PERSISTENCE OF VISION: FACTORS INFLUENCING THE RETENTION OF WOMEN OF COLOR IN STEM PROGRAMS

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Montana Vasquez-Grinnell
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# Table of Contents

Abstract ........................................................................................................................................... 7  
Dedication ....................................................................................................................................... 8  
Acknowledgement .......................................................................................................................... 8  
Chapter One: Introduction to the Study .......................................................................................... 9  
Statement of the Problem .............................................................................................................. 11  
Significance of the Research Question .......................................................................................... 14  
Research Problem and Research Question ................................................................................... 16  
    Hypotheses ................................................................................................................................ 18  
Definitions of Key Terminology ................................................................................................... 20  
Theoretical Framework .................................................................................................................. 25  
    Critical Race Theory ................................................................................................................. 25  
    QuantCrit ................................................................................................................................... 28  
    Critics of CRT and QuantCrit .................................................................................................... 29  
    Rationale for using CRT and QuantCrit .................................................................................... 33  
    Applying CRT and QuantCrit ..................................................................................................... 35  
Conclusion .................................................................................................................................... 36  
Chapter Two: Literature Review .................................................................................................. 37  
STEM Workforce ............................................................................................................................ 38
<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of Diversity</td>
<td>39</td>
</tr>
<tr>
<td>Retention of Women of Color in STEM</td>
<td>41</td>
</tr>
<tr>
<td>Conclusion</td>
<td>43</td>
</tr>
<tr>
<td>STEM Education</td>
<td>43</td>
</tr>
<tr>
<td>Persistence in STEM</td>
<td>44</td>
</tr>
<tr>
<td>Faculty Support</td>
<td>44</td>
</tr>
<tr>
<td>Work-based Experiences</td>
<td>47</td>
</tr>
<tr>
<td>Student Transition Support</td>
<td>49</td>
</tr>
<tr>
<td>Conclusion</td>
<td>53</td>
</tr>
<tr>
<td>Challenges in STEM Education</td>
<td>54</td>
</tr>
<tr>
<td>Lack of Teacher Training with Diverse Populations</td>
<td>55</td>
</tr>
<tr>
<td>Funding</td>
<td>56</td>
</tr>
<tr>
<td>Integration of STEM Subjects</td>
<td>57</td>
</tr>
<tr>
<td>Equitable Access to STEM Disciplines</td>
<td>57</td>
</tr>
<tr>
<td>Conclusion</td>
<td>58</td>
</tr>
<tr>
<td>Academic Persistence</td>
<td>59</td>
</tr>
<tr>
<td>Predictors of Academic Persistence</td>
<td>60</td>
</tr>
<tr>
<td>Barriers to Academic Persistence</td>
<td>62</td>
</tr>
<tr>
<td>The University Environment</td>
<td>66</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Culturally Responsive Classrooms</td>
<td>66</td>
</tr>
<tr>
<td>Perceptions within the University Environment</td>
<td>68</td>
</tr>
<tr>
<td>Conclusion</td>
<td>69</td>
</tr>
<tr>
<td>Summary</td>
<td>70</td>
</tr>
<tr>
<td>Chapter Three: Methodology</td>
<td>72</td>
</tr>
<tr>
<td>Research Questions and Hypothesis</td>
<td>72</td>
</tr>
<tr>
<td>Hypotheses</td>
<td>73</td>
</tr>
<tr>
<td>Research Approach</td>
<td>73</td>
</tr>
<tr>
<td>Research Design</td>
<td>74</td>
</tr>
<tr>
<td>Population and Sampling</td>
<td>76</td>
</tr>
<tr>
<td>Data Collection Procedures</td>
<td>77</td>
</tr>
<tr>
<td>Data Analysis</td>
<td>78</td>
</tr>
<tr>
<td>Validity, Reliability, and Generalizability</td>
<td>79</td>
</tr>
<tr>
<td>Protection of Human Subjects</td>
<td>79</td>
</tr>
<tr>
<td>Ethical Considerations</td>
<td>81</td>
</tr>
<tr>
<td>Limitations</td>
<td>81</td>
</tr>
<tr>
<td>Summary</td>
<td>81</td>
</tr>
<tr>
<td>Chapter 4: Data analysis and results</td>
<td>83</td>
</tr>
<tr>
<td>Description of Sample</td>
<td>84</td>
</tr>
</tbody>
</table>
Abstract

