond a lack of women in STEM career fields because there is also low representation of people of color (Amon, 2017; Lehman et al., 2016; Ma & Liu, 2017; McAlear et al., 2018; Meschitti & Smith, 2017; Niepel et al., 2019; Ong et al., 2018; van Tuijl & van der Molen, 2016; Yamaguchi & Burge, 2019). Diverse perspectives in STEM can promote innovative technologies and bring awareness and recognition to common oversights (e.g., colorblind algorithms; gender and racial bias) that often affect women of color (Blosser, 2019; Ireland et al., 2018; Lehman et al., 2016). For instance, algorithms used by Google are known to link search terms “Black girls” and “Black women” to pornographic images and discriminatory phrases and images (Noble, 2018). These oversights can happen when only White men and their individual perspectives are involved in the development process (Blosser, 2019). Thus, retention of women of color in STEM is clearly a significant concern (Alexander & Hermann, 2016; Amon, 2017; Collins, 2018; Dung et al., 2019; Johnson et al., 2019).

Research shows that having diversity in STEM inclusive of minority women drives innovation in technology and increased profits for companies who truly value diversity (Crawford et al., 2021; Lehman et al., 2016; Yamaguchi & Burge, 2019). Therefore, institutions of higher learning should continually update their STEM programs to become more diverse and inclusive (Evans et al., 2020; Niepel et al., 2019; Ong et al., 2018; Poster, 2018). Getting more women of color in STEM starts with access to the higher education pipeline, as well as increasing resources and support for minority populations in STEM (Ireland et al., 2018; Ma & Liu, 2017; Manning, 1991; Yamaguchi & Burge, 2019). Research suggests that if the number of women of color starting in STEM persisted through graduation and entered the STEM workforce, the reported lack of qualified STEM workers in the United States could be resolved (Alexander & Hermann, 2016). Institutions willing to support diversity and inclusion in STEM should also be receptive to understanding the specific needs of women of color to persist in their STEM education programs (Amon, 2017; Ong et al., 2018; Yamaguchi & Burge, 2019).

Research shows that students who share the same gender, race, or ethnicity as faculty, staff, and educators find safety and have a stronger sense of belonging in STEM fields (Cheryan et al., 2017; Hicks & Wood, 2016; Johnson et al., 2019; Ong et al., 2018). For example, Historically Black Colleges and Universities (HBCUs) have done well to support women of color in STEM (Hicks & Wood, 2016; Johnson et al., 2019; Smith, 2016; Washington Lockett et al., 2018; Watkins & Mensah, 2019). HBCUs have most likely been successful since they can provide faculty, staff, and educators with whom their general student population (e.g., Black or

African American) can relate (Hicks & Wood, 2016; Johnson et al., 2019; Smith, 2016; Washington Lockett et al., 2018; Watkins & Mensah, 2019). However, many institutions in the United States, men (e.g., White, Asian) dominate STEM faculty positions (Cheryan et al., 2017; Herrmann et al., 2016; Lawson et al., 2018; Lewis et al., 2017; McGee & Bentley, 2017; Meschitti & Smith, 2017; Ong et al., 2018). The dominance of male faculty in STEM education is a disadvantage to women of color, especially Black women (Alexander & Hermann, 2016; Amon, 2017; McGee & Bentley, 2017).

Black Women and STEM

For Black women, marginalization has continued to feed the decline of their representation in STEM fields (Amon, 2017; Ireland et al., 2018; Lehman et al., 2016; Ong et al., 2018), and they are considered one of the most marginalized groups of individuals in STEM (Lewis et al., 2017; Ong et al., 2018; Yamaguchi & Burge, 2019). Black women are also among the least represented groups in STEM, even though many have interest in these fields (Ireland et al., 2018; Johnson et al., 2019; Lewis et al., 2017). Research suggests that instead of promoting all URM in STEM, it would benefit institutions to focus on Black women as an individual group (Ahn et al., 2020; Crenshaw, 1989; Johnson et al., 2019). The experiences of young Black women pursuing STEM appear to include more discrimination beyond merely being women (Crenshaw, 1989; Lewis et al., 2017). The fear of discrimination and a sense of not belonging have caused many women of color to choose not to pursue academics in a STEM field (Alexander & Hermann, 2016; Blosser, 2019; Lewis et al., 2017; Ong et al., 2018; Rice et al., 2019). There are limited qualitative research studies that uncover the experiences and highlight the voices of Black women who have persisted in STEM, particularly in computer science (Washington Lockett et al., 2018; Yamaguchi & Burge, 2019).

Many Black women have done well at the undergraduate level in STEM only to face barriers and lack of opportunities preventing them from moving forward in their education and careers (Alexander & Hermann, 2016; Charleston et al., 2014; Crenshaw, 1989; Hu & Ortagus, 2019; Lewis et al., 2017; Ong et al., 2018; Pietri et al., 2018). Research shows some Black women have expressed not feeling a sense of belonging, stating there are a lack of role models and mentorship, and believing there are fewer opportunities to engage in STEM research (Alexander & Hermann, 2016; Amon, 2017; Herrmann et al., 2016; Johnson et al., 2019; Lewis et al., 2017; Watkins & Mensah, 2019). In one study, a Black female engineering student shared she was told to her face that her professor did not want to become her research mentor because she did not have as much experience as his other students (i.e., majority White males), and she should take courses and not pursue research in engineering (Alexander & Hermann, 2016). Another student expressed how difficult it was connecting with her White peers to study outside of class because they would form cliques, and she was often left alone and not included (Alexander & Hermann, 2016). Conversely, some Black women were able to seek out or create safe spaces, find motivation in their future aspirations, and learn to adapt to their environments to help them overcome struggles in STEM that threatened their persistence (Blosser, 2019; Ong et al., 2018). Others could find mentors who looked like them and who were willing to provide crucial academic support (Ong et al., 2018; Washington Lockett et al., 2018). Now and in the future, continuing to identify safe spaces and successful strategies to encourage Black women to pursue and persist in STEM is going to be essential to the growth of Black women in various STEM fields (Amon, 2017; Blosser, 2019; Johnson et al., 2019; Meschitti & Smith, 2017; Ong et al., 2018).

Intersectional Experiences. The intersection of race and gender has created issues and has marginalized Black women for years (Collins, 2018; Crenshaw, 1989; McAlear et al., 2018; Meschitti & Smith, 2017; Rankin & Thomas, 2020). If society continues to rely solely on the experiences of the majority, the experiences of Black women will continue to be marginalized unfairly (Collins, 2018; Collins et al., 2020; Crenshaw, 1989; McAlear et al., 2018; Meschitti & Smith, 2017; Ong et al., 2018; Rice et al., 2019; Yamaguchi & Burge, 2019). Focusing on the intersectional experiences of Black women opens the door for them to voice concerns regarding their own experiences and helps overrule social standards of what is considered normal (Charleston et al., 2014; Collins, 2018; Crenshaw, 1989; McAlear et al., 2018; Meschitti & Smith, 2017; Ong et al., 2018; Rice et al., 2019; Yamaguchi & Burge, 2019). Therefore, the individual experiences of Black women with degrees in computer science fields are essential, regardless of their experiences not reflecting those of the majority (Collins, 2018; Collins et al., 2020; Crenshaw, 1989; McAlear et al., 2018; Meschitti & Smith, 2017; Rice et al., 2019). Black women's experiences in computer science are different from other social groups (Yamaguchi & Burge, 2019), and their experiences cannot continue to be overlooked and treated as unimportant (Collins et al., 2020; Crenshaw, 1989). The intersection of being Black and a woman is vital, since merging the two identities creates unique narratives and experiences for Black women in computer science fields (Rankin & Thomas, 2020; Yamaguchi & Burge, 2019). Their intersectional experiences in computer science fields paint a distinct picture of how they have navigated the STEM pipeline (Rankin & Thomas, 2020).

Educational and Occupational CDM

The environment influences educational and occupational preferences through biological influences (e.g., genetics, hereditary factors, physical appearance), parenting influences (e.g., education, income level, role models, expectations), socio-cultural influences (e.g., society and culture), and socio-historical influences (e.g., political, economic, and environmental; Cheryan et al., 2017; Krumboltz et al., 1976; van Tuijl & van der Molen, 2016). Family influence plays a significant role in whether an individual encounters people who model or advocate engaging in specific occupations or fields of work (Jaeger et al., 2017; Krumboltz, 1979; Krumboltz et al., 1976; Puccia et al., 2021; van Tuijl & van der Molen, 2016). Communities influence educational and occupational preferences depending on the types of people working in various occupations (Krumboltz et al., 1976). In addition, the sense of belonging for women interested in specific careers is elevated when society presents certain careers as gender-neutral rather than stereotypically masculine, along with encouraging effort and hard work (Lewis et al., 2017; Wang & Degol, 2017). Institutions of learning have an important role in educational and occupational preferences because education provides access to role models and career guidance while stimulating interest in particular subject areas and topics (van Tuijl & van der Molen, 2016). Technological developments bring about career opportunities for those with the necessary and valued skillsets needed (Krumboltz et al., 1976). In essence, family, friends, and peers provide a listening ear; valued individuals and role models guide and increase confidence; and faculty members, academic clubs, and organizations offer crucial educational guidance and support (Ireland et al., 2018; Meschitti & Smith, 2017; Yamaguchi & Burge, 2019)

Family Experiences and Resources

Families can significantly impact CDM (Krumboltz, 1979; Krumboltz et al., 1976) and can be a significant influence on an individual's exposure and interest in STEM academics and careers (Blosser, 2019; Chan & Wang, 2018; Cheryan et al., 2017; Ireland et al., 2018; Jacobs et al., 2017; Phume & Bosch, 2020; Puccia et al., 2021; Sax et al., 2017; Talley & Martinez Ortiz, 2017; van Tuijl & van der Molen, 2016; Vitores & Gil-Juárez, 2016). Parents, close relatives, or loved ones serve as role models through their careers, provide support and encouragement, and send implicit and explicit messages regarding an individual's choice to pursue an interest in STEM (Charleston et al., 2014; Davenport et al., 2020; Jacobs et al., 2017; Sax et al., 2017; Talley & Martinez Ortiz, 2017; Vitores & Gil-Juárez, 2016). Those who are positively reinforced by their parents, close relatives, or loved ones for participating in a learned activity that is associated with success in an academic area, occupation, or field of work are more likely to want to learn more about that area (Jacobs et al., 2017; Krumboltz, 1979; Krumboltz et al., 1976). For instance, a father who purchases a chemistry set for his young daughter is essentially encouraging her to develop an interest in chemistry (Cheryan et al., 2017). In other studies, female participants settled on majoring in engineering at a university close to family because family support was essential to their success (Blosser, 2019; Ireland et al., 2018). Female participants also shared stories of having supportive parents and family members who encouraged STEM as a lucrative career area, signed them up for STEM camps, or had STEM careers themselves (Blosser, 2019; Talley & Martinez Ortiz, 2017). M. Wang and Degol (2017) suggested that parents can also combat negative stereotypes of women in STEM by highlighting achievements of women and communicating that "men and women are receiving equivalent achievement in nearly every STEM subject and that greater numbers of women have been entering and succeeding in STEM fields in recent years" (p. 131). Encouragement like this is essential because parents are encouraging their daughters to enter fields that have been male-dominated for years (Cheryan et al., 2017).

Consistent positive reinforcement from a valued person or someone who advocates participating in an academic area, occupation, or field of work positively influences continued engagement (Krumboltz, 1979; Krumboltz et al., 1976; van Tuijl & van der Molen, 2016). However, if parents, close relatives, or loved ones express negative opinions about an academic area, occupation, or field of work, individuals may reject participating in these areas (Davenport et al., 2020; Krumboltz, 1979; Krumboltz et al., 1976). For instance, parents, relatives, and friends who ridicule or degrade occupations requiring computing skills can influence individuals to reject those types of professions (Cheryan et al., 2017; Vitores & Gil-Juárez, 2016). Other studies showed that young girls and minorities who enjoy math and science may never consider careers in STEM because they will never be exposed to STEM occupations or encouraged to take that step (Blosser, 2019; Lee, 2020; Talley & Martinez Ortiz, 2017). Young girls and minorities will require much encouragement, especially to pursue fields like computer science, engineering, and physics, to resolve the representation issues in these male-dominated areas (Blosser, 2019; Cheryan et al., 2017). Encouragement is not a solution to the underrepresentation issues but a strategy along with addressing the various barriers preventing women from entering these fields in the first place (Alexander & Hermann, 2016; Amon, 2017; Blosser, 2019; Cheryan et al., 2017; Rankin & Thomas, 2020; Yamaguchi & Burge, 2019).

Community and Supporting Network

Not knowing of many Black women in computer science fields has prevented homogeneous networks of shared experiences from increasing participation (Ong et al., 2018; Yamaguchi & Burge, 2019). Black women would benefit significantly from a support network and community of other women of color who can share their experiences (Garcia, 2020; Ireland et al., 2018; Talley & Martinez Ortiz, 2017). Having a support network and like-minded women with shared STEM experiences is critical to lowering the attrition rates of women in STEM (Garcia, 2020; Ireland et al., 2018; Ong et al., 2018). In a study on peer support and STEM success, participants shared how peer mentors encouraged them to persist during challenging times and helped them cope with the exclusiveness of often being the only Black person in their STEM course or academic department (Watkins & Mensah, 2019). The experiences of Black women in computer science fields are much different from other groups, and institutions and society must also understand this to increase their participation (Crenshaw, 1989; Ehrlinger et al., 2018; Yamaguchi & Burge, 2019).

By conducting a research study that focuses on the experiences of Black women, a framework is created to help understand the opportunities and barriers faced by Black women pursuing STEM-related disciplines and careers (Watkins & Mensah, 2019). There has been plenty of research regarding the barriers and exclusion of Black women in STEM (Alexander & Hermann, 2016; Amon, 2017; Hicks & Wood, 2016; Johnson et al., 2019; Lewis et al., 2017; Niepel et al., 2019; Ong et al., 2018; Shin et al., 2016; Smith & Gayles, 2018; van Tuijl & van der Molen, 2016; Yamaguchi & Burge, 2019), but not many success narratives or experiences have been shared or researched thoroughly (Amon, 2017; Vitores & Gil-Juárez, 2016; Yamaguchi & Burge, 2019). Giving young Black women a lens through which to see the benefits of computing skills may change their impression of what society says a computer scientist should look like (Dekelaita-Mullet et al., 2021; Yamaguchi & Burge, 2019). Increased visibility of Black women in computer science fields will provide more inspiration, motivation, and a stronger sense of belonging for those wondering if the area is attainable for them (Dung et al., 2019; Johnson et al., 2019; Niepel et al., 2019; Ong et al., 2018; Pietri et al., 2018).

Educational Systems

Educational goals and expectations motivate forces that affect educational and occupational preferences early in life (Krumboltz et al., 1976; van Tuijl & van der Molen, 2016).

Having support from school organizations, faculty, and minority organizations is critical to the success of Black women in STEM education (Evans et al., 2020; Hu & Ortagus, 2019; Ireland et al., 2018; Lawson et al., 2018; Sax et al., 2018; Watkins & Mensah, 2019). In one study, a woman of color attributed her persistence to her participation in a federally funded diversity program in computing located on her campus for URM (Ong et al., 2018). Another woman of color attributed her persistence to a Black visiting professor in physics from a neighboring institution who expressed belief in her academic abilities, held her to high expectations, and offered support to her whenever she needed it (Ong et al., 2018). Professors who provide encouragement, support, and connect with students help create a sense of belonging among female students in STEM departments (Lawson et al., 2018; Ong et al., 2018; Sax et al., 2018; van Aalderen-Smeets & Walma van der Molen, 2018; Watkins & Mensah, 2019).

In Blosser's (2019) study, three Black female students attended a national computer science conference known as the Grace Hopper Celebration. Two of the women stated that "it was the first time they had ever seen or met any professional Black women in computer science" (Blosser, 2019, p. 15). These women appreciated the efforts of their undergraduate program coordinator to help them attend the conference and stated that "their sense of belonging in computer science and their desire to continue in the field" (Blosser, 2019, p. 15) had increased significantly. Knowing and understanding the content required to succeed in computer science fields is essential but having support systems to help Black women to persist and succeed is equally important (Meschitti & Smith, 2017; Yamaguchi & Burge, 2019). Those who are developing strategies in education to help increase the representation of Black women and other women of color in STEM should adopt the intersectional approach (e.g., combining race and gender) to ensure effectiveness among minority women (Alexander & Hermann, 2016; Blosser, 2019; Collins, 2018; Johnson et al., 2019; Ma & Liu, 2017). Not all women share the same educational experiences (Charleston et al., 2014; Crenshaw, 1989), so it is imperative to consider gender and race together as relevant when discussing the representation of women of color in STEM (Alexander & Hermann, 2016; Ma & Liu, 2017).

The same prevalent gender and racial stereotypes in STEM trigger educator biases that discourage women from pursuing STEM coursework (Amon, 2017; Davenport et al., 2020; McGee & Bentley, 2017; Ong et al., 2018; Shin et al., 2016). A student is less likely to show a preference and more likely to reject specific courses of study if the student has been consistently reinforced by education departments or professors who do not model or advocate engaging in that course of study (Clark et al., 2021; Krumboltz et al., 1976). For instance, Black women in STEM have described not being able to seek help from their professors or classmates, unsupportive and disengaged professors, professors causing them to feel dumb, and subtle or overt sexist and racist remarks from classmates (Alexander & Hermann, 2016; Blosser, 2019; McGee & Bentley, 2017; Ong et al., 2018; Stearns et al., 2020). By failing to provide more opportunities to engage and encourage Black women, educators and STEM departments have played a significant role in their attrition from STEM fields (Lawson et al., 2018; Sax et al., 2018; Washington Lockett et al., 2018). Nevertheless, educators do have the power to disrupt the social and cultural norms that view Black women and other URM as less qualified or incapable of succeeding in STEM and become allies for heterogeneity in STEM (Blosser, 2019; Collins et al., 2020; Nix & Perez-Felkner, 2019).

Two-Year College STEM Success. Community colleges and technical colleges (i.e., 2-year colleges) are known for their accessibility, affordability, and open admissions (X. Wang et al., 2017). Because of this, 2-year colleges have served as excellent pathways to postsecondary education (i.e., after completing high school education) for traditionally underrepresented populations (e.g., women, minorities, first-generation college students, low-income students, part-time students; Bahr et al., 2017; Cohen & Kelly, 2020; Evans et al., 2020; Hu & Ortagus, 2019; X. Wang et al., 2017). Two-year colleges also substantially improve the number of STEM graduates and prepare STEM professionals (Bahr et al., 2017; Smith, 2016) and are generally more racial and gender-friendly in STEM environments (Hu & Ortagus, 2019; X. Wang et al., 2017). Consequently, 2-year colleges have helped underrepresented populations get early exposure to STEM courses (Bahr et al., 2017; Evans et al., 2020; Smith, 2016; X. Wang, 2016; X. Wang et al., 2017). Early exposure for URM in foundational STEM courses such as the computer sciences and physical sciences (e.g., chemistry, physics, astronomy, or geology) serve a meaningful purpose in the CDM process regarding STEM fields (Cheryan et al., 2017; Hicks & Wood, 2016; Phume & Bosch, 2020; Roberts et al., 2018; X. Wang, 2016). Therefore, 2-year colleges can contribute to the STEM workforce demands in the United States since they are favorably positioned to access a pool of students usually underrepresented in STEM fields (Cohen & Kelly, 2020; Evans et al., 2020; X. Wang et al., 2017). Some researchers found that students, in particular URM, in STEM programs at 2-year colleges are least likely to earn a bachelor’s degree in a STEM field than those who initially attend 4-year institutions (i.e., colleges or universities; Bahr et al., 2017; X. Wang et al., 2017). However, 2-year colleges foster a more significant momentum of students in their STEM coursework than do 4-year institutions, especially for underrepresented populations (Bahr et al., 2017; Chan & Wang, 2018; Hu & Ortagus, 2019; Smith, 2016; X. Wang et al., 2017).

Computer Science and Computing Technology

There is a growing demand for individuals trained in computing fields and heightening concerns regarding increasing diversity (e.g., more women and people of color; Alexander & Hermann, 2016; Ellis et al., 2016; Lehman et al., 2016; Pascale et al., 2021; van Aalderen-Smeets & Walma van der Molen, 2018; X. Wang et al., 2017; Yamaguchi & Burge, 2019). Unfortunately, women and people of color have not had a consistent increase in representation in computer science (Amon, 2017; Lehman et al., 2016; Ma & Liu, 2017; McAlear et al., 2018; Meschitti & Smith, 2017; NCSES, 2021; Niepel et al., 2019; van Tuijl & van der Molen, 2016). For instance, from 1993 to 2007, even though the share of bachelor's degrees awarded to women increased in many STEM fields, women's share of bachelor's degrees in computer sciences, mathematics, and engineering declined (NSB, 2010). Between 2006 and 2009, the number of women earning a degree in computer science decreased by 14%, compared to a 4% increase in males (NCSES, 2019). In 2007, students who earned undergraduate degrees awarded in engineering (81%), computer sciences (81%), and physics (79%) were male STEM graduates, while women earned more than half of the bachelor's degrees in psychology (77%), biological sciences (60%), agricultural sciences (50%), chemistry (50%) and social sciences (54%; NSB, 2010). Over the next decade, women made substantial gains in bachelor's degree completion in biological and agricultural fields yet fell behind men in other STEM fields such as physical sciences (39%), mathematics (43%), engineering (19%), and computer science (18%; Evans et al., 2020; NSB, 2016). In 2018, of all degrees awarded in STEM fields, women earned almost 50% of bachelor's degrees, 45% of master's degrees, and 41% of doctorates (NCSES, 2021). However, most of these degrees were awarded in psychology, biological sciences, and agricultural sciences, with fewer degrees awarded in engineering and computer sciences (Evans et al., 2020; NCSES, 2021).

Bachelor's degrees in STEM fields by race and ethnicity have continued to fluctuate over time due to population changes and increased college attendance by URM (NSB, 2010). Since 1995, the number of STEM bachelor's degrees, except for computer sciences, has increased for all racial and ethnic groups (excluding White students; NSB, 2010). In 2012, only 4.8% of students awarded computer science degrees were female minorities compared to 9.7% in biological sciences, 6.5% in physical sciences, and 5.4% in mathematics (Lehman et al., 2016). Between 2016 and 2018, the percentage of STEM degrees earned by URM increased from 22% to 24% in bachelor's degrees and 21% to 22% in master's degrees, but doctorates decreased slightly from 14% to 13.5% (NCSES, 2021). In 2018, degrees awarded to Latinos or Hispanics in STEM fields were mainly in psychology (20.0%), social sciences (18.0%), and biological and agricultural sciences (13.6%), while computer sciences and engineering were approximately 11% and 12%, respectively (NCSES, 2021). Comparatively, degrees awarded to Blacks or African Americans in STEM fields mainly were for psychology (12.2%), social sciences (11.3%), and biological and agricultural sciences (6.8%); in comparison, computer sciences and engineering were approximately 9% and 4%, respectively (NCSES, 2021). Like Latina and Hispanic women, Black and African American women earn a higher share of bachelor's degrees in psychology, social sciences, and biological and agricultural sciences than any other field under the science and engineering umbrella (NCSES, 2021).

Despite not having consistent representation of women and people of color over the years, the computing workforce has seen increased diversity among women (DuBow & Gonzalez, 2020). In 2007, White women accounted for approximately 68% of the computing and mathematical occupations (employed and experienced unemployed), while female minorities (i.e., Black/African American, Asian/Pacific Islander, and Latina/Hispanic) accounted for roughly 32% (DuBow & Gonzalez, 2020). More recently, in 2019, the numbers show an increased mix of diversity, with White women now accounting for approximately 56% of the computing and mathematical occupations (employed and experienced unemployed) and female minorities accounting for approximately 44% (DuBow & Gonzalez, 2020). The numbers are still much lower when focusing exclusively on women employed in computing and mathematical occupations by race and ethnicity (DuBow & Gonzalez, 2020). In 2019, the percentages were 15.3% (White), 3.1% (Black/African American), 6.6% (Asian/Pacific Islander), and 2.2% (Latina/Hispanic; DuBow & Gonzalez, 2020). Thus, minority women only account for roughly 11% of the computing and mathematical workforce (DuBow & Gonzalez, 2020), with Black or African American and Latina or Hispanic women remaining severely underrepresented in these fields relative to their representation in the United States population (Cabell et al., 2021; Johnson et al., 2019; NASEM, 2020; Ong et al., 2018; Yamaguchi & Burge, 2019).

Learning Experiences

Educational and occupational preferences stem from a lifelong process of making decisions from learning experiences (Jaeger et al., 2017; van Tuijl & van der Molen, 2016), and positive and negative factors influence those CDM preferences (Krumboltz, 1979; Krumboltz et al., 1976). By progressing through numerous learning experiences, individuals develop certain skills and acquire preferences for various activities (Jaeger et al., 2017; Krumboltz et al., 1976). With positive experiences, individuals are more likely to express a preference for an academic course, occupation, field of work, or the activities related to it (Krumboltz, 1979; Krumboltz et al., 1976), while negative experiences may cause individuals to be less likely to express a preference stimulating rejection of an academic course, occupation, field of work, or the activities related to it (Krumboltz, 1979; Krumboltz et al., 1976). For Black women, their learning experiences involving STEM fields and the impact their experiences have had on their persistence and CDM have not often been a focus of study (Blosser, 2019; Jaeger et al., 2017; Yamaguchi & Burge, 2019).

ILEs and ALEs on CDM

ILEs occur over a person's lifetime through rewards or punishments for specific actions or skills (Krumboltz et al., 1976; Krumboltz & Worthington, 1999). In other words, a person develops a positive association with activities or skills that bring rewards and avoidance towards activities or skills that bring punishment (Jaeger et al., 2017). For example:

> Two college undergraduate women both dreamed of becoming scientists as children. One of these women was encouraged by her teachers to participate in science fairs and almost always received first prize. The other woman had teachers who discouraged her from participating in science fairs because they believed her project ideas were not strong enough to be competitive, and on the one occasion she decided to enter a science fair against her teacher's advice, the judges criticized her project, and she did not place. In this example, the first woman would be much more likely than the second woman to pursue a major and career in science based on their opposing instrumental learning experiences. (Jaeger et al., 2017, p. 490)

Self-perceptions generated by ILEs produce generalizations about abilities and skills, thus impacting CDM (Collins, 2018; Jaeger et al., 2017; Lewis et al., 2017; van Tuijl & van der Molen, 2016).

Unlike ILEs, ALEs are driven by external forces (e.g., environment or society; Krumboltz, 1994). For example, being exposed to positive words, images, and verbal descriptions of an academic area, occupation, or field of work leads individuals to seek or continue participation in these areas (Bajcar & Bąbel, 2018; Bandura, 1977; Cherry, 2020; Krumboltz, 1979; Krumboltz et al., 1976). For example, young Black women who grew up surrounded by family members who are successful in STEM fields or positive career role models are more likely to pursue a major or career in STEM (Jaeger et al., 2017; Puccia et al., 2021). On the other hand, being exposed to negative words, images, and verbal descriptions of an academic area, occupation, or field of work leads individuals to decline to participate in these areas (Bajcar & Bąbel, 2018; Bandura, 1977; Cherry, 2020; Jaeger et al., 2017; Krumboltz, 1979; Krumboltz et al., 1976). Therefore, young Black women hearing and learning about other successful women who look like them is critical to their success in STEM fields (Herrmann et al., 2016; Ong et al., 2018; Pietri et al., 2018).

Societal Perceptions

There are differences in the way women and men are socialized; thus, their value systems and perceptions concerning interest and participation in STEM are not equal (Cheryan et al., 2017; Sax et al., 2017). If a woman believes STEM fields are valuable, meaningful, and useful, she is more likely to choose courses and pursue a career in a STEM field that coincides with her beliefs (Cheryan et al., 2017; Perez et al., 2019; M. Wang & Degol, 2017). Due to social stereotypes and norms, some women tend to view computer science and other STEM fields as individualistic fields with minimal impact on society (i.e., not community- or people-oriented) and therefore are less likely to pursue a degree in computer science (Jaeger et al., 2017; Lee, 2020; Niepel et al., 2019; Sax et al., 2017; M. Wang & Degol, 2017).

Women and women of color have a lack of interest in computing fields due to stereotypical roles, cultural gender beliefs, and the pressure on them to adhere to those roles and beliefs (Cheryan et al., 2017; Ehrlinger et al., 2018; Lee, 2020; Thébaud & Charles, 2018; van Aalderen-Smeets & Walma van der Molen, 2018; Vitores & Gil-Juárez, 2016). Many stereotypes regarding women in computer science and other STEM fields are not very positive (Alexander & Hermann, 2016; van Tuijl & van der Molen, 2016), creating an overtly unwelcoming environment towards women and further damaging to women's and URMs' interest and persistence in computing fields (Cheryan et al., 2017; Niepel et al., 2019; Pietri et al., 2018; Sax et al., 2017, 2018; van Aalderen-Smeets & Walma van der Molen, 2018). For instance, there are social notions that computer science is full of White or Asian males who are reclusive hackers, geeks, socially awkward, nerdy, technology-obsessed, or science fiction enthusiasts, and the only women (e.g., White or URM) are those who fit masculine stereotypes (Charleston et al., 2014; Cheryan et al., 2017; NASEM, 2020; Sax et al., 2017; Vitores & Gil-Juárez, 2016). There are false narratives such as computer science being a White male-dominated field, that women in general have no interest in computing, and that women and women of color do not have the natural capabilities for coding (Rankin & Thomas, 2020). Exposure to more women in computer science as well as proximity to female role models will help weaken the effects of these negative stereotypes regarding women in these fields (Cheryan et al., 2017; Dekelaita-Mullet et al., 2021; Herrmann et al., 2016; Pietri et al., 2018; Shin et al., 2016; Thébaud & Charles, 2018). Being able to identify with successful counter-stereotypical examples (i.e., women computer scientists) will help many women and those from URM to ignore and reject the negative stereotypes (Ahn et al., 2020; Dekelaita-Mullet et al., 2021; Johnson et al., 2019; King & Pringle, 2019; Phume & Bosch, 2020; Pietri et al., 2018; M. Wang & Degol, 2017; Yamaguchi & Burge, 2019).

Role Models

When individuals perceive they are similar to a valued individual or role model, their motivation to persevere and vicariously seek the same rewards increases (Bandura, 1986). Likewise, the perception of a strong connection with a future self could increase their motivation, since valued individuals and role models set examples of perseverance during both good and bad times (Herrmann et al., 2016; Shin et al., 2016). However, within the STEM community, there is a lack of awareness of the successful experiences of other Black women (Herrmann et al., 2016; Yamaguchi & Burge, 2019). One strategy to address this lack is to increase young Black women's exposure to successful Black scientists and additional female role models in the field (Johnson et al., 2019; Ong et al., 2018; Phume & Bosch, 2020; Shin et al., 2016; Washington Lockett et al., 2018). Exposure to the experiences of successful and resilient Black women in STEM can help protect other Black female students and career-seekers against the adverse effects of stereotypes in STEM (Ahn et al., 2020; Amon, 2017; Blosser, 2019; Herrmann et al., 2016; Shin et al., 2016; van Tuijl & van der Molen, 2016). There is hope that once more positive Black female figures in STEM are seen and their voices heard, more representation will occur (Herrmann et al., 2016; Ong et al., 2018; Pietri et al., 2018).

There is a benefit to having women exposed to relatable role models to encourage a sense of belonging and retention in STEM (Johnson et al., 2019). Thus, young Black women need to have access to role models among Black women in technology to support increased representation in STEM (Ahn et al., 2020; Blosser, 2019; Johnson et al., 2019; Washington Lockett et al., 2018). Role models must be credible, successful, and display the appropriate behaviors for others to learn to facilitate the attention process (Horsburgh & Ippolito, 2018). The existing literature focuses on top-down factors influencing recruiting, retaining, and promoting

STEM, but has tended to overlook factors contributing to success for Black women in STEM (Alexander & Hermann, 2016; Amon, 2017; Lehman et al., 2016; Ong et al., 2018). Among Black female students, having access to Black role models is essential to promote a continued sense of belonging, trust, and lowered stigma consciousness (Johnson et al., 2019; Yamaguchi & Burge, 2019). There are many benefits from having a successful career in STEM, and young Black women need a less filtered lens to change their thoughts and impressions of what type of individuals work in STEM fields (Yamaguchi & Burge, 2019).

Media Depictions

Whether directly or indirectly, observing others plays an essential role in an individual acquiring new knowledge and skills (Bajcar & Bąbel, 2018; Bandura, 1977; Cherry, 2020; McLeod, 2016). Symbolic modeling can happen through an indirect representation of behavior through media portrayals (e.g., books, movies, videos, TV commercials; Bajcar & Bąbel, 2018; Bandura, 1977; Cherry, 2020). Media portrayals have as much influence on CDM as parents, relatives, and friends for some individuals (Krumboltz, 1979; Krumboltz et al., 1976; van Tuijl & van der Molen, 2016). The media's lack of representation of women and women of color in computing fields and their role in circulating male-dominated depictions has taught young Black girls that these career fields do not match their race or gender identity (Lewis et al., 2017; van Tuijl & van der Molen, 2016; Vitores & Gil-Juárez, 2016). The media should create more positive representations of women in STEM so young girls and women can visually see well-rounded realistic images of successful females in STEM fields (M. Wang & Degol, 2017).

Recently, however, media outlets have started to provide the world with some stories of how Black women have been included, excluded, and then included again in STEM fields (Leslie, 2018; Niepel et al., 2019). For instance, the movie *Hidden Figures* (Melfi, 2016) described the true story of Katherine Johnson (mathematician), Dorothy Vaughan (mathematician), and Mary Jackson (engineer), three Black women who were instrumental in the launch of astronaut John Glenn's space orbit around the Earth (Condon, 2018). Other examples provided by M. Wang and Degol (2017) include *SciGirls* and *Project Scientist*. *SciGirls* is an NSF-funded television series showing young girls performing science experiments with a female scientist mentor (M. Wang & Degol, 2017). *Project Scientist* is a summer camp where girls spend five weeks studying various scientific topics, conducting hands-on experiments, and working alongside female STEM role models (M. Wang & Degol, 2017).

Summary

Historically, women have played a major role in STEM fields such as computing and provided support to the United States during war times employed as computer programmers and mathematicians (Chun, 2011; Dick, 2016; Grier, 2001; Light, 1999; Poster, 2018; Vogel, 2017). During the 1950s and 1960s, unfortunately, computing became a male-dominated white-collar profession, thus creating a disassociation of computing from its origins of feminine clerical work (Amon, 2017; Dick, 2016; Light, 1999; Vogel, 2017). The dissociation of computing as a career for women is partly to blame for the lack of interest from women and women of color. The lack of interest is also due to stereotypical roles, cultural gender beliefs, and pressures to stick to those roles and beliefs (Cheryan et al., 2017; Ehrlinger et al., 2018; Rankin & Thomas, 2020; Thébaud & Charles, 2018; van Aalderen-Smeets & Walma van der Molen, 2018).

Existing research shows that diverse perspectives and ideas promote STEM innovations and discoveries, and women and people of color need more representation in STEM fields (Crawford et al., 2021; Ireland et al., 2018; Ma & Liu, 2017; McAlear et al., 2018; Niepel et al., 2019; Ong et al., 2018; Snyder & Cudney, 2017). For fields such as computer science, women and women of color have not had an increase of consistent representation (McAlear et al., 2018; NCSES, 2021; Niepel et al., 2019). Black women are one of the most marginalized groups in STEM and are amongst the lowest of URM in computer science (Ireland et al., 2018; Johnson et al., 2019; Lewis et al., 2017; Ong et al., 2018; Yamaguchi & Burge, 2019). Essential to the growth of Black women in computer science fields are identifying success strategies, safe spaces in education, mentors, family and peer support, access to role models, and positive images of successful Black women in STEM (Alexander & Hermann, 2016; Amon, 2017; Blosser, 2019; Johnson et al., 2019; Lawson et al., 2018; Meschitti & Smith, 2017; NASEM, 2020; Niepel et al., 2019; Ong et al., 2018; Poster, 2018; Sax et al., 2017; Washington Lockett et al., 2018; Yamaguchi & Burge, 2019).

Being exposed to more Black women in computer science, proximity to female role models, and being able to identify with successful counter-stereotypical examples will help eliminate the negative stereotypes of women in computer science (Ahn et al., 2020; Cheryan et al., 2017; Dekelaita-Mullet et al., 2021; Herrmann et al., 2016; Johnson et al., 2019; Pietri et al., 2018; Shin et al., 2016; Thébaud & Charles, 2018; M. Wang & Degol, 2017; Yamaguchi & Burge, 2019). Thus, this study seeks to increase the body of literature on the experiences of Black women in STEM, specifically in computer science fields. This study will also provide a platform for Black women to share their experiences and factors contributing to their persistence in their education and career fields. Krumboltz's (1979) SLTCDM will serve as the primary framework to focus the study on how a combination of factors (e.g., genetic endowment and special abilities, environmental conditions and events, learning experiences) impact an individual's academic and occupational preferences and skills.