The United States is currently experiencing a demographic shift that will impact the future workforce available for all positions in the country, especially in STEM fields. Persistence of women of color is increasing, but not at the percentage needed to diversify and support the number of STEM jobs that are projected to be available in the future in a variety of STEM fields. This quantitative study sought to explore the use of the Cultural Congruity Scale and University Environment Scale as predictive measures for whether women of color will persist in a STEM field. The scales were used to measure if 68 participants did or did not persist in STEM fields and if their scores on those scales would significantly be able to predict their persistence. The results indicated that the cultural congruity scale could be used to predict whether a woman of color would persist in STEM fields.
Dedication

This dissertation is dedicated to my parents, Yvette and Luis Vasquez, for their unconditional support, for their tireless selflessness throughout my life to ensure that I got the best opportunities available, for pushing through the obstacles of being immigrants in a sometimes hostile place, for helping me loosen up, and for supporting my role as mother and teacher throughout this process. Thank you to my husband, Steve Vasquez-Grinnell, for listening as I spoke ideas out loud and for supporting me throughout the late nights and the days I just needed to sit and write. Thank you to my sister, Daniela Vasquez, for being a listening ear, even from far away, to help me process and vent throughout this program, and for being my best friend. And finally, for my children, Parker & Saoirse, I hope Mami can inspire you to follow your dreams and to reach for the stars the way that you inspire me to do better and reach higher every day. Mami loves you!

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Chapter One: Introduction to the Study

STEM which stands for science, technology, engineering, and math seems like a specific and straightforward acronym, however, when it comes to the definition of what is a STEM field the specifics can be vague (Beede, Julian, Langdon, McKittrick, Khan, & Doms, 2011). For this study, STEM does not include jobs in education, non-STEM management positions, and social sciences (Beede et al., 2011). STEM fields are central to the changing United States (U.S) economy (Basile & Lopez, 2015). The U.S. educational system must focus on strategies for developing students’ skills to ensure that they can be competitive in STEM fields (Finkel, 2016). However, people of color and women are not as prevalent in STEM fields, especially based on their relative proportion of the overall population (Peralta, Caspary, & Boothe, 2013). A recent report found that 67 percent of STEM occupations are held by Non-Hispanic Whites, which is comparable to their total U.S. population (National Science Board Science and Engineering Indicators, 2018).

Conversely, Blacks, Hispanics, and American Indians, who represent 27 percent of the total U.S. population, yet in total hold 11 percent of STEM occupations (National Science Board Science and Engineering Indicators, 2018). People of color enter higher education interested in STEM fields yet do not complete degrees at a high rate (Museus & Liverman, 2010). In fact, women of color enter higher education just as interested in entering STEM careers, approximately 32 percent, with the intent to complete a STEM degree while 31 percent of their white counterparts planned on pursuing a STEM field (Mack, Rankins, & Woodson, 2013) yet women of color make up 10.6% of all the recipients of undergraduate degrees in STEM disciplines (Mack et al., 2013). Many students who do pursue STEM degrees from diverse
backgrounds begin their degrees at community colleges (National Science Board Science and Engineering Indicators, 2016) and then must transfer to four-year institutions to continue with higher-level STEM degrees. Every step of this process is essential to improving diversity in STEM fields. Women of color are often well-prepared by their K-12 settings, but it is in undergraduate and, especially, graduate education settings where women of color often feel like they cannot persist or that they face barriers (Thiry, Laursen, & Liston, 2007; Welde & Laursen, 2011).

Improving racial and gender diversity in STEM is vital to prepare a sufficient number of individuals to be the future workforce with unique and different experiences and perspectives (National Science Board Science and Engineering Indicators, 2016). Improving racial and gender diversity is also a social justice issue that allows marginalized groups to move up socially and economically (Basile & Lopez, 2015). Improving transfer relationships and processes, continuation, and supporting women of color students throughout their time in higher education may lead to more diversity in all STEM fields. That support can be through a variety of different modes – learning communities, mentors, faculty support, and positive peer interactions within their degree programs. Supporting women and students of color to persist in STEM fields will require an understanding of what types of programming in higher education settings best encourage women of color to continue in STEM fields. With this understanding and knowledge, there can be an improvement in diversity across STEM fields.