CHAPTER THREE: METHODS

Overview

Chapter Three describes the methods used to conduct the study. The purpose of this transcendental phenomenological study was to describe the lived experiences of Black women with a bachelor's, master's, or doctoral degree in computer science, currently employed in the United States. First, the research design chosen for the framework of this study is provided. Next, the research questions guiding the study are reiterated, followed by the study's setting and participant details. The procedures to conduct the study are outlined, a section explaining the role of the researcher is provided, and the data collection methods and data analysis procedures are described in detail. Chapter Three concludes with trustworthiness topics, ethical considerations for the research, and a summary.

Research Design

According to Creswell and Creswell (2018), qualitative research methods are useful for exploring and seeking to understand the meanings that groups or individuals attribute to their experiences. Qualitative research allows researchers to "study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them" (Denzin & Lincoln, 2018, p. 10). Since this study sought to describe the lived experiences of Black women with a bachelor's, master's, or doctoral degree in computer science, currently employed in the United States, the qualitative research method was appropriate for this study.

The phenomenological research approach was the best-suited qualitative research method to understand the real meaning of an experience and describe the essence of a lived phenomenon (Creswell & Poth, 2018; Patton, 2015). Phenomenological research emphasizes the lived experiences of a group of individuals who have experienced the same phenomenon (Creswell &

Poth, 2018). A phenomenon is a concept or idea experienced by the participants and the chosen topic of investigation in a phenomenological research study (Creswell & Poth, 2018; Gall et al., 2007). Understanding the lived experiences regarding a phenomenon and the meaning the phenomenon holds for the participants is vital to a phenomenological study (Creswell & Poth, 2018; Patton, 2015). Since the purpose of this study was to describe the lived experiences of Black women with a bachelor's, master's, or doctoral degree in computer science, currently employed in the United States, and identify the essence of their experiences, the best design for this study was the phenomenological research design.

Phenomenology was first introduced by the German philosopher and mathematician Edmund H. Husserl to study how individuals describe their experiences through their senses (Moustakas, 1994; Patton, 2015; van Manen, 2014). A key feature of phenomenological research includes exploring the phenomenon and distilling it into a single concept or idea (the essence of the experience; Creswell & Poth, 2018; Moustakas, 1994; Patton, 2015). According to Husserl, representing the true nature of the phenomenon means getting to the essence of the phenomenon, which is the ultimate goal (Moustakas, 1994). The essence is the central meaning commonly shared and understood by all participants who have experienced the phenomenon (Creswell & Poth, 2018; Moustakas, 1994; Patton, 2015). Martin Heidegger expanded on the original views of Husserl and transcendental phenomenology to introduce hermeneutic phenomenology (Peoples, 2021; van Manen, 2014). Heidegger believed it was impossible for the researcher to completely set aside their prejudgments regarding a phenomenon (Peoples, 2021; van Manen, 2014). He believed interpretation revealed what was hidden behind the phenomenon's meanings and was not an isolated activity (Moustakas, 1994).

There are two types of phenomenology: transcendental phenomenology and hermeneutic phenomenology (Creswell & Poth, 2018; Moustakas, 1994; van Manen, 2014). Transcendental phenomenology involves the researcher engaging in disciplined and systematic efforts, setting aside any prejudgments (the *epoche* process) regarding the phenomenon, and being open to various experiences as the participants describe their experiences regarding the phenomenon (Moustakas, 1994). *Epoche* is a Greek word that means to "stay away or abstain" (Moustakas, 1994, p. 85). The researcher focuses more on the in-depth descriptions of the participants' lived experiences and less on their interpretation of those experiences (Creswell & Poth, 2018; Moustakas, 1994). Hermeneutic phenomenology is different from transcendental phenomenology in that the focus is placed on interpreting the participants' experiences and providing descriptions of the experiences (Creswell & Poth, 2018; Patton, 2015; van Manen, 2014). The researcher would make their personal biases and judgments known within their research study (Peoples, 2021).

Transcendental phenomenology focuses on examining things, is concerned with examination from multiple perspectives, and is committed to the descriptions of experiences and not on explanation or analysis (Moustakas, 1994). There is importance placed on individual experiences and the expression of those experiences in the participants' own words (Moustakas, 1994; Patton, 2015; Polkinghorne, 1989; van Manen, 1990). Thus, this study utilized the transcendental approach to phenomenology.

Research Questions

Central Research Question

What are the lived experiences of Black women with a bachelor's, master's, or doctoral degree in computer science, currently employed in the United States?

Sub-Question One

How do Black women in computer science fields describe the impact of race and gender on their career decision-making?

Sub-Question Two

How do Black women in computer science fields describe any environmental factors or circumstances that influenced their career decision-making?

Sub-Question Three

How do Black women in computer science fields describe the various learning experiences that influenced their career decision-making?

Setting and Participants

The setting and participants section provides the rationale and details regarding the population demographics and physical description of the setting for this study. I utilized the online professional networking platform LinkedIn to locate professional organizations with members currently working in STEM fields. Online professional networking sites like LinkedIn provide access to small and large heterogeneous populations, offer sharing capabilities, are flexible, and reduce the time and effort involved in recruiting initial participants for research studies (Bender et al., 2017; Marks et al., 2017). In addition, using social media as a recruitment tool helps overcome the difficulties of recruiting hard-to-reach populations and can help with snowballing further participants (Bender et al., 2017; Gundur, 2019; Marks et al., 2017).

Setting

To identify a feasible site for this study, I purposefully selected organizations geared explicitly towards advocating for professional networking, education, outreach, and scholarship for women and women of color working in STEM. I contacted three random professional organizations found on LinkedIn by email (see Appendix A): Black Women in Technology, Black Women in Science and Engineering, and the Society of Women Engineers. These organizations have at least 2,000 followers on LinkedIn. They are located in major cities across the United States, including Atlanta, GA; Austin, TX; Chicago, IL; Houston, TX; Los Angeles, CA; San Diego, CA; and Washington, DC. Out of the three organizations contacted, the Society of Women Engineers (SWE) had the largest number of followers and responded to my email with interest in the study (see Appendix B).

The SWE was founded in 1950 and offers training, development programs, networking opportunities, and scholarships for women in engineering (SWE, 2021). The main office for the SWE is in Chicago, IL, but the organization has members located in over 400 professional and collegiate areas across the United States and Puerto Rico (SWE, 2021). The SWE also has over 500 active members in their membership directory who have computer science or computer engineering listed as their professional field. I chose the SWE organization because of its value regarding diversity, equity, and inclusion for women in engineering and technology. After receiving formal approvals, including IRB approval, the SWE shared recruitment correspondence with groups consisting of participants who met the criteria for this study. Once participants were identified and selected, I used pseudonyms instead of real names and other identifying information to protect the participants' privacy, institutions, and places of employment (Creswell & Creswell, 2018; Creswell & Poth, 2018).

Participants

Purposeful criterion sampling was used to choose 12 participants based on the criteria important to the study (Creswell & Creswell, 2018; Gall et al., 2007; Patton, 2015). Participants who met the criteria important to the study were female, Black or African American and had a bachelor's, master's, or doctoral degree in computer science (e.g., computer engineering, data science, information systems, information technology, software engineering, software development). Participants were graduates of an accredited college, university, or vocational program, and are currently employed in the United States. I maximized the population sample based on criteria such as ethnicity, age, employment status, education level, and computer science field. Participants were also selected based on their shared experiences with the phenomenon (Moustakas, 1994).

Researcher Positionality

My motivation for conducting this study was twofold. First, I am a Black woman with a computer science degree who works in a technology role. I would love to see more Black women decide to pursue careers in computer science fields. The lack of representation of Black women in computer science fields may derive from the lack of knowing such areas exist with Black women working in them (Lewis et al., 2017). My second motivation for conducting this study was to bring visibility to other Black women's roles in computer science fields. There is insufficient research on the experiences of Black women who have successful careers in STEM fields and how their experiences have contributed to their success (Amon, 2017; Herrmann et al., 2016; Yamaguchi & Burge, 2019).

Interpretive Framework

The unique beliefs, worldviews, and biases are considered paradigms or interpretive frameworks and are lenses through which the researcher conducts research (Creswell & Poth, 2018; Guba, 1990). The constructivist paradigm guided this study, since I sought to describe the lived experiences of Black women with a bachelor's, master's, or doctoral degree in computer science, currently employed in the United States. Constructivism is when the researcher seeks to understand the world based on where they live and work (Creswell & Poth, 2018; Denzin & Lincoln, 2011). The participants' experiences have multiple meanings, and the research relies on the participants' views and experiences as much as possible (Creswell & Poth, 2018). The essence of the experiences came from constructed themes gathered through interaction with the study participants.

Philosophical Assumptions

Philosophical assumptions shape the structure of research problems and research questions in qualitative studies (Creswell & Poth, 2018). My ontological, epistemological, and axiological assumptions led to my choice of using the phenomenological research method. As the researcher, my ontological assumption is that reality will not be the same for all participants in my study. Reality is seen through different views and perspectives (Creswell & Poth, 2018; Moustakas, 1994). My epistemological assumption is that I will learn what reality means to my participants from their lived experiences (Creswell & Poth, 2018). From their lived experiences, I provided a deep analysis of how the participants perceived their experiences differently (Moustakas, 1994). My axiological assumption is that my values, opinions, and beliefs play an essential role in how I conduct research (Creswell & Poth, 2018), meaning that my biases and personal experiences can influence the interpretation of my participants' lived experiences regarding the phenomenon I am researching (Creswell & Poth, 2018; Patton, 2015). However, even though I have experience with the phenomenon myself, I sought to understand the phenomenon better by gaining fresh perspectives from other Black women in computer science fields.

Researcher's Role

My role as the human instrument in this study was to follow the transcendental phenomenological research design. By doing so, I put aside what was personally known to me regarding the phenomenon to obtain a fresh perspective from the participants' experiences (Creswell & Poth, 2018). Being able to set aside any prejudgments and biases concerning the phenomenon allowed me to not be "hampered by voices of the past that tell us the way things are or voices of the present that direct our thinking" (Moustakas, 1994, p. 85). Throughout the data collection and analysis procedures, I used a personal journal to document and isolate my perspectives and experiences (Moustakas, 1994). The goal was to not allow my personal experiences with the phenomenon to overshadow and supersede the lived experiences of the participants.

I am a Black woman with a computer science degree who also works in a technology role. My career field is currently in information technology, and my title is a senior programmer/analyst. I graduated from the University of Central Missouri with a Bachelor of Science in Computer Science and Mathematics. Thus, as the human instrument, I am connected to the phenomenon. I believe Black women can succeed in computer science fields no matter what life throws in their way. However, my experiences do not reflect the experiences of many Black women navigating STEM fields. My positive experiences could potentially overshadow the experiences of other Black women and thus downplay the experiences of their career decision-making (CDM) journey. As the researcher, it was important to bracket out my experiences, prejudgments, and biases regarding the phenomenon (Creswell & Poth, 2018; Moustakas, 1994).

I knew it was impossible not to have presumptions that may influence how I viewed the data or conducted my analysis. To ensure this did not happen, I bracketed and outlined my own personal, professional, and academic experiences regarding my CDM journey to avoid any unintentional influence on the data analysis (Creswell & Poth, 2018). Also, as the researcher, I did not purposely limit the results of this study by only including descriptions of positive experiences from the participants or experiences I believe were like my own experiences. To avoid any voluntary participation issues and eliminate any bias, participants with whom I had a personal or professional working relationship were not selected as participants.

Procedures

First, obtaining the necessary permissions is discussed, followed by detailed information on how participants were solicited and how informed consent was achieved. Next, the data collection plan is discussed, detailing the data collection strategies that were used in this study. Following each data collection strategy is a discussion of the associated data analysis strategy for each type of data collected. An explanation of how the study achieves triangulation is also covered. This section ends with a brief explanation of how the collected data were synthesized to identify themes to assist in answering the study's research questions.

Permissions

Before conducting this study, I obtained approval from the Institutional Review Board (IRB) at Liberty University. After obtaining IRB approval (see Appendix C), I received final site approval from the SWE (see Appendix B). The SWE required submission of a research application and applicable participant forms, and 2 weeks for consideration from their director of research. Upon receiving IRB approval, the SWE agreed (see Appendix B) to share participant recruitment items (Appendices F–H) with appropriate groups inside their organization. Identified and selected participants were asked to complete a participant consent form (Appendix H) prior to any data collection procedures.

Recruitment Plan

I located individuals who met the criteria important to the study: a female, Black or African American, with a bachelor's, master's, or doctoral degree in computer science who graduated from an accredited college, university, or vocational program and is currently employed in the United States. Purposeful criterion sampling was used to choose 12 participants based on the criteria important to the study (Creswell & Creswell, 2018; Gall et al., 2007; Patton, 2015). The recruitment process began with emailing the SWE director of research (see Appendix D) the IRB approval along with the participant recruitment correspondence (Appendix E), a recruitment flyer (Appendix F), and a social media recruitment post (Appendix G). All participant recruitment items included a link to a participant demographic questionnaire (Appendix I). The research director was asked to share the participant recruitment items with members of their organization who they felt fit the criteria for the study. Individuals who believed they meet the criteria for the study completed the participant demographic questionnaire (Appendix I) using the link provided in the participant recruitment documents. The demographic questionnaire was created using Google Forms and contained 13 questions to provide characteristics of possible participants (Creswell, 2018; Patton, 2015).

Demographic Questionnaire Questions

1. Please provide your first and last name.
2. In what U.S. state do you currently reside?
3. Which category describes you?
4. What is your biological sex?

5. What is your age range?
6. What is your marital status?
7. What is your current employment status?
8. Did you graduate from an accredited college, university, or vocational program?
9. What is the highest level of education you have completed?
10. Did you graduate with a bachelor's, master's, or doctoral degree in a computer science field (e.g., computer engineering, data science, information systems, information technology, software engineering, software development)?
11. Are you currently employed in a computer science field?
12. Would you like to be considered as a possible participant for this study?
13. If you would like to be considered as a possible participant for this study, please provide a valid contact email address.

Questions 1, 5, and 6 are standard background questions. Questions 2, 3, 4, and 7–11 helped identify participants who met the criteria important to the study. Questions 12 and 13 helped identify those who wanted to be considered as a participant for the study. The participant providing their full name in Question 1, selecting yes to Question 12 asking if they would like to participate, and providing a valid email address in Question 13 served as the participant's digital signature. As individuals submitted the questionnaires, the results were sent to my password-protected email address.

To maximize population sampling, I attempted to obtain geographical variation among participants (Patton, 2015). I also ensured each participant was as unique as possible using dimensions (e.g., ethnicity, age, employment status, education level, computer science field) collected from the participant demographic questionnaire (Appendix I; Patton, 2015). I emailed the participant consent form (Appendix H) to individuals who met the study's criteria and who provided their full name, email address, and selected yes to participate on the demographic questionnaire (Appendix I). The participants were asked to print, sign, and email the signed participant consent form to me within 2 weeks of receiving the email. If I had not heard back from a potential participant within 2 weeks of sending the initial email, I sent a second follow-up email (Appendix E). If I did not hear back from the potential participant within 1 week of the second follow-up email, no other follow-up emails were sent to that individual. The participant consent form provided information on the purpose of the study, how much of the participant's time would be needed, and how they could withdraw from the study at any time (Creswell & Creswell, 2018; Creswell & Poth, 2018). After receiving the necessary approvals and participant consent, the data collection process began. The data collection approaches included individual interviews (see Appendix J), letter writing (see Appendix K), and focus groups (see Appendix L).

Data Collection Plan

I incorporated data collection methods to collect enough data to create rich and thick descriptions of the participants' experiences with the phenomenon (Erlandson et al., 1993; Patton, 2015). I utilized three data collection methods for this study: individual interviews, letter writing, and focus groups. The interviews allowed me to engage one-on-one with each participant to uncover their experiences with the phenomenon (Lambert, 2019; Rubin & Rubin, 2012). Interviewing helped participants recall personal experiences and assisted them in the letter writing activity. Thus, the letter writing immediately followed the interview. Letter writing allowed participants to encourage other Black women by expressing their experiences in their own words regarding computer science. The letter writing followed the style of an informal letter of encouragement. Lastly, the focus group sessions allowed me to bring together participants for open dialogue regarding the phenomenon (Rubin & Rubin, 2012). Having multiple sources of data collection was beneficial to the study, since one source alone could not provide sufficient information to comprehend the experiences completely (Creswell & Poth, 2018; Patton, 2015). Implementing three data collection methods also accomplished data triangulation and increased the credibility and trustworthiness of the research findings (Erlandson et al., 1993; Lincoln & Guba, 1986; Patton, 2015).

Individual Interviews

The first data collection method used was individual interviews (see Appendix J) to have participants discuss their experiences and interpretations regarding the phenomenon (Creswell & Poth, 2018; Lambert, 2019). Semi-structured interviews have specified questions, providing the researcher with freedom to probe for additional meanings beyond the answers given, and allow for the questions to be reordered as needed during the interview (Kvale, 1996; Lambert, 2019; Lincoln & Guba, 1986; Patton, 2015; Rubin & Rubin, 2012). The recommended duration for in-depth interviews is between 1 hour and 1.5 hours and can be shorter or longer depending on the participant (Burgess, 1984; Creswell & Poth, 2018). For this research study, each interview was anticipated to last no longer than 1 hour and consisted of 22 open-ended questions (see Appendix J). Open-ended questions and additional probing questions helped collect in-depth responses and accessed the richness of the participant's experiences (Erlandson et al., 1993; Patton, 2015; Rubin & Rubin, 2012).

Some researchers recommend interviewing between 5 and 25 participants who have experienced the phenomenon in the study (Creswell & Poth, 2018; Polkinghorne, 1989). For this study, I interviewed 10 participants who met the criteria important for the study, interviewing until saturation was reached and redundancy began to occur (Creswell & Poth, 2018; Guba & Lincoln, 1981, 1989; Moustakas, 1994; Patton, 2015). Since the participants in the study were from various locations in the United States, the interviews were conducted virtually using the web-based platform Zoom. All interviews were recorded using my personal computer, an iPad (password-protected), and a backup electronic recorder. In addition to recording, interviews were also transcribed verbatim using a transcription service (Creswell, 2018; Lincoln & Guba, 1985; Patton, 2015). I validated the quality of the transcriptions by comparing the audio recording to the transcription and making corrections where necessary (Rubin & Rubin, 2012).

Before starting the interview, I reviewed the purpose of the study and ethical considerations, reiterated the interview time length, and reminded the participants of their right to withdraw from the study at any time (Creswell & Poth, 2018). The participants were also reminded of their choice not to answer questions. Participants were offered a copy of their transcribed interview to assist me with establishing credibility. Providing the participants copies of their interview allowed them to validate their responses and provide clarification where desired (Erlandson et al., 1993; Lincoln & Guba, 1986). The interview questions, followed by the research question (identified in brackets) which each question addresses, are listed in the next section.

Individual Interview Questions

1. Please introduce yourself to me, as if we just met each other.
2. Without using the title of your job, please describe for me what you do. [Central Research Question (CRQ)]
3. How did race impact your career choice? Describe any increased or limited opportunities. [Sub-Question One (SQ1)]

4. How did gender impact your career choice? Describe any increased or limited opportunities. [SQ1]
5. Individuals are often born with special abilities or talents that cause them to excel in specific areas, leading them to choose a particular career. What special skills or talents were you born with that might have influenced the direction of your career path? [SQ1]
6. There are inherited qualities and personal identities that make up who we are (e.g., race, gender, nationality, ethnicity, physical appearance, characteristics, handicaps). What inherited qualities and personal identities other than race and gender influenced your career choice? [SQ1]
7. Describe for me any expectations on education and career choices you received from your family. [Sub-Question Two (SQ2)]
8. Tell me about your family or household experiences where you received support of your choice to pursue education in a STEM area. [SQ2]
9. Tell me about your family or household experiences where you did not receive support of your choice to pursue education in a STEM area. [SQ2]
10. Describe for me any individuals in the neighborhood or community you grew up in who influenced your education and career choice. If there is no one in your neighborhood or community, describe any individual outside of your family who influenced your education and career choice. [SQ2]
11. How did your choice of education (college, university, or vocational program) influence your decision to pursue your academics? [SQ2]
12. How did your choice of education (college, university, or vocational program) influence your decision to pursue your career? [SQ2]

13. Tell me a time when a school administrator or faculty member was supportive of your choice to pursue a degree in a STEM field. [SQ2]
14. Tell me a time when a school administrator or faculty member was not supportive of your choice to pursue a degree in a STEM field. [SQ2]
15. Tell me about any academic clubs or organizations you credit with your degree completion. [SQ2]
16. Describe for me an experience involving technology that aroused your interest in STEM, specifically your current field. [SQ2]
17. What educational (college, university, or vocational program) learning experiences prepared you for your role in your career field? [Sub-Question Three (SQ3)]
18. Describe for me any negative verbal stereotypes you have heard about regarding Black women in STEM or your current occupation. Any positive verbal stereotypes? How did hearing about those stereotypes affect you mentally? academically? socially? [SQ3]
19. Describe for me any negative visual stereotypes you have seen regarding Black women in STEM or your current occupation. Any positive visual stereotypes? How did seeing those stereotypes affect you mentally? academically? socially? [SQ3]
20. Tell me about any supportive role models or mentors you attach to your degree completion. [SQ3]
21. Reflecting on your career advancement, what critical learning experiences helped develop the set of skills you have now (e.g., software, hardware, coding, people skills, communication, teamwork, leadership, management, etc.)? [SQ1, SQ2, SQ3]

22. We have covered a lot of information today. I thank you so much for your time and consideration in doing this interview. Is there anything else you would like to share about your experiences regarding STEM or your career field? [CRQ]

The interview questions were designed to gather detailed responses from the participants to access the richness of their experiences and unfold the entire essence and meanings of those experiences (Erlandson et al., 1993; Moustakas, 1994; Patton, 2015). Thus, participants were encouraged to begin remembering "vivid and accurate renderings" (Moustakas, 1994, p. 105) of their experiences. The semi-structured interview questions allowed for interaction and open discussions between myself and participants (Lambert, 2019). Interview questions were modified after the first and subsequent data collection to ensure the questions were clear and would help answer the research questions as anticipated.

Questions 1 and 2 served as icebreaker questions and encouraged the interview process to begin as an open dialogue between the participant and myself. Icebreakers give the participants time to warm up and help create a relaxed atmosphere (Erlandson et al., 1993; Lincoln & Guba, 1986). Creating an atmosphere of comfort helped participants open up and respond freely throughout the entire interview process (Moustakas, 1994). Questions 3–21 were designed to elicit responses to the central research question and the sub-questions for this study. The questions followed Krumboltz's (1979) social learning theory of career decision-making (SLTCDM) by addressing three of the four factors influencing career decision-making (CDM): genetic endowment and special abilities, environmental conditions and events, and learning experiences (Krumboltz, 1979; Krumboltz et al., 1976).

Questions 3–6 began the open-ended questions of the interview. They were designed to elicit responses to SQ1: How do Black women in computer science fields describe the impact of race and gender on their career decision-making? These questions were experience questions (Patton, 2015) and helped me understand how the participants viewed their experiences. Asking these questions using the lenses of race, gender, special abilities, inherited qualities, and personal identities aligned with Krumboltz's (1979) first factor influencing CDM, genetic endowment, and special abilities (Krumboltz, 1979; Krumboltz et al., 1976).

Questions 7–16 were designed to elicit responses to SQ2: How do Black women in computer science fields describe any environmental factors or circumstances that influenced their career decision-making? These questions aligned with Krumboltz's (1979) second factor influencing CDM: environmental conditions and events (Krumboltz, 1979; Krumboltz et al., 1976). Educational and occupational decision-making is influenced by several factors outside of a person's control (Krumboltz, 1979; Krumboltz et al., 1976). These influential factors include family, neighborhoods, communities, education, and technology (Krumboltz, 1979; Krumboltz et al., 1976). Questions 7–10 addressed the influential factors of family, neighborhood, and communities, while Questions 11–16 addressed education and technology. These questions revealed some of the factors the participants believed contributed to their persistence and ultimate degree completion.

Questions 17–20 were designed to elicit responses to SQ3: How do Black women in computer science fields describe the various learning experiences that influenced their career decision-making? These questions aligned with Krumboltz's (1979) third factor influencing CDM: learning experiences (Krumboltz, 1979; Krumboltz et al., 1976). According to the SLTCDM, learning experiences combine instrumental learning experiences and associative learning experiences, and learning experiences influence CDM (Krumboltz, 1979; Krumboltz et al., 1976). Knowing the content required to succeed in computer science fields is essential academically, but support in learning and support from others are also needed for Black women to succeed (Meschitti & Smith, 2017; Yamaguchi & Burge, 2019). These questions were designed to focus the participant on any learning experiences and support systems that contributed to their persistence and ultimate degree completion.

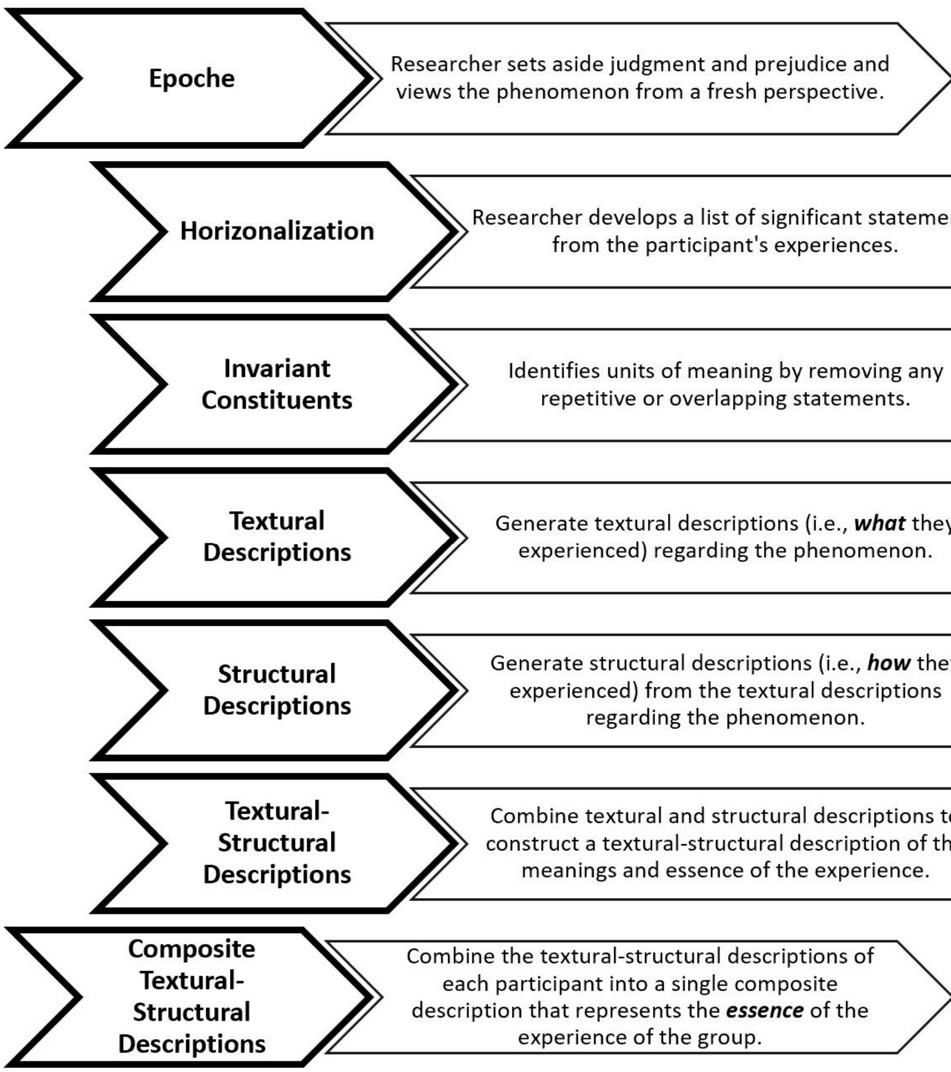
Question 21 associates with the combination of Krumboltz's (1979) three factors (e.g., genetic endowment and special abilities, environmental influences, learning experiences) influencing CDM and was designed to elicit a response to SQ1, SQ2, and SQ3. Question 22 terminated the interview and provided closure to the interview process. At the end of the interview, I summarized the participant's major points and thanked the participant for their cooperation (Erlandson et al., 1993; Lincoln & Guba, 1986), thus creating a positive conclusion to the interview process (Erlandson et al., 1993; Lincoln & Guba, 1986). The concluding question also provided the participant with an opportunity to share any additional information about their experiences (Creswell & Poth, 2018; Lincoln & Guba, 1986; Moustakas, 1994).

Individual Interview Data Analysis Plan

I used the modified version of the Stevick-Colaizzi-Keen (SCK) method of data analysis provided by Moustakas (1994; Figure 1).

Figure 1

Modification of the Stevick-Colaizzi-Keen Method of Analysis



Note. Figure created from the process described in *Phenomenological Research Methods,* by C. Moustakas, 1994, pp. 121–122.

The researcher is one of the participants in this method, and the participants are considered co-researchers (Creswell & Poth, 2018; Moustakas, 1994). Since I met the criteria for the study and the central research question under investigation is a personal passion, the SCK method of analysis was an excellent fit for this study. The SCK method first involves the researcher setting aside personal experiences and prejudgments regarding the phenomenon (Moustakas, 1994). I used a journal for documenting biases and describing personal experiences to set aside, as much as possible, any preconceptions regarding the phenomenon (Creswell & Poth, 2018). After this process, data analysis began as soon as the first interview was transcribed and the transcription verified for accuracy. To begin the data analysis process, I organized the interview transcripts by creating a file-naming system, using the participant's pseudonym and date of the interview (Creswell & Poth, 2018). Developing a file-naming system ensured files could be easily located later for additional analysis (Bazeley, 2013). Next, I read through each interview transcript several times to get a feel of the interview and wrote memos while reading (Corbin & Strauss, 2015; Creswell & Poth, 2018). Memos are pertinent words, short phrases, or concepts that stand out while reading and help with synthesizing the data (Corbin & Strauss, 2015; Creswell & Poth, 2018).

The next step in the data analysis process involved organizing the data and conducting horizonalization (Moustakas, 1994). Horizonalization of data includes generating a list of significant statements from the collected data relevant to the research topic and giving these statements equal value (Moustakas, 1994). From the verbatim transcribed interviews, I developed a list of relevant statements that described how the participants experienced the phenomenon and aligned those statements with the study's research questions (Moustakas, 1994). I then labeled each relevant statement with a descriptive code to help organize and sort the information (Moustakas, 1994; Saldaña, 2016). Descriptive coding is helpful in qualitative research when there are multiple participants and various data sources to analyze (Saldaña, 2016). Developing clusters of meaning was the next step in the data analysis process (Moustakas, 1994). Creating clusters of meaning involves clustering the relevant statements into themes and removing repetitive and overlapping statements (Moustakas, 1994). The clusters of meaning are called the invariant constituents or meaning units of the experiences (Moustakas, 1994). I grouped the relevant statements into common themes, since this provided a foundation for me to begin analyzing the information (Creswell & Poth, 2018; Moustakas, 1994).

Next, from the transcribed interviews, I generated the themes into textural descriptions of what the participants experienced regarding the phenomenon (Creswell & Poth, 2018; Moustakas, 1994). I also included as examples verbatim responses from the interviews when writing the textural descriptions (Moustakas, 1994). The next step in the process was to generate individual structural descriptions from the textural descriptions, providing vivid accounts from the participants regarding their experiences (Moustakas, 1994). The structural descriptions represented the context or setting that influenced how the participants experienced the phenomenon (Creswell & Poth, 2018; Moustakas, 1994). In the context of this study, I provided individual structural descriptions about how the feelings and thoughts connected with being a Black woman in a computer science field were aroused and evoked (Moustakas, 1994). The individual structural descriptions are built through an idea called imaginative variation. According to Moustakas (1994), imaginative variation "seek[s] possible meanings through the utilization of imagination, varying the frames of reference, employing polarities and reversals, and approaching the phenomenon from divergent perspectives, different positions, roles, or functions" (pp. 97–98). In short, imaginative variation considered how being a Black woman in a computer science field was experienced from varying perspectives.

For each transcribed interview, I repeated the SCK method of analysis (Moustakas, 1994). The textural and structural descriptions from the individual interviews were combined into a final list before data synthesis. Triangulation, peer debriefing, and member checking were used to develop a complete understanding of the context of the interviews and to establish credibility (Lincoln & Guba, 1985; Manning, 1997).

I used the online software DelveTool to assist with coding the data and identifying meaningful themes. DelveTool is a Computer Assisted Qualitative Data Analysis Software tool designed to help qualitative researchers analyze and manage qualitative data (Creswell & Poth, 2018; Saldaña, 2016). I used this software as a management tool to help manage and organize data from personal journaling, memo-writing, and the data collected during the interviews, letter writing, and focus groups.

Letter Writing

At the end of each interview, I sent the participant an email with instructions regarding the letter-writing activity (Appendix K). Through letter writing, the participants were able to self-reflect and express, in their own words, their experiences with the phenomenon (Patton, 2015). The letter-writing activity asked each participant to write a maximum two-page letter of encouragement to another Black woman pursuing a career or majoring in the participant's same career field. Participants were asked to introduce themselves and share their career field. They could also share why they chose computer science, their most memorable experiences, and how they stayed motivated and persisted in their journey. Participants were expected to spend between 10 to 15 minutes on this activity, complete it within 2 weeks, and return the letter back to me via email. The letter writing instructions (Appendix K) also provided sample prompts to guide the participants:

Letter Writing Sample Prompts

1. Please introduce yourself.
2. Identify your career field. [CRQ]

3. Explain why you chose computer science as a major and pursued a career in your field. [CRQ]
4. Share your most memorable experience after completing your degree and starting your career. [CRQ]
5. Share any benefits you have experienced being a Black woman working in a technology role. [CRQ]
6. Share the most critical piece of advice you wish you were given while completing your degree or working in your career field. [CRQ]
7. Share how you were able to stay motivated and persist throughout your journey. [CRQ]
8. Please include anything else beneficial for the young lady to know. [CRQ]

Sample Prompts 1, 2, and 3 are introductory items. Prompts 4–8 were designed to reveal the participant's personal experiences and views regarding their academics and career field. The sample prompts were meant to guide the participant in writing the letter, and this activity elicited responses to the central research question.

Letter Writing Data Analysis Plan

Data analysis for the letter writing followed the same process as the individual interviews (see Figure 1). I organized the letters using the same file-naming system as the interviews, using the participant pseudonym and date the letter was received (Creswell & Poth, 2018). Next, I read through each letter multiple times and used memoing to document any notes (Corbin & Strauss, 2015; Creswell & Poth, 2018). I compiled a list of significant statements from each participant letter relevant to the participant's experiences regarding the phenomenon (Moustakas, 1994). Any repetitive, overlapping, or vague statements were removed from the list of significant statements (Moustakas, 1994). The remaining significant statements were labeled with descriptive codes and aligned appropriately to the study's research questions (Moustakas, 1994; Saldaña, 2016). Next, I took the list of significant statements, generated clusters of themes, and generated textural (i.e., "what" they experienced) descriptions regarding the phenomenon (Moustakas, 1994). From the textual descriptions, I generated structural (i.e., "how" they experienced) descriptions of the participants' experiences regarding the phenomenon (Moustakas, 1994). Generating the textural and structural descriptions completed the data analysis for the letter writing, and I repeated these steps for each letter received. The textural and structural descriptions were combined into a final list before data synthesis. I utilized activities such as triangulation, peer debriefing, and member checking to develop a complete understanding of the context of the letters and to establish credibility (Lincoln & Guba, 1985; Manning, 1997).

Focus Groups

The voices of the participants in this study, Black women, are often marginalized within STEM. Having a focus group gave these women's voices a platform, and I could learn more in-depth about their perspectives by listening to the open dialogues (Patton, 2015). Sociologist and feminist researcher Esther Madriz said, "For years, the voices of women of color have been silenced in most research projects" (Madriz, 2000, p. 835). She argued that focus groups assist in advancing the social justice agenda for women, since focus groups can expose and validate women's everyday experiences of suppression and survival and resistance strategies (Madriz, 2000).

The focus group sessions (Appendix L) were scheduled within 2 weeks after conducting the last participant interview. The purpose of a focus group is to confirm and expand on the themes and patterns that emerge from the interviews and letters (Patton, 2015). The focus group setting is not meant to be a judgmental comparison of stories but rather the encouragement of open discussions to increase my understanding of the participants' experiences (Patton, 2015). Focus groups are usually small, typically between six to 10 people, and last approximately 1 to 2 hours (Patton, 2015; Rubin & Rubin, 2012). Keeping the number of participants small provides sufficient time for them to share their experiences (Patton, 2015). 12 participants were selected for this study; thus, I scheduled two separate focus group sessions to keep the groups small.

Both focus group sessions were recorded using my personal computer, an iPad (password-protected), and a backup electronic recorder. In addition to recording, the focus group sessions were transcribed verbatim using a transcription service (Creswell, 2018; Lincoln & Guba, 1985; Patton, 2015). Like the interviews, I validated the quality of the transcriptions by comparing the audio recording to the transcription and making corrections where necessary (Rubin & Rubin, 2012). Due to the nature of focus groups, I could not guarantee participants would not share any part of the focus group session with those outside of the group (Patton, 2015). Also, if any participant chose to withdraw from the study during that time, their contributions to the focus group were not included in the study results.

Since the participants in the study were from various locations in the United States, the focus group sessions were conducted virtually using the web-based platform Zoom. Virtual focus groups are advantageous because virtual meetings help with "cost and time efficiency in terms of reduced cost for travel and data transcription" (Creswell & Poth, 2018, p. 160). A virtual focus group was scheduled with the participants at a convenient date and time. Each virtual focus group session lasted for 1 hour and consisted of open-ended questions (see Appendix L; Moustakas, 1994). One limitation of conducting the focus group was the constrained time to hear from every participant (Patton, 2015). Thus, Patton (2015) recommended asking no more than 10 essential questions for a group of eight people in a 1-hour session.

Focus Group Sample Questions

1. First introduce yourself to the group. Please tell us your name, your computing field, and briefly describe what you do in your current role.
2. If you had to describe your feelings right now regarding the current representation of Black women in computer science fields as a weather pattern, what is your forecast and why? [CRQ]
3. After the individual interviews, I asked each of you to write a letter of encouragement to a young Black woman considering studying or entering your computing field. How did you feel as you were writing the letter? [CRQ]
4. There were some themes that emerged from the letters. As I read to you the following themes, I would like to know which of these helped you succeed in your field and how (the theme) helped you. [CRQ]
5. During the interviews, I asked questions regarding items that affected your CDM, and a few issues surfaced. The first was the question of (issue). How did you experience (this issue)? [SQ1, SQ2, SQ3]
6. As Black women in the field, what do you think makes your experiences different from others? [CRQ]
7. To conclude this interview, what means the most to you about your experiences and the possible impact your experiences could have on other Black women or society as a whole? [CRQ]

Questions 1 and 2 served as icebreaker questions to open up the interview, gave participants time to warm up, and created a light and comfortable atmosphere (Erlandson et al., 1993; Lincoln & Guba, 1986; Moustakas, 1994). Questions 3 and 4 allowed for open dialogue among the participants regarding the letter-writing activity and clarified the themes that emerged. Question 5 focused on the SLTCDM and provided opportunities for the participants to elaborate on existing themes or steer the discussion toward themes not yet exposed. The intersection of race and gender characterizes the individual experiences and shows how their unique experiences can be based on social and political identities (Crenshaw, 1989; Johnson et al., 2019; Ong et al., 2018; Rice et al., 2019). Thus, Questions 6 and 7 were designed to elicit responses to the central research question. Question 7 also brought the interview to a close. The focus group questions were modified after I conducted the individual interviews and received the participant letters to ensure suitable follow-up questions were asked.

Focus Group Data Analysis Plan

Data analysis for the focus group interviews followed the same process as the individual interviews (see Figure 1). I organized the verbatim transcripts using the same file-naming system as the interviews, using the participant pseudonym and date of the focus group (Creswell & Poth, 2018). Next, I read through each verbatim transcript multiple times and used memoing to document any notes (Corbin & Strauss, 2015; Creswell & Poth, 2018). I compiled a list of significant statements from each verbatim transcript relevant to the participants' experiences regarding the phenomenon (Moustakas, 1994). Any repetitive, overlapping, or vague statements were removed from the list of significant statements (Moustakas, 1994). The remaining significant statements were labeled with descriptive codes and aligned appropriately to the study's research questions (Moustakas, 1994; Saldaña, 2016). Next, I took the list of significant statements, generated clusters of themes, and generated textural (i.e., “what” they experienced) descriptions regarding the phenomenon (Moustakas, 1994). From the textual descriptions, I generated structural (i.e., “how” they experienced) descriptions of the participants’ experiences regarding the phenomenon (Moustakas, 1994). Generating the textural and structural descriptions completed the data analysis for the focus group interviews, and I repeated these steps for each verbatim transcript. The textural and structural descriptions were combined into a final list before data synthesis. I utilized activities such as triangulation, peer debriefing, and member checking to develop a complete understanding of the context of the focus group interviews and to establish credibility (Lincoln & Guba, 1985; Manning, 1997).

Data Synthesis

The textural and structural descriptions identified from the data collected (i.e., interviews, letter writing, and focus groups) were compared and checked for accuracy to ensure the relevant information was represented (Patton, 2015). I then took the final combined list of all relevant textural and structural descriptions of the phenomenon and generated a composite description of the phenomenon experienced by all participants (Creswell & Poth, 2018; Moustakas, 1994). The composite description showed what the participants in this study experienced regarding the phenomenon, described the context in which they experienced it, and represented the essence of the experiences (Creswell & Poth, 2018; Moustakas, 1994). The essence is the central meaning commonly shared and understood by all participants who have experienced the phenomenon (Creswell & Poth, 2018; Moustakas, 1994; Patton, 2015). Arriving at the essence is the end goal of a phenomenological study (Creswell & Poth, 2018; Moustakas, 1994).

Trustworthiness

Trustworthiness in a research study consists of establishing credibility of the research findings and interpretations, showing applicability is possible in other contexts or with different groups of participants, ensuring consistency of research findings if the study were to be replicated, and displaying neutrality in the final results (Erlandson et al., 1993; Lambert, 2019; Lincoln & Guba, 1986; Patton, 2015). In addition, being balanced, fair, and mindful of the participants' multiple perspectives, interests, and experiences contributes to trustworthiness in a study (Lincoln & Guba, 1986). To help build and establish trustworthiness, Guba and Lincoln (1981) recommended addressing four criteria areas: credibility, dependability, confirmability, and transferability.

Credibility

When presenting research studies to add to the body of education, there should be a guarantee of credibility of the research topic and how individuals can fact-check the findings (Erlandson et al., 1993). Researchers establish credibility when they are up front about personal biases, opinions, and limitations found in the study (Creswell, 2018). Credibility is also established when there is a corresponding relationship between the phenomenon being studied and the collected data (Erlandson et al., 1993; Peoples, 2021). I provided the participants with an opportunity to verify the study results and findings. Matching the experiences the participants shared also helped establish the trustworthiness of the research and researcher (Creswell, 2018). I remained consistent with the study and in the observation of the elements relevant to the study to build a foundation of credibility (Erlandson et al., 1993; Patton, 2015; Peoples, 2021). The methods I used to establish credibility included triangulation, peer debriefing, and member checks.

Triangulation was the first method I used to establish credibility in this study. Triangulation involves collecting information using multiple sources and then comparing them, focusing on parallels and consistencies among the sources (Erlandson et al., 1993; Guba, 1990; Lincoln & Guba, 1986; Peoples, 2021). I analyzed the responses from the individual interviews, letter writing, and focus groups using the same data analysis steps to accomplish triangulation. Triangulation enhanced the accuracy and consistency of the study (Creswell, 2018). Having consistency across multiple data sources also increased confidence in the patterns and themes found in the data (Patton, 2015).

Peer debriefing involves having others (an authority figure or professional individual) outside of the study review the research data findings and provide feedback to refine and redirect the research process as necessary (Erlandson et al., 1993; Manning, 1997; Peoples, 2021). Peer debriefing can help uncover any unexamined assumptions made by the researcher (Manning, 1997). Lincoln and Guba (1985) stated that peer debriefing provides opportunities for the researcher to gain clarity from others and insight to keep the research moving in the right direction. Peer debriefing for this study involved my dissertation chair and additional committee member, as they already had some general knowledge of the research study.

Member checks consist of asking the participants to verify the research data and the researcher's descriptions of the data (Erlandson et al., 1993; Lincoln & Guba, 1986; Peoples, 2021). I made every effort to have the participants validate how their personal experiences were written and synthesized regarding the phenomenon by providing participants with a copy of their transcribed interview (Manning, 1997). There was not any data collected and placed into this study the participants could not verify or validate themselves (Erlandson et al., 1993; Peoples, 2021). Involving the participants in testing and validating the data, interpretations, and conclusions of the study is an essential technique for establishing credibility (Lincoln & Guba, 1986; Manning, 1997).

Transferability

Transferability involves generalizations formed by the reader of the study. If the reader can transfer the study results to other contexts and settings, then transferability has been established (Erlandson et al., 1993; Lincoln & Guba, 1986). Transferability enables readers to replicate this study because they can utilize the research findings for other participant populations. For instance, other researchers can use this analysis of Black women in computer science fields to study other women of color or minority populations in the same areas or other technological fields. To ensure transferability of this study, the focus was on providing details of the study's characteristics (i.e., rich, thick descriptions and discussion of the site/setting and participants) that would allow application to other settings (Shenton, 2004). I interpreted the findings to ensure that shifting to different contexts was available for others (Erlandson et al., 1993; Guba, 1990; Lincoln & Guba, 1986).

Dependability

Dependability is established when the research process can be duplicated and the research findings show consistency (Creswell, 2018; Erlandson et al., 1993; Guba, 1990; Lincoln & Guba, 1986). It is recommended to create documentation in the form of an audit trail to establish dependability and ensure the data's stability (Guba, 1990). A dependability audit includes documentation consisting of the steps and procedures used throughout the study (Erlandson et al., 1993; Guba, 1990). I checked and confirmed this study's dependability by utilizing an audit trail of the notes and documentation collected during the study.

Confirmability

Confirmability is established when the research findings, interpretations, and conclusions are supported by the data collected and there is consistency (Guba, 1990; Lincoln & Guba, 1986). I ensured the study results reflected the essence of the participants' experiences and not my own presumptions and prejudices (Erlandson et al., 1993; Lambert, 2019). Similar to how I checked for dependability using a dependability audit, the confirmability of this study was confirmed through a confirmability audit. I reviewed and verified confirmability by matching the research data back to its source (Erlandson et al., 1993; Guba, 1990; Lincoln & Guba, 1986). This included any notes, documentation, and data collected during the study, all of which were reviewed and extensively compared against the research findings and conclusions to ensure consistency between the data and the information source.

Reflexivity is also essential because readers of the study have a right to know about the researcher and what piques their interest in the topics they choose to investigate, to whom they are reporting their findings, and what they stand to gain from their study (Creswell & Poth, 2018; Manning, 1997). In addition, setting aside personal experiences and prejudgments from the study and avoiding siding with participants based on their experience was at the forefront of my mind. I presented the research findings using the multiple perspectives of the participants. Researchers should not just include what feels right to them but reflect a detailed image of the participants' experiences (Creswell & Poth, 2018).

Ethical Considerations

Throughout the qualitative research process, researchers should strive for sensitivity to ethical considerations, since ethical issues could arise during the research process (Lincoln & Guba, 1986; Patton, 2015). When conducting an ethical research study, the researcher considers any impact placed on participants. Up-front transparency with participants is essential. Transparency and reciprocity with participants are vital to the reliability and validity of the research study.

I obtained permission from participants to participate in the study by having them complete a consent form (Creswell & Creswell, 2018; Patton, 2015). When contacting participants, I informed them of the study's general purpose, how much of the participants' time was required, and that their participation was voluntary (Creswell & Creswell, 2018; Creswell & Poth, 2018). Sharing copies of the reports and results from the study with the participants also showed transparency. Providing an award or gift for participation in the study created reciprocity between myself and the participants (Creswell & Poth, 2018). After completing the participant demographic questionnaire, interview, letter writing, and focus group session, participants received a $25 gift card to a company of their choosing.

Another primary responsibility of the researcher is to protect the participants' privacy and allow confidentiality throughout the research study. Confidentiality was provided for the individual interviews and letter writing; however, there was no guarantee of confidentiality in the focus groups (Patton, 2015). During data collection, I used pseudonyms for individuals, schools, and places of employment and masked any personally identifiable information in the analysis files (Creswell & Poth, 2018). Securely storing collected data and materials was another priority for this study. I stored collected data on a password-protected computer. Liberty University's IRB advises researchers to retain data for a minimum of 3 years after the study has been completed. After 3 years, audio recordings will be deleted from my personal computer, iPad, and digital recorder. Soft copies will also be deleted and paper copies shredded. Emails will be deleted from my personal email account. Securely storing data and material is vital for the safety and privacy of participants. Respecting participants involves fair and equitable treatment, protecting their data, and ensuring adequate protection of their privacy (Creswell & Poth, 2018). It is essential for the researcher not to place participants at risk of any danger or exposure.

Summary

The purpose of this transcendental phenomenological study was to describe the lived experiences of Black women with a bachelor's, master's, or doctoral degree in computer science, currently employed in the United States. The transcendental approach to phenomenology was best suited for this study since I focused on individual experiences and the expression of those experiences in the participants' own words (Moustakas, 1994; Patton, 2015; Polkinghorne, 1989; van Manen, 1990). I utilized three data collection methods for this study: individual interviews, letter writing, and focus groups to accomplish data triangulation and increase the credibility and trustworthiness of the research findings (Erlandson et al., 1993; Lincoln & Guba, 1986; Patton, 2015). I used the transcendental phenomenological research data analysis steps provided by Moustakas (1994) and the modified version of the SCK method (Creswell & Poth, 2018). The data analysis started with setting aside my personal experiences and prejudgments regarding the phenomenon, horizonalization of the data, creating clusters of meaning, creating textural and structural descriptions of the participants' experiences, and concluding with the essence of the phenomenon (Moustakas, 1994).

CHAPTER FOUR: FINDINGS

Overview

The purpose of this transcendental phenomenological study was to describe the lived experiences of Black women with a bachelor's, master's, or doctoral degree in computer science, currently employed in the United States. Chapter Four describes the results of the study findings. First, the chapter provides a table of participant demographic descriptions (Table 1) followed by individual descriptions of each participant. Second, the results section covers the themes and subthemes from the data analysis. The research question responses section lists the study's research questions along with their narrative responses. Chapter Four concludes with a summary of the study's major themes and significant findings.

Participants

Ten women with a bachelor's, master's, or doctoral degree in computer science from an accredited college, university, or vocational program who are currently employed in the United States participated in this study. A recruitment flyer containing a link to a participant demographic questionnaire was shared with a professional social media engineering group of Black and African American women. The researcher also utilized social media to share the recruitment flyer and word-of-mouth to help identify potential participants. A total of 130 individuals completed the participant demographic questionnaire. Of these 130 individuals, 10 did not qualify because they were male (5) or were not Black or African American (5). The remaining 120 individuals who met the criteria for the study were emailed a participant consent form. Purposeful criterion sampling and maximum variation were used to identify and select participants meeting the requirements for the study. Each participant was as unique as possible using demographic features such as age group, U.S. region, highest education level, and computer science field. Of the 120 individuals who were emailed a consent form, 19 signed and returned the participant consent form, and of those 19, 10 individuals scheduled and completed the interview, while one scheduled an interview but did not show. Follow-up emails were sent to the remaining nine participants, but no responses were received. The participants ranged from 22 to 65 years of age, all self-identified as Black or African American, and were located in various regions across the United States. Eight of the participants had a bachelor's degree, one had a master's degree, and one had a doctoral degree, all in computer science. Every participant expressed an eagerness to see more Black women pursue computer science. Descriptions of each participant are found below (see Table 1).

Table 1

Participant Demographic Data

Pseudonym	Generation Group	Highest Degree Earned	Computer Science Field	HBCU Graduate	U.S. Region
Andrea	Baby Boomers	Doctoral	Computer Information Systems	Yes	Southeast
Asia	Baby Boomers	Master’s	Software Engineering	No	Northeast
Bella	Millennials	Bachelor’s	Computer Science	No	Northeast
Breanne	Millennials	Doctoral	Computer Engineering	Yes	Northeast
Jada	Generation X	Bachelor’s	Cybersecurity	No	Midwest
Jane	Generation Z	Bachelor’s	Data Science/ Engineering	No	Southeast
Kris	Generation Z	Bachelor’s	Computer Science	No	West
Lisa	Millennials	Master’s	Data Science/ Engineering	No	Southeast
Mary	Generation X	Doctoral	Computer Information Systems	No	West
Shanice	Generation X	Master’s	Software Engineering	Yes	Midwest

Note. Baby Boomers: born 1946–1964; Generation X: born 1965–1980; Millennials: born 1981–1996; Generation Z: born 1997–2012. HBCU Graduate: graduated from a Historical Black College or University at any point during postsecondary education.

Andrea

Andrea is a tenured, full-time professor teaching computer information systems at the university level. She has a bachelor’s degree in computer information systems (computer science) from a Historically Black College and University (HBCU). Andrea has also earned a doctoral degree. She serves as a mentor and role model and is an inspiration to her students. Andrea shared the following during her interview:

> There are professors that can make or break you. There are experiences that can make or break you, so as a professor of computer information systems in the business school, most of the work I do in my community is getting [Black] girls to major in computer science.

Andrea agrees that convincing girls to major in computer science is challenging, but she remains committed because the field is full of opportunities for Black women.

Asia

Asia is a retired software engineer. She has a bachelor's degree in computer science and a master's degree in another field. She has always loved science and enjoyed courses like chemistry and biology in high school. Fortunately, working in the medical field is what opened the door to computer science for her. Asia said:

> I started working in the medical field, and one thing about the medical field, at that time, a lot of the equipment was being computerized—this was in the early eighties. It's like, well, if there is a computer that can do what I do by hand, then maybe I should get interested in this computer.

So, Asia ended up taking a Pascal programming course and fell in love with coding.

Bella

Bella is a software engineer working at a tech company. She has a bachelor's degree in computer science. Bella credits her enjoyment of watching detective movies and how they use critical thinking to solve problems; this inspired her interest in technology. She got into computer science with the desire to become a pioneer in the field. Bella shared this during her interview:

> If I can be like a role model to encourage others who are really doing their best, to also get an opportunity to work in the same field—so that when they work towards that goal, they know they're not alone, that it has been done before and it is possible.

Bella wants to change the mistaken assumption that women are not good at STEM.

Breanne

Breanne is an assistant professor teaching computer science courses at an HBCU. She has a bachelor's degree in computer engineering and a PhD in another field. Breanne graduated top of her high school class and has always excelled in math and science. She said:

> Math, science, and numbers have always been my thing. So, math is truly my first love, and I was always curious, taking stuff apart, putting stuff back together, [that] type [of] thing. So, by sixth grade, people were like Engineering! Engineering! So, me being the overachiever, I said, "I'm going [to college] for engineering."

As an educator, Breanne cares deeply about her students learning and applying themselves in the classroom. Her level of care has earned her much respect from those who take her courses.

Jada

Jada is a cybersecurity expert who works with cryptography, keeping sensitive data secure. She has her bachelor's degree in cybersecurity and is looking forward to earning a master's degree and eventually a PhD. Jada considers herself a lifelong learner and seeks opportunities to advance her knowledge and expertise in her field. When asked about her learning experiences, she said, "Nobody from work guided me [to opportunities]. I had to be very resourceful. I would seek out learning opportunities [on my own]. This was the only way I could advance my career, obviously without a degree." Because of her success in the classroom and her work ethic, Jada has been able to travel across the United States and Europe, working in highly classified environments and assume a truly global role.

Jane

Jane is a business intelligence engineer and diversity researcher. She has a bachelor's degree in computer science and is also a first-generation college graduate with a bright future. She shared this about her future:

> I knew I wanted a career where I would make decent money. I also wanted to be interested in my career. My grandmother always wanted me to be a doctor or something in the medical field, and I just never liked hospitals. I always told her that was not going to work out. So, I started looking into other lucrative careers, and from there, I kind of came across tech and computer science itself. Then things just kind of expanded into what that looks like for me. Just because I knew I wanted that human interaction side of computer science, I wanted to be very client-facing if possible. So, through all of that, I kind of deepened my interest and knowledge of computer science as a whole, as well as the world of tech. And that's how I ended up in business analytics.

Jane credits her bright future to her parents. She said her parents ingrained the importance of education at a very young age to prepare her for a great career.

Kris

Kris is a research assistant and has just started her doctoral journey in computer science building on her bachelor's degree. Her father was a mechanical engineer, and her parents saw great potential in her when she took technology and science courses at a very young age. Kris spoke about her childhood education:

> My parents made me go to science class, and I think they saw a lot of my potential. They just wanted me to be at the top of [my] class anytime. So, it didn't matter [to them] if it was technology or healthcare or anything like that.

Kris also said that she received her parents' approval to study computer science in part because of her uncle who is in cybersecurity and talked with her mother about computer science and the opportunities in the field. Therefore, her parents were okay with her seeking a career in a technical field.

Lisa

Lisa is a software and data solutions manager. She has a bachelor's degree in computer science and is also a doctoral student in systems engineering. Lisa is passionate about serving and helping others and considers people her passion:

> I mean, I enjoy the technical side of things for sure, which is why I have at this point too many degrees and in computer-related fields. My passion is people, and my passion is helping people who both look like me and who don't get themselves in a position in their career where they're comfortable. In my opinion, it's a way for people of color to really get out of the systemic poverty we've been placed in. So [for people] to be able to get just some education and climb [their] way to wherever they feel like is good for them is my passion. So, helping other people get there is my real passion, which is why I enjoy managing people and helping them get there.

Lisa enjoys understanding the technical side of computers and using technology as a tool to help others.

Mary

Mary is an instructor who builds project-based computer science experiences for high school students. She has a bachelor's degree in computer information systems (computer science) and a doctoral degree in computer science. She has worked 20-plus years in education, using her expertise in technology to inspire her students to get more involved in STEM. When asked about keeping her students interested, she said, "We try to create experiences that use cutting-edge technologies. We have programs currently in game design and web development." Mary also explained, "I always said that I would teach kids to use tools that I never got to really immerse myself in learning about them and, you know, utilizing them myself." She does not want anyone, especially young people, to miss out on the many opportunities for learning available through technology.

Shanice

Shanice has been a small business owner for over 10 years. She runs a technology company providing various services from managing data centers to system integration. She earned her bachelor's degree in electrical engineering from an HBCU and a master's degree in telecommunications with an emphasis in computer science. Shanice has a desire to pursue her doctoral degree as well as become a professor in higher education. When describing her time studying engineering at an HBCU, she said:

> It was very supportive. The professors were supportive. When I talk to women in other professional organizations that I'm a part of and we share stories about college, they [the women] were ostracized from study groups because they were women. Whereas [at an HBCU] the women, we ran the college [of] engineering. The boys were like, "Hey, can

> we study with you all?" Cause you know, we had our stuff together and like everybody helped everybody. It was just like a big family reunion.

Attending an HBCU was one of her educational goals, and she also credits having some of the best times in her life to attending an HBCU.

Results

The results of this study were gathered by analyzing three data collection methods: individual semi-structured interviews, a letter-writing activity, and two focus group sessions. Implementing three data collection methods accomplished data triangulation, increased the credibility and trustworthiness of the results, and ensured a rich understanding of the phenomenon (Creswell & Poth, 2018; Patton, 2015). The first data collection method was individual semi-structured interviews. After each interview, the audio files were uploaded to REV.com for automated transcription. Within REV, I could listen to each interview, clean up the transcriptions where needed, and ensure accuracy. Each transcription was downloaded as a Microsoft Word document and named using the participant's pseudonym and the interview date. To establish trustworthiness, I then emailed each participant a copy of their interview transcription to check for accuracy and notify me of any needed corrections. Six out of the 10 participants participated in member checking and provided me with feedback, which was then used to update the transcripts.

The letter-writing activity allowed participants to document freely their thoughts and words of encouragement to another Black woman in computer science. The letter-writing activity added to the participants' perspectives as described in the interviews. Two focus group sessions were conducted to keep the sessions small and give every participant a chance to speak. The first focus group session was conducted after five participants were interviewed, and the second after the last five participants were interviewed. The audio files from both focus group sessions were uploaded to REV.com for automated transcriptions. Like the individual interviews, I could listen to each session, clean up the transcription where needed, and check for accuracy. The focus group sessions allowed me to expand on the themes and patterns emerging from the individual interviews and letter-writing activities (Patton, 2015).

Before beginning data analysis and throughout the data collection process, I used journaling to document personal thoughts, experiences, and preconceptions regarding Black women's experiences in computer science fields (Creswell & Poth, 2018; Moustakas, 1994). Bracketing out personal, professional, and academic experiences allowed me to focus solely on the participants' experiences. After member checking was completed, I again listened to the audio recordings of the interviews and focus group sessions and took notes (Corbin & Strauss, 2015; Creswell & Poth, 2018). Since all transcripts were already downloaded as Word documents, I was able to reread each of the transcripts several times, compare them to the notes, and gain a deeper understanding of the participants' responses. Taking notes and journaling during the data collection process also helped me begin synthesizing the data (Corbin & Strauss, 2015; Creswell & Poth, 2018).

I initially wanted to use NVivo to help organize the interview and focus group transcripts and the letter-writing activities; however, NVivo was found to be much more complex than necessary for the research tasks. I found another qualitative analysis tool to organize the transcripts and letters called DelveTool. Before uploading all transcripts and letters into DelveTool, I printed the study's research questions and theoretical framework for guidance during the data analysis process. Next, every interview and focus group transcript and letter were uploaded into DelveTool. All uploaded transcripts and letters were named using the pseudonym given to each participant, and any real names in the individual transcripts or letters were replaced with the pseudonyms of the participants.

Using the research questions and theoretical framework as guidance, I created initial codes to begin the data analysis process. After creating these initial codes, I began the first round of coding, adding any new codes as they appeared (Braun & Clarke, 2006; Moustakas, 1994; Saldaña, 2016). I then analyzed the excerpts that were assigned codes and reread those excerpts to make sure appropriate codes were applied, combining and expanding codes as needed (Braun & Clarke, 2006). Multiple rounds of coding following the same process were conducted until I was satisfied with the code assignment and new codes were no longer emerging (Braun & Clarke, 2006; Saldaña, 2016). Next, I reviewed and rearranged all codes to determine potential themes regarding the participants' experiences (Braun & Clarke, 2006; Saldaña, 2016). Two themes emerged from the interviews, letter writing, and focus group sessions: external environments and support systems (see Table 2).

Table 2

Themes and Subthemes

Themes	Subthemes	% of participants where subtheme appeared
External Environments	College Choice	80%
	Clubs, Organizations, & Networking	80%
	Racial Issues	80%
Support Systems	Family Support & Expectations	90%
	Mentors & Role Models	70%
	Advocates & Faculty Support	90%

External Environments

External environments was the most prominent theme that emerged from the data. Some of the participants' environmental factors influenced their decision-making to pursue educational and occupational opportunities in computer science. For instance, Andrea shared in her letter that one of many factors that contributed to her persistence in computer science was her "desire never to be homeless again." Jada, who also described her humble beginnings, could see the technology trends changing. When describing why she chose to pursue cybersecurity, she said, "The work is challenging, the opportunities to learn are endless, and technology is ever evolving!"

College Choice

College choice was a significant decision for these Black women when deciding what educational opportunities were available. For most Black women, having the financial support and a college offering the degree program they wanted were the most significant influential factors in college choice. Asia explained, "I worked at the medical center, and they were willing to pay for college while you worked. So, I was able to go back to school debt free because they paid for my courses." Jada made her college choice based on financial support and cybersecurity being offered. She said, "Yeah, once I saw they [were] basically paying people to go to school for cybersecurity because they are so understaffed, and I already had [the] experience . . . like, just finish the rest of these credits and check the box." For other Black women, attending an HBCU was the deciding factor in choosing to learn, study, and grow with others who looked like them and could relate to them from a cultural perspective. Shanice acknowledged that attending an HBCU was beneficial to her life and career. She excitedly shared, "Yes. It just felt good. I mean, the best times of my life [were] at [this university], I met my husband there . . . some of my best friends [and] closest friends. The [university] was very supportive, and the professors were supportive."

Clubs, Organizations, and Networking

While pursuing their education, these Black women described how being a part of clubs and organizations was their saving grace throughout their undergraduate and graduate studies. Most of the Black women in this study also could not stress enough the importance of networking. Mary said she was able to stay motivated in her field through her "friendships, networking groups, and mentors." Breanne said that the "Black Graduate Student Association (BGSA) definitely saved my life in grad school because it was lonely. It was definitely lonely. So, I needed that family deeply. And to this day, I still talk to a lot of them." Lisa affirmed Breanne's feelings:

> The [scholarship] group kept me connected as a student, to have a group of students that looked like me, had a similar background, and we were all just struggling up the ladder trying to finish school. So that was really special. That was like a club that really kept me going.

Racial Issues

The Black women in this study eventually realized that their race would become an issue for other people during their academic studies, working in educational settings, and even in corporate America. As Breanne put it, "Even if I describe myself, I'm a Black person first, my race comes first before woman. [Because] you honestly can't change my color; it's literally what you see first." Jane described how people would always suggest affirmative action was in play. She said people would say, "You're only here because they're trying to fill a certain quota, or you got into this school from affirmative action, and since the school is on your resume now, you're getting these other things." Jada has had to correct people when they assume she was the cleaning lady:

> I would be going to my office, and people would stop me on the way to the bathroom, "Can you . . ." they thought I was the cleaning person. Just because they see a Black face, really? You can only [say] so many times like, "No, I'm not the cleaning person." Now I'm just like, are you kidding me? You also need to say something because they will think twice the next time they look and see a Black person and ask them to clean or [get] something.

Support Systems

Support systems was the second dominant theme that emerged from the data. Some of the Black women interviewed shared experiences of having access to mentors and people who could influence their education and careers. In contrast, depending on the period of time, some participants were not so fortunate to have such connections with a mentor or person of influence. Jada, however, was fortunate and described the impact her mother and grandmother had on her education at an early age:

> There was an expectation [on education]. They wanted me to go and get a higher education, but as they didn't have any higher education themselves, they couldn't really guide me. My grandma is 104 years old, [and] still living. This is who raised me and those kinds of people, those old[er] people; they don't sugarcoat. I was an only child, her only granddaughter. We spent a lot of time together when I was [in my] formative years. She spent time telling me about how she wished that she could have had [higher] education and [about] Jim Crow, and she could only go to school [un]till she was in the sixth grade. She was telling me this as an 8-year-old, 9-year-old kid. She put this into my

> head when I was a little kid, you are so smart, and make sure you get your education. So even though she didn't have a college degree, she wanted to be in my position.

Family Support & Expectations

All of the Black women in this study shared how supportive their parents and other family members were of their decision to study computer science. The participants described how their parents wanted them to do well in school and pursue careers they would enjoy. Bella said, "They generally wanted me to be successful in whatever path I took, but I think when they got to know more about what I'm really doing, they became more interested and were okay [with my choice]." Only a few participants had parents who either had a STEM career or some familiarity with STEM, but the consensus was that support was there, nonetheless. Mary shared that her father was "a man of many trades. He was a police officer [and] when they immigrated, he learned to do electrical work. He did a lot of construction jobs before he got his EE [electrical engineering] degree." She added that there were not any expectations that she would follow in his footsteps but noted that her father being in a STEM field "was kind of the link."

Mentors & Role Models

The data revealed that having a mentor or role model is essential, but access to a mentor or role model was not always available, depending on the generation of the participant. Having a mentor or role model made a great difference in being able to succeed in their education and careers. As Kris mentioned in her letter:

> There are many organizations in place to provide a sense of belonging for Black women in this [computer science] field. Regardless of background, they [organizations] provide mentorship and opportunities to meet other Black women, and [there] are funded programs for minorities who want to continue their studies.

Lisa also shared her unique experiences with mentors during her education:

> All of my mentors were White men in computer science. All of them were really great in that they saw me and they were like, she's so good at this. I really wanna help her out. They [were] very much invested in my success at every step along the way.

Advocates & Faculty Support

When deciding whether to pursue educational or occupational opportunities in computer science, advocates and faculty members greatly impact these decisions. The data revealed that advocacy and faculty support did not always come from another Black or African American person, showing that such support could come from White men or women, Black men, and other women of color. Jane described being the only girl in her technology club, and the teacher impacted her interest in technology. She said, "The teacher was a Black woman, and she sparked my interest in technology as a whole. She sparked my interest in computers and made me start doing some research about other careers out there." Asia is from the Baby Boomer generation, and so she did not have many advocates or faculty support throughout her education. Now, she has turned into an advocate herself and agrees that times have changed:

> Yes, the doors are opening, and [within] the last 7 years, I started doing more training, teaching, and coaching. I had never even worked side by side with a Black woman in my whole career, but I was teaching them. So, I was teaching them, and I was encouraging them. I am seeing it is changing. Things have changed quite a bit.

Research Question Reponses

One central research question and three sub-questions guided this transcendental phenomenological study to understand the essence of the lived experiences of Black women with a bachelor's, master's, or doctoral degree in computer science, currently employed in the United

States. The sub-questions follow Krumboltz's (1979) social learning theory of career decision-making (SLTCDM) by addressing three of the following factors that influence career decision-making: genetic endowment and special abilities, environmental conditions and events, and learning experiences. The participants described through their experiences the factors that led them to pursue a degree or potential career in computer science.

Central Research Question

What are the lived experiences of Black women with a bachelor's, master's, or doctoral degree in computer science, currently employed in the United States?

The Black women in this study shared their experiences and the factors contributing to their decision to pursue education in computer science and in their careers. Based on the data collected, Black women have always been interested in STEM fields such as computer science because they loved math, science, technology, and problem-solving. Mary chose computer science because of the "creativity and problem-solving" involved. Asia shared that when she was a child, she was "always attracted to science," and Breanne said, "I chose computer engineering because I was always good in math and science and love[d] to take things apart and reassemble them as a kid."

Sub-Question One

How do Black women in computer science fields describe the impact of race and gender on their career decision-making?

None of the Black women in this study chose computer science because of its representation of Black women or the lack thereof. Race and gender became an issue for these Black women within educational and occupational settings because of other individuals, primarily White men. For example, Shanice said, "I could not list many benefits of being a Black woman in tech during 2001–2009 when I worked [in] Corporate America, other than being a check in the diversity box." Andrea shared similar sentiments as one of only two Black women working in her department. She said, "Racism and sexism dominated my experiences. I often felt alone and isolated, overlooked and undervalued."

Sub-Question Two

How do Black women in computer science fields describe any environmental factors or circumstances that influenced their career decision-making?

Environmental factors and circumstances are often beyond the control of the individual affected. The Black women in this study chose to persevere rather than allow the things they could not control to stop them from completing their educational and occupational goals. Asia said:

> There were people that sabotaged my work. There were people that tried to take credit for my work. Mostly these were all White men who did this to me. I would have to [say to myself], okay, you know that happened, they didn't win, let me pick up and keep going.

Bella echoed similar feelings:

> All the success did not just follow me out of luck. I had challenges every now and then due to my young age and the fact that I was a young Black lady in a male-dominated field. I had to put up with tough colleagues who, for some reason, did not think I was old enough [to be in my position], but my outstanding skills and determination always got me a seat at the big table.

Sub-Question Three

How do Black women in computer science fields describe the various learning experiences that influenced their career decision-making?

The participants viewed their learning experiences as pivotal and critical points in their lives that affected their decisions to continue pursuing computer science. Andrea was too embarrassed to drop a class, but her professor, another Black woman, allowed her to audit the course instead. Andrea spoke about this critical learning experience:

> I physically dropped the class, but I still came every day when that class was held. So, I finished the class, and it was the best decision I could have ever made because I wasn't understanding [the material]. Of course, I had skin in the game because I was failing it, but she allowed me to stay in that class and get it. And I got it! One of the things I learned is that you have to count your losses, but counting your losses does not mean you have to give up. So, I stayed in that class.

Jane learned from her experiences not to count herself out either. She said, "It can be very easy as a Black woman to downplay your skills, not negotiate your salary, and feel imposter syndrome, but you've earned the right to be in those spaces."

Summary

The purpose of this transcendental phenomenological study was to describe the lived experiences of Black women with a bachelor's, master's, or doctoral degree in computer science, currently employed in the United States. There were 10 Black and African American participants between the ages of 22 and 65. All participants were women with bachelor's, master's, or doctoral degrees in computer science. Some of the participants had more than one degree in computer science. Two themes and six subthemes emerged from the data collected from the individual interviews, letter-writing activities, and focus group sessions. The two themes painted a strong picture of what these Black women needed to persevere in computer science. The first theme emerged from the participants' experiences regarding how they chose their college, what clubs and organizations they participated in during their academic studies, and any racial issues they encountered within specific environments. The second theme came from the participants' experiences regarding different types of support systems. The most significant amount of support came from family, mentors, role models, and even unexpected advocates from different races. A significant finding from the data collected was that every one of these Black women wanted to pursue computer science because they already had a love for math, science, and/or technology. All of the participants shared how they loved to solve problems, take things apart, and put them back together again. The findings of this study provide a look into the experiences that contributed to the decisions to pursue computer science academically and as a career. Combining and analyzing the data collected from the interviews, letter-writing activities, and focus group sessions were used to answer the study's central research question and three sub-questions.

CHAPTER FIVE: CONCLUSION

Overview

The purpose of this transcendental phenomenological study was to describe the lived experiences of Black women with a bachelor's, master's, or doctoral degree in computer science, currently employed in the United States. Chapter Five summarizes the study's findings, conclusions, and recommendations. First, interpretation of the study's findings and a summary of the thematic findings are presented. Next, implications for policy and practice are discussed, followed by the study's theoretical and empirical implications. Finally, Chapter Five concludes with the limitations and delimitations of the study and recommendations for future research.

Discussion

Since the purpose of this study was to examine the essence of the experiences of Black women with a bachelor's, master's, or doctoral degree in computer science currently employed in the United States, the best option for this study was the phenomenological research design (Creswell & Poth, 2018). The SLTCDM provided a framework for understanding how a combination of three factors (e.g., genetic endowments and special abilities, environmental conditions and events, and learning experiences) led these Black women to pursue a bachelor's, master's, or doctoral degree in computer science (Krumboltz, 1979; Krumboltz et al., 1976). The discussion section establishes the study's findings by bringing together the interpretation of findings, implications for policy or practice, theoretical and empirical implications, limitations and delimitations, and recommendations for future research.

Interpretation of Findings

This section begins with a summary of the thematic findings discussed in Chapter Four, followed by interpretations of the thematic findings. From the combined analysis of individual interviews, letter writing, and focus groups, two significant themes emerged from the data: external environments and support systems. Three subthemes emerged under each of these themes.

Summary of Thematic Findings

The themes discussed in Chapter Four were external environments and support systems. External environments included the subthemes of college choice, clubs, organizations, networking, and racial issues. The theme of support systems included the subthemes of family support and expectations, mentors and roles models, and advocates and faculty support.

Pure Love and Interest. One fascinating feature of all of the Black women who participated in this study was that none of them became interested in computer science as children because they saw someone else that looked like them already in the field. At very young ages, every single one of these Black women had a love for math or a passion for science or both, and all enjoyed problem-solving and wanting to figure out how things work, take things apart, and put things back together. This triggered their initial interest; however, it was not until they got into computer science academically and professionally that some of these Black women realized there was nobody else that looked like them. They were probably asking themselves, "Am I the only one?" At this point, they may also have met resistance, racism, sexism, and many other issues that have prevented Black women from persisting and continuing with their education or careers in computer science.

The initial interest appears to be related to their innate abilities, which led them towards a STEM field like computer science. Unfortunately, quite a few Black women have had their dreams of pursuing education and careers in computer science diminished. Some were able to persevere and make it through those tough times with a degree in computer science and a career.

The findings of this study show that although representation matters, so does putting the right people in positions to encourage young Black women throughout their journey in computer science. It is critical for Black girls not to have to deal with educators, administrators, or school counselors diminishing their pursuit of careers in a STEM field.

Turning the Tide. Clubs and organizations available to Black women during their academic studies served as safe spaces. Shanice said the Institute of Electrical and Electronics Engineers (IEEE) “was a safe environment” because she was with her “peers and friends.” Mary said being part of the National Society of Black Engineers (NSBE) and Society of Women Engineers (SWE) got “me through undergrad,” and Breanne said the Black Student Graduate Association (BSGA) “saved my life.” Young Black women being able to read about these types of experiences can learn how to navigate their academic pursuits in computer science more smoothly. Black women should also be able to see some of these women; this is where social media can play a significant role in networking. All participants stressed the importance of networking in the letter-writing activity, and social media platforms such as LinkedIn, Twitter, and Facebook are great for networking.

Black women may not see other Black women in computer science on television or even at their colleges and universities. However, through various social media platforms, Black women can join technology and computer science groups (e.g., GirlsWhoCode, STEMher Magazine, Project Scientist, Code.org, GirlStart.org), follow other Black women who are leading voices in the industry, and connect with others with degrees and careers in computer science. Perhaps this type of access can open the door to more young Black women successfully navigating academics and careers in computer science and help them to understand better what they need to do to navigate specific spaces wisely and safely. They will learn about which colleges and universities encourage and support Black women in STEM fields like computer science and which ones do not. Young Black women will learn about organizations such as IEEE, NSBE, and SWE and access these organizations as safe spaces.

Generational Changes. From reading through the transcripts and letters of these Black women, it is interesting to note the changes from one generation to the next. I felt blessed to have interviewed Black women from different generations and time periods in computer science. The findings show that the older and more seasoned generations had a more difficult time navigating their academics and careers, yet they still persevered. When one fast forwards to the younger generations, those still in their 20s with their bachelor's and some moving on to their master's, they share their experiences about how they did not have a problem finding the Black engineering groups or computer science groups. The younger generations share experiences about leading technology and computer science clubs in college and having peers in their computer science course who were White males or White females, and they all worked together.

Some of the narratives are changing, and the change does not negate or mitigate the trauma Black women in previous generations have had to endure. People are slowly changing; not just Black women, but also those who have essentially tried to keep Black women out of computer science. Computer science is still a White, male-dominated field; however, the area is opening up to a point where most individuals are willing to work with Black women. A mentor can be a White or Asian male or another non-Black female. It's becoming more apparent that the current generations of stories and how Black women are navigating through computer science are much different than the original Black women trailblazers. Lisa shared this powerful statement at the end of her interview:

> I would [simply] say that I push forward. I hope the Black women who come after us feel less pressure to be great. That's why as soon as I saw [this research study], I was [happy] to do this. [I thought] So glad she's doing this research. I hope the pressure feels just a little lighter for the next people coming behind us. I think the pressure for me, for sure, has been lightened, and I feel that the pressure to be a Black woman in STEM has been lightened by the women that came before me. I recognize that, and I'm grateful because that's a privilege to have had that lightened by women that came before me, and men that came before me to make it possible for me to be here. But I hope the next people feel even lighter. That's kind of my lasting statement.

Implications for Policy or Practice

The findings of this study highlighted factors that impacted the career decision-making of Black women with degrees in computer science. The results also confirmed the topic was worth exploring to build visible, relatable, and positive representations of Black women in computer science fields through the details of their experiences. The findings revealed significant theoretical, empirical, and practical implications for both policy and practice.

Implications for Policy

The results of the study support recommendations for higher education institutions to develop policies to help increase the number of Black women in computer science. Higher education institutions should revisit and restructure their hiring practices regarding faculty in their STEM departments. For instance, policies that would affect hiring practices in STEM departments would benefit from hiring more women and women of color to teach their tech courses. They could start by ensuring that no more than 50% of their faculty in STEM departments are males. Research shows that students who share the same gender, race, or ethnicity as faculty and staff feel safer and develop a stronger sense of belonging in STEM fields (Johnson et al., 2019). In addition, institutions receiving federal funding to support their STEM activities should be considered on the basis of the racial and gender makeup of their STEM faculty and staff.

Implications for Practice

The findings from this study provide implications for Black women in computer science, corporations, businesses, and higher education institutions. Black women with computer science degrees can have an impact when they share their experiences of perseverance and success with other Black women. Illuminating these experiences can be crucial to the expansion, growth, promotion, and support for more Black women entering or desiring to enter computer science (Rice et al., 2019; Yamaguchi & Burge, 2019). They can serve as mentors, role models, educators, and administrators in STEM spaces. Black women can also have an impact by volunteering their time to clubs and organizations that promote diversity in STEM (e.g., code.org, Girls Who Code, Black Girls Code). Black women educators and administrators can offer safe places for Black female students in higher education. As educators and administrators, they have the power to disrupt social and cultural norms that view Black women as less qualified or incapable of succeeding, and thus become allies for heterogeneity in STEM (Collins et al., 2020).

Corporations, businesses, and higher education institutions should seek to value diverse perspectives and contributions more within their organizations and STEM departments (Niepel et al., 2019). Tim Cook, the CEO of Apple, recently expressed concerns about the shortage of women hampering the future of tech (Morrison, 2022). To excel, push innovation and discovery, and promote diverse perspectives and ideas, corporations and businesses should consider maximizing the talents of more women and women of color in the workplace (Yamaguchi & Burge, 2019). Corporations and businesses should look deeper into their hiring practices and determine why they are not hiring more women and women of color for their technical positions and to appreciate how they can impact the number of Black women who pursue computer science and enter the workforce. The results from this study confirmed that Black women had difficulties entering corporate America—not regarding their technical knowledge or abilities to do their jobs, but rather the toxic masculine work environments to which Black women are subjected. Thus, corporations and businesses should ensure that their workplaces are safe, welcoming, and supporting environments for women and women of color.

Higher education institutions developing strategies to increase the representation of Black women and other women of color in computer science should consider both race and gender and continually update their STEM degree programs to become more diverse and inclusive of minority women (Blosser, 2019; Evans et al., 2020; Johnson et al., 2019; Niepel et al., 2019). STEM departments can increase visibility through social events such as career fairs, mentoring programs, or STEM clubs and department newsletters featuring women and students of color (Niepel et al., 2019). The results from this study confirmed that Black women in computer science have had to deal with pervasive racial and gender stereotypes, instructor bias, presumed incompetence from peers and faculty, and academic isolation (Clark et al., 2021; Collins et al., 2020; Davenport et al., 2020; Jaumot-Pascual et al., 2021; Lee et al., 2020). Thus, a final recommendation to higher education institutions is to take a closer look at their academic environments and remove obstacles that have hindered Black female students.

Theoretical and Empirical Implications

The study's findings confirmed that Krumboltz's (1979) SLTCDM was an appropriate theoretical framework to guide the study. The SLTCDM is traditionally used in counseling psychology research (Scheel et al., 2018; Uyanik et al., 2017). Only a few studies have applied the theory to culturally diverse populations in STEM (Evans et al., 2020; Jaeger et al., 2017). This study provided a new application of the SLTCDM to support Black women in computer science and document their experiences.

Each participant in the study shared their experiences regarding three factors (e.g., genetic endowment and special abilities, environmental conditions and events, and learning experiences) influencing their educational and occupational decision-making to pursue computer science. The Black women in this study innately loved math, science, technology, and problem-solving, which initiated their interest in STEM fields. Rather than allow their current environment or factors entirely out of their control to deter them from computer science, these Black women chose to persevere to achieve their educational and occupational goals. Finally, the Black women in this study treated their various learning experiences as pivotal moments in their lives that launched their academics and careers in computer science. The results of this study demonstrate that Black women's experiences in computer science are legitimate, and that these experiences should be documented to uplift and empower other Black women in similar fields.

This study fills an existing gap in the literature and contributes new empirical research on Black women in computer science fields. The collective shared experiences of the Black women in this study confirm previous research studies regarding the interest of Black women in STEM in general. For instance, Black women have always been interested in computing fields, and have always faced obstacles while pursuing academics or careers in computing (Johnson et al., 2019;

Wilkins-Yel et al., 2022). Black women have persisted in STEM education and have achieved successful careers in computing fields (Collins et al., 2020; Pietri et al., 2021). This study underlined the necessity of Black women in computer science to have safe spaces created for them to successfully navigate academics and careers in computer science (Blosser, 2019; Jaumot-Pascual et al., 2021; Johnson et al., 2019; Wilkins-Yel et al., 2022).

Limitations and Delimitations

The sample pool of participants for this study was limited. Due to the small number of Black women with degrees in computer science, the search for participants was somewhat challenging and limited to using social media and word of mouth. According to the National Science Foundation, the percentages of Black or African American women awarded degrees in computer sciences in 2019 were 10.4% for bachelor's, 6.5% for master's, and 4.0% for doctoral degrees (NCSES, 2021). This limitation proves the existing gap in the literature on the career decision-making and persistence of Black women with degrees in computer science. Another limitation of the study was that the participants were in various locations across the United States. Thus, Zoom was the method of choice to conduct the individual interviews and focus group sessions, since neither could be conducted face-to-face.

Using an online Google form to solicit participants is another study limitation. For example, using an online participant demographic questionnaire to identify participants who met the criteria for the study led to several social media bots and fake individuals completing the questionnaire. These social media bots and counterfeit individuals made it difficult for me to determine which participants were who they said they were. To combat this issue, I added a question to the end of the questionnaire asking participants to provide either a professional or personal social media account so that I could verify the participants. At the beginning of each interview, I asked the participant to have their camera turned on to verify who they were. Every participant was willing or complied with the request to have their camera on except for one participant who did not wish to be recorded.

Finally, another limitation of the study is due to the qualitative research design. All 10 participants completed the individual interview; however, not all participants completed the letter-writing activity or attended the focus group sessions. In total, 60% of the participants contributed to the focus group, and 90% of the participants responded to the letter-writing activity. Follow-up attempts were made to contact the participants to submit their letter-writing activity as well as confirm participation in one of the focus group sessions, but these follow-up attempts were unsuccessful. Thus, data resources from these participants were lost due to their absence from these two data collection methods.

There are delimitations in this study set purposefully by me as the researcher to limit and define the boundaries for the study. For example, the study only included participants over the age of 18. To participate in the study, the participants had to identify as a Black or African American female and have a degree in a computer science field; thus, each participant should have been 18 years or older to have at least a bachelor's degree. Another delimitation of the study is that I only evaluated Black women in computer science who are currently employed in the United States. Excluding other minority groups, women of color, and other STEM fields was intentional, as I am a Black woman with a bachelor's degree in computer science, and the central research question under investigation is a personal passion. There may also be other minorities, women of color, and other STEM fields that share some of the same experiences, but those experiences cannot be confirmed or denied by this study.

Recommendations for Future Research

There are recommendations for future research considering the study's findings, limitations, and delimitations. This study gives a voice to Black women with degrees in computer science and is a step towards balancing research on the experiences, career decision-making, and the persistence of Black women in STEM fields. Future researchers can further extend this research study in various ways.

One recommendation is to investigate other minority women groups with degrees in computer science and why they chose computer science. For example, the percentages of two other minority women groups in computing and mathematical occupations (employed and experienced unemployed) in 2019 were 24.3% Asian/Pacific Islander and 8.2% Latina/Hispanic (DuBow & Gonzalez, 2020). Another group to investigate is Black men with degrees in computer science. In 2019, out of 89,421 individuals awarded a bachelor's in computer sciences, only 7,362 (8.2%) were Black or African American (NSB, 2022), and of these 7,362 Black or African American individuals, only 5,434 (6.1%) were men (NSB, 2022).

Another recommendation is to investigate the experiences of Black women with degrees in computer science using a narrative approach or a case study design. It would be beneficial to cover the story of one or multiple individuals' experiences, exploring the past, present, and future (Creswell & Poth, 2018) to uncover more factors that led to their decision to study and have a career in computer science. Full representation of Black women in computer science fields is essential, so being able to study the complete experiences of Black women in computer science fields is beneficial. An exclusive experience would include family, peers, mentors, academics, and other factors that may have profoundly impacted these women and their education and career decision-making. Another possible suggestion is to study Black women with degrees in computer science fields across generational groups (e.g., Baby Boomers, Generation X, Millennials, and Generation Z) to see how persistence, resources, and other factors may have significantly changed over time.

Conclusion

The purpose of this transcendental phenomenological study was to describe the lived experiences of Black women with a bachelor's, master's, or doctoral degree in computer science, currently employed in the United States. Krumboltz's (1979) SLTCDM served as the study's theoretical framework. The theory provided a foundation for understanding how a combination of factors led to Black women's educational and occupational preferences for computer science. Four factors influence career decision-making: (1) genetic endowment and special abilities, (2) environmental conditions and events, (3) learning experiences, and (4) task approach skills (Krumboltz, 1979).

Ten women with a bachelor's, master's, or doctoral degree in computer science from an accredited college, university, or vocational program who are currently employed in the United States participated in this study. The age range of the participants was 22–65, all self-identified as Black or African American, and all were located in various regions across the United States. Individual interviews, letter writing, and focus groups were used to uncover the essence of the participants' lived experiences. Two themes and six subthemes emerged from the data collected. The results of this study demonstrated that Black women's experiences in computer science are legitimate, and that their experiences should be documented. The collective shared experiences in this study also confirmed previous research studies regarding the interest of Black women in computer science and their persistence and success in computing fields (Collins et al., 2020; Pietri et al., 2021; Wilkins-Yel et al., 2022). Identifying success strategies, safe spaces, mentors, family and peer support, access to role models, and positive images of successful Black women in STEM are essential to the growth of Black women in computer science fields (Blosser, 2019; Jaumot-Pascual et al., 2021; NASEM, 2020; Wilkins-Yel et al., 2022).

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Appendix A

Site Interest Correspondence

Dear [Recipient]:

As a doctoral student in the School of Education at Liberty University, I am conducting research as part of the requirements for a Doctor of Philosophy. The title of my research project is *The Minority in the Minority, Black Women in Computer Science Fields: A Phenomenological Study*. The purpose of my research is to describe the lived experiences of Black women with a bachelor's, master's, or doctoral degree in computer science, currently employed in the United States. This study is being done to bring visible, relatable, and positive representations of Black women in computer science, highlight the factors that contributed to their success, and help craft a pipeline of visual interest and foreseeable careers in computer science for young Black women.

I am writing to request your permission to utilize your membership list to recruit participants for my research.

Participants will be asked to complete a demographic questionnaire to determine if they meet the criteria for the study. For the study, selected participants will be asked to participate in an individual interview (1-hour), a letter-writing activity (10–15 minutes), and one focus group session (1-hour). Participants will be presented with informed consent information prior to participating. Taking part in this study is completely voluntary, and participants are welcome to discontinue participation at any time.

Thank you for considering my request. If you choose to grant permission, please respond by email to [redacted].

Sincerely,

Blanche' D. Anderson
Doctor of Philosophy Candidate
[redacted]

Appendix B

SWE Approval Pending IRB

[External] Re: Research Request Application & Forms

[redacted]

Mon 10/18/2021 1:52 PM

To: Anderson, Blanche Deann [redacted]

You don't often get email from [redacted] Learn why this is important

[EXTERNAL EMAIL: Do not click any links or open attachments unless you know the sender and trust the content.]

Good afternoon, Blanche',

I have reviewed your materials and would be happy to share this research opportunity with our African American Affinity Group, once you receive IRB approval and are ready to begin your data collection.

We rarely share external research opportunities through email, but the lead for the affinity group might choose to do so. It would be up to them on how they feel it would best reach their members - email or social media. But hopefully this will help you with your recruitment efforts.

Please let me know when you have obtained IRB approval, and I will reach out to the affinity group lead.

Best,

[redacted]

Facebook / Twitter / LinkedIn / Instagram / YouTube

Pronouns: She/Her/Hers

Appendix C

Institutional Review Board Approval

LIBERTY UNIVERSITY
INSTITUTIONAL REVIEW BOARD

April 28, 2022

Blanche Anderson
Matthew Ozolnieks

Re: IRB Approval - IRB-FY20-21-978 The Minority in the Minority, Black Women in Computer Science Fields: A Phenomenological Study

Dear Blanche Anderson, Matthew Ozolnieks,

We are pleased to inform you that your study has been approved by the Liberty University Institutional Review Board (IRB). This approval is extended to you for one year from the following date: April 28, 2022. If you need to make changes to the methodology as it pertains to human subjects, you must submit a modification to the IRB. Modifications can be completed through your Cayuse IRB account.

Your study falls under the expedited review category (45 CFR 46.110), which is applicable to specific, minimal risk studies and minor changes to approved studies for the following reason(s):

7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Your stamped consent form(s) and final versions of your study documents can be found under the Attachments tab within the Submission Details section of your study on Cayuse IRB. Your stamped consent form(s) should be copied and used to gain the consent of your research participants. If you plan to provide your consent information electronically, the contents of the attached consent document(s) should be made available without alteration.

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

Sincerely,

G. Michele Baker, MA, CIP
Administrative Chair of Institutional Research
Research Ethics Office

Appendix D

Director of Research Correspondence

Dear [redacted]:

Thank you for your assistance in identifying and recruiting participants for my research project.

As a doctoral student in the School of Education at Liberty University, I am conducting research as part of the requirements for a Doctor of Philosophy. The title of my research project is *The Minority in the Minority, Black Women in Computer Science Fields: A Phenomenological Study*. The purpose of my research is to describe the lived experiences of Black women with a bachelor's, master's, or doctoral degree in a computer science field currently employed in the United States. I am seeking eligible participants to join my study.

Participants must be female, be 21 years of age or older, be Black or African American, have a bachelor's, master's, or doctoral degree in a computer science field (e.g., computer engineering, data science, information systems, information technology, software engineering, software development), have graduated from an accredited college, university, or vocational school, and be currently employed in the United States. Participants do not need to be currently employed in a computer science field. Participants, if willing, will be asked to participate in an interview (1-hour), a letter-writing activity (10–15 minutes), and one focus group session (1-hour). Names and other identifying information will be requested as part of this study, but the information will remain confidential.

I have attached a participant recruitment flyer, social media post, and a correspondence that can be shared with your members. The recruitment flyer, social media post, and correspondence all contain a link to a demographic questionnaire that will be used to identify participants who meet the criteria for the study. The results of the questionnaire will be returned to me automatically via email.

Thank you again for your assistance. Should any questions arise, don't hesitate to contact me by email at [redacted] or by phone at [redacted].

Sincerely,

Blanche' D. Anderson
Doctor of Philosophy Candidate
Liberty University

Appendix E

Participant Recruitment Correspondence

Dear [Recipient]:

As a doctoral student in the School of Education at Liberty University, I am conducting research as part of the requirements for a Doctor of Philosophy. The title of my research project is *The Minority in the Minority, Black Women in Computer Science Fields: A Phenomenological Study*. The purpose of my research is to describe the lived experiences of Black women with a bachelor's, master's, or doctoral degree in a computer science field currently employed in the United States. I am writing to invite eligible participants to join my study.

Participants must be female, be 21 years of age or older, be Black or African American, have a bachelor's, master's, or doctoral degree in a computer science field (e.g., computer engineering, data science, information systems, information technology, software engineering, software development), have graduated from an accredited college, university, or vocational school, and be currently employed in the United States. Participants do not need to be currently employed in a computer science field. Participants, if willing, will be asked to participate in an interview (1-hour), a letter-writing activity (10–15 minutes), and one focus group session (1-hour). Names and other identifying information will be requested as part of this study, but the information will remain confidential.

To be considered a participant for this study, please complete the demographic questionnaire by clicking here. The results of the questionnaire will be returned to me automatically via email.

A consent document will be emailed to selected participants before scheduling an interview. The consent document contains additional information about my research. If selected to participate, participants will need to type their name and the date on the document and return the consent document via email to [redacted] within 2 weeks of receiving the document.

Participants will receive a $25 gift card to a location of their choosing to show my appreciation for their full participation in this study.

Sincerely,

Blanche' D. Anderson
Doctor of Philosophy Candidate
[redacted]

Participant Recruitment Correspondence Follow-Up

Dear [Recipient]:

As a doctoral student in the School of Education at Liberty University, I am conducting research as part of the requirements for a Doctor of Philosophy. Two weeks ago, an email was sent to you inviting you to participate in a research study and complete the participant consent form. This follow-up email is being sent to remind you to complete and return the participant consent form if you would like to participate and have not already done so. The deadline for participation is [Date].

Participants, if willing, will be asked to participate in an interview (1-hour), a letter-writing activity (10–15 minutes), and one focus group session (1-hour). Names and other identifying information will be requested as part of this study, but the information will remain confidential.

If you choose to participate, you will need to type your name and the date on the consent document and return it to me via email at [redacted] within 2 weeks of receipt.

Participants will receive a $25 gift card to a location of their choosing to show my appreciation for their full participation in this study.

Sincerely,

Blanche' D. Anderson
Doctor of Philosophy Candidate
[redacted]

Appendix F

Participant Recruitment Flyer

Research Participants Needed

The Minority in the Minority, Black Women in Computer Science Fields: A Phenomenological Study

- Are you 21 years of age or older?
- Do you have a bachelor's, master's, or doctoral degree in a computer science field (e.g., computer engineering, data science, information systems, information technology, software engineering, software development)?
- Did you graduate from an accredited college, university, or vocational school?
- Are you a Black or African American Female?
- Are you currently employed in the United States?

If you answered **yes** to all of these questions, you may be eligible to participate in this research study.

The purpose of this research study is to gain an in-depth understanding of the lived experiences of Black and African American women who persisted in their STEM education and were able to pursue careers in computer science fields in the United States. Selected participants will receive a $25 gift card to a location of their choosing to show my appreciation for their participation in this study. Names and other identifying information will be requested as part of this study, but participant identities will not be disclosed.

Selected participants will be asked to:

- Participate in a 60-minute interview.
- Participate in a 10–15-minute letter-writing activity.
- Participate in a 60-minute focus group session.

If you would like to be considered as a potential participant for the study, please complete the following demographic questionnaire **HERE**.

A consent document will be emailed to selected participants before scheduling an interview.

Blanche' D. Anderson a doctoral candidate in the School of Education at Liberty University, is conducting this study. **Please contact Blanche' D. Anderson at [redacted] or [redacted] for more information.**

Liberty University IRB – 1971 University Blvd., Green Hall 2845, Lynchburg, VA 24515

Appendix G

Participant Recruitment Social Media

PARTICIPANTS NEEDED: I am conducting research as part of the requirements for a Doctor of Philosophy degree at Liberty University. The purpose of my research is to describe the lived experiences of Black women with a bachelor's, master's, or doctoral degree in a computer science field, currently employed in the United States. To participate, you must be 21 years of age or older, be female, be Black or African American, have a bachelor's, master's, or doctoral degree in a computer science field (e.g., computer engineering, data science, information systems, information technology, software engineering, software development), have graduated from an accredited college, university, or vocational school, and be currently employed in the United States. Participants do not need to be currently employed in a computer science field. Participants will be asked to participate in an interview (1-hour), a letter-writing activity (10–15 minutes), and a focus group session (1-hour). If you would like to participate and meet the study criteria, please click the link provided at the end of this post. A consent document will be emailed to select participants before scheduling interviews.

To be considered as a participant for this study, please complete the demographic questionnaire by clicking here. There are 13 questions, and it should take no more than 10 minutes to complete.

Appendix H

Participant Consent Form

Title of the Project: The Minority in the Minority, Black Women in Computer Science Fields: A Phenomenological Study
Principal Investigator: Blanche' De'Ann Anderson, Doctoral Candidate, Liberty University

Invitation to be Part of a Research Study

You are invited to participate in a research study. In order to participate, you must be a female, be 21 years of age or older, be Black or African American, have a bachelor's, master's, or doctoral degree in a computer science field (e.g., computer engineering, data science, information systems, information technology, software engineering, software development), have graduated from an accredited college, university, or vocational program, and be currently employed in the United States. Participants do not need to be currently employed in a computer science field. Taking part in this research project is voluntary.

Please take time to read this entire form and ask questions before deciding whether to take part in this research project.

What is the study about and why is it being done?

The purpose of this study is to describe the lived experiences of Black women with a bachelor's, master's, or doctoral degree in a computer science field who are currently employed in the United States. This study is being done to bring visible, relatable, and positive representations of Black women in computer science, highlight the factors that contributed to their success, and help craft a pipeline of visual interest and foreseeable careers in computer science for young Black women.

What will happen if you take part in this study?

If you agree to be in this study, I will ask you to do the following things:

1. Interview: Participate in a 45-minute to 1-hour interview. The interview will be audio- and video-recorded and conducted on Zoom.
2. Letter Writing: Write a letter of encouragement to a young Black woman considering a career or majoring in a computer science field. This should take between 10 to 15 minutes. The letter will need to be returned by email within 2 weeks of receipt of its prompt.
3. Focus Group: Participate in a 1-hour focus group session. The focus group session will be audio- and video-recorded and conducted on Zoom.

How could you or others benefit from this study?

Participants should not expect to receive a direct benefit from taking part in this study.

Benefits to society include future young Black women having knowledge of real-world examples of successful Black women in computer science fields. Increasing the visibility of Black women who are successful in these fields may bring hope, inspiration, motivation, and a greater sense of belonging to be felt by other Black women in these fields.

What risks might you experience from being in this study?

The risks involved in this study are minimal, which means they are equal to the risks you would encounter in everyday life.

How will personal information be protected?

The records of this study will be kept private. Any published reports will not include any information that will make it possible to identify a participant. Research records will be stored securely, and only the researcher will have access to the records.

- Participant responses will be kept confidential using pseudonyms (including the participant's academic institution/workplace name).
- Data collected will be stored on a password-locked computer and may be used in future presentations. Physical records will be kept in a locked filing cabinet. After three years, all electronic records will be deleted, and all physical records will be shredded.
- Interviews and focus groups will be conducted in a location where others will not easily overhear the conversation. In addition, interviews and focus groups will be recorded and transcribed. Recordings will be stored on a password-locked computer for three years and then erased. Only the researcher will have access to these recordings.
- The researcher cannot guarantee participants that other individuals in the focus group will not share what was discussed with others outside of the group.

How will you be compensated for being part of the study?

Participants will receive a gift of appreciation for participating in this study upon completion. No gift will be given if the participant does not complete the study. After full completion and participation in the interview, letter writing, and focus group session, the participant will receive a $25 gift card to a location of the participant's choosing. Participants may choose to either have their gift card emailed electronically or sent by mail.

Is study participation voluntary?

Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with Liberty University. If you decide to participate, you are free to not answer any question or withdraw at any time during the study without affecting those relationships. Prior to all data collection procedures, you will receive written reminders that you are not obligated to answer any question, you may skip any question(s) you choose, and you may end your participation in the study at any time for any reason.

What should you do if you decide to withdraw from the study?

If you choose to withdraw from the study, please contact the researcher at the email address/phone number included in the next paragraph. Should you choose to withdraw, data collected from you, apart from focus group data, will be destroyed immediately and will not be included in this study. Focus group data will not be destroyed, but your contributions to the focus group will not be included in the study if you choose to withdraw.

Whom do you contact if you have questions or concerns about the study?

The researcher conducting this study is Blanche' D. Anderson. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact her at [redacted] or [redacted]. You may also contact the researcher's faculty chair, Dr. Matthew Ozolnieks, at [redacted].

Whom do you contact if you have questions about your rights as a research participant?

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Institutional Review Board, 1971 University Blvd., Green Hall Ste. 2845, Lynchburg, VA 24515 or email at irb@liberty.edu.

Disclaimer: The Institutional Review Board (IRB) is tasked with ensuring that human subjects research will be conducted in an ethical manner as defined and required by federal regulations. The topics covered and viewpoints expressed or alluded to by student and faculty researchers are those of the researchers and do not necessarily reflect the official policies or positions of Liberty University.

Your Consent

By signing this document, you are agreeing to be in this study. Make sure you understand what the study is about before you sign. ***You will be given a copy of this document for your records.*** The researcher will keep a copy with the study records. If you have any questions about the study after you sign this document, you can contact the study team using the information provided above.

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

☐ The researcher has my permission to audio- and video-record me as part of my participation in this study.

____
Participant Printed Name

___________________________________ ________________________
Participant Signature Date

Appendix I

Participant Demographic Questionnaire

1. **Please provide your first and last name:**

2. **In what U.S. state do you currently reside?**

3. **Which category describes you?**
American Indian or Alaska Native Asian Black or African American
Hispanic, Latino, or Spanish Origin Middle Eastern or North African
Native Hawaiian or Other Pacific Islander White Prefer not to say Other

4. **What is your biological sex?**
Female Male Prefer not to say Other

5. **What is your age range?**
Under 21 21–34 35–49 50–74 75–99 Over 99

6. **What is your marital status?**
Single Married or Domestic Partnership Divorced Other

7. **What is your current employment status?**
Self-Employed Employed Full-Time Employed Part-Time Contract/Freelance
Student Retired Unemployed

8. **Did you graduate from an accredited college, university, or vocational program?**
Yes No

9. **What is the highest level of education you have completed?**
Some High School High School Graduate or GED Vocational Program Some College
Associate's Degree Bachelor's Degree Post Undergraduate Work Master's Degree
Specialist Degree Applied or Professional Degree Doctoral Degree Other

10. **Did you graduate with a bachelor's, master's, or doctoral degree in a computer science field (e.g., computer engineering, data science, information systems, information technology, software engineering, software development)?**
Yes No

11. **Are you currently employed in a computer science field?**
Yes No

12. **Would you like to be considered as a possible participant for this study?**
Yes No

13. **If you would like to be considered as a possible participant for this study, please provide a valid contact email address:**

Appendix J

Individual Interview Questions

1. Please introduce yourself to me, as if we just met each other.
2. Without using the title of your job, please describe for me what you do. [CRQ]
3. How did race impact your career choice? Describe any increased or limited opportunities. [SQ1]
4. How did gender impact your career choice? Describe any increased or limited opportunities. [SQ1]
5. Individuals are often born with special abilities or talents that cause them to excel in specific areas, leading them to choose a particular career. What special skills or talents were you born with that might have influenced the direction of your career path? [SQ1]
6. There are inherited qualities and personal identities that make up who we are (e.g., race, gender, nationality, ethnicity, physical appearance, characteristics, handicaps). What inherited qualities and personal identities, other than race and gender, influenced your career choice? [SQ1]
7. Describe for me any expectations on education and career choices you received from your family. [SQ2]
8. Tell me about your family or household experiences where you received support of your choice to pursue education in a STEM area. [SQ2]
9. Tell me about your family or household experiences where you did not receive support of your choice to pursue education in a STEM area. [SQ2]
10. Describe for me any individuals in the neighborhood or community you grew up in that influenced your education and career choice. If there is no one in your neighborhood or

community, describe any individual outside of your family who influenced your education and career choice. [SQ2]

11. How did your choice of education (college, university, or vocational program) influence your decision to pursue your academics? [SQ2]
12. How did your choice of education (college, university, or vocational program) influence your decision to pursue your career? [SQ2]
13. Tell me a time when a school administrator or faculty member was supportive of your choice to pursue a degree in a STEM field. [SQ2]
14. Tell me a time when a school administrator or faculty member was not supportive of your choice to pursue a degree in a STEM field. [SQ2]
15. Tell me about any academic clubs or organizations you credit with your degree completion. [SQ2]
16. Describe for me an experience involving technology that aroused your interest in STEM, specifically your current field. [SQ2]
17. What educational (college, university, or vocational program) learning experiences prepared you for your role in your career field? [SQ3]
18. Describe for me any negative verbal stereotypes you have heard about regarding Black women in STEM or your current occupation. Any positive verbal stereotypes? How did hearing about those stereotypes affect you mentally? academically? socially? [SQ3]
19. Describe for me any negative visual stereotypes you have seen regarding Black women in STEM or your current occupation. Any positive visual stereotypes? How did seeing those stereotypes affect you mentally? academically? socially? [SQ3]

20. Tell me about any supportive role models or mentors you attach to your degree completion. [SQ3]
21. Reflecting on your career advancement, what critical learning experiences helped develop the set of skills you have now (e.g., software, hardware, coding, people skills, communication, teamwork, leadership, management, etc.)? [SQ1, SQ2, SQ3]
22. We have covered a lot of information today. I thank you so much for your time and consideration in doing this interview. Is there anything else you would like to share about your experiences regarding STEM or your career field? [CRQ]

Appendix K

Letter Writing Sample Prompts

For this letter-writing activity, please write a letter of encouragement to a Black woman pursuing a career or majoring in a computer science field. The letter should be no more than two pages in length, take between 10–15 minutes to complete, and completed using a word processing software (e.g., Microsoft Word, Open Office, Google Docs). Sample prompts are provided below to assist you with this activity. Please return your letter back to the researcher via email at [redacted] within 2 weeks of receiving these instructions.

1. Please introduce yourself.
2. Identify your career field. [CRQ]
3. Explain why you chose computer science as a major and pursued a career in your field. [CRQ]
4. Share your most memorable experience after completing your degree and starting your career. [CRQ]
5. Share any benefits you have experienced being a Black woman working in a technology role. [CRQ]
6. Share the most critical piece of advice you wish you were given while completing your degree or working in your career field. [CRQ]
7. Share how you were able to stay motivated and persist throughout your journey. [CRQ]
8. Please include anything else beneficial for the young lady to know. [CRQ]

Appendix L

Focus Group Sample Questions

1. First, introduce yourself to the group. Please tell us your name, your field, and briefly describe what you do in your current role.
2. If you had to describe your feelings regarding the current representation of Black women in computer science fields as a weather pattern, what would your forecast be and why?
3. After the individual interviews, I asked each of you to write a letter of encouragement to a young Black woman considering studying or entering your field. How did you feel as you were writing the letter?
4. There were some themes that emerged from the letters. As I read to you the following themes, I would like to know which of these helped you succeed in your field and how (the theme) helped you.
5. During the interviews, I asked questions regarding items that affected your career decision making (CDM), and a few issues surfaced. The first was the question of (issue). How did you experience (this issue)?
6. As Black women in the field, what do you think makes your experiences different from others?
7. To conclude this interview, what means the most to you about your experiences and the possible impact your experiences could have on other Black women, or society, as a whole?