People of color and women remain underrepresented in STEM fields, despite an ever-changing demographic landscape and women comprising approximately half of the U.S. population (Peralta, Caspary, & Boothe, 2013). Within STEM, marginalized women of color
face the double bind (Malcom, Hall, & Brown, 1975). The double bind zeroed in on the
challenges of being a woman of color pursuing a profession in the sciences for several reasons,
including personal and financial sacrifices, and the multiple identities and groups women of
color in STEM must navigate (Malcom et al., 1975). When factors such as socioeconomics,
gender, and race factored into the equation pursuing a STEM profession becomes that much
more difficult (Malcolm et al., 1975). Exploring how women of color persist in STEM programs
and professions can increase their numbers in STEM fields. STEM jobs will face a deficit of
qualified individuals, and without enough individuals trained in STEM fields now in the U.S., we
will not have the workforce needed to sustain a STEM-focused economy and our status as
technology innovators (Foltz, Gannon, & Kirschmann, 2014). Without a large, STEM-trained
workforce, the U.S. will have a challenge maintaining a competitive and innovative spot in the
global economy (Basile & Lopez, 2015: Hewlett, Marshall, Sherbin, 2013). Therefore,
addressing the double bind and how to best support women of color entering STEM fields
through their higher education settings is critical.

Statement of the Problem

Despite students of color entering higher education studies as interested in STEM fields
as their white counterparts, they are 24% less likely to graduate with a STEM degree (Museus &
Liverman, 2010). Developing an understanding of what supports within higher education
programs help or hinder women of color is part of maintaining our position as innovators in the
 technological world and promoting social mobility to ensure our global competitiveness. This
study aimed to investigate what factors, specifically learning communities, culturally accepting
campus environment, and informal and formal mentorship, contribute to the persistence of
women of color through STEM degree programs. Persistence, which is defined as whether a person can complete a STEM degree in higher education (Toven-Lindsey, Levis-Fitzgerald, Barber, & Hasson, 2015), can be further defined as not continuing into a STEM career especially if they did not complete their program (Toven-Lindsey et al., 2015). STEM fields are not humanities and education-based, but rather STEM programs, in this study, are defined as programs that center on research science, applied sciences, engineering, technology, or mathematics as setting up in higher education academic settings (Cole & Espinoza, 2008). For this study, women of color defined as women who are African American (Black), Latina (either White or Black), Asian, Pacific Islander, and Native American. Therefore, the purpose of this quantitative study was to employ two scales in a survey, the University Environment Scale and the Cultural Congruity Scale, to understand what factors affect the perception of a university environment by female students of color in STEM degree programs, and the ability of researchers or educators to predict their persistence.

STEM is not just important economically, but also socially because it allows marginalized communities to improve their economic status (Basile & Lopez, 2015). Along with the social justice component, women of color face the double bind where they are pulled between their identities as women and minorities and are expected to pick one side of themselves (Malcolm, Hall, & Brown, 1975). The women of color who chose to go into STEM fields continue to face not only this pull between two groups but also the issue of lack of support from the institutions they attend to pursue STEM fields (Malcolm & Malcolm, 2011).

Women of color are a group where two underrepresented groups in science intersect – women and people of color. Increasing diversity in STEM is critical for addressing this issue. In
prior studies, young women of color have suggested several issues that they have faced persisting in STEM. Some of these challenges include building a professional network, a lack of relatable role models, and feeling different from the white men and women around them (Kachchaf, Ko, Hodari, & Ong, 2015; Ong, Wright, Espinosa, & Orfield, 2011). Museus (2008) pointed to the importance of ethnic organizations or communities for students of color in predominantly white institutions (PWIs) and how they help a student of color adjust to their institution of higher education. These factors of learning communities, mentorships, role models, and feeling the cultural acceptance or congruity with their institutions are important factors for students of color and women of color. Addressing these factors of persistence in higher education institutions can lead to addressing the issue of diversity in STEM fields in general.

Gathering data on the specific factors that support women of color persist in STEM fields is becoming an increasingly popular research topic. Community colleges are central to the diversification of STEM fields (Labov, 2012) and are a sector of higher education that needs to be explored to understand better how these factors support women of color move from community college to a four-year institution. Many of the women and people of color in higher education attend community colleges (American Association of Community Colleges, 2017). Forty-four percent of people who hold STEM degrees stated that they received at least some of their credits from a community college (National Science Foundation Science and Engineering Indicators, 2014). Gathering more data about what women of color need to start a STEM degree in a community college successfully is one specific area of research that should be explored. Combined with the information from women of color in other higher education settings, both
undergraduate four-year institutions and graduate programs, scholar-practitioners, and other researchers can offer higher education settings data to better support this population of students.

Gathering additional data on women of color and STEM retention in higher education settings has the potential to be essential for increasing retention rates and diversifying STEM fields throughout the U.S. Keeping students in STEM fields is vital to promoting social mobility and justice for women of color in this country. Boosting social movement for groups that are currently marginalized increases the middle class and addresses a major social justice issue in the U.S. It also supports our country’s economic and social interests which should be important to politicians and higher education administrators at every level of government and in any party looking to make a positive impact in our nation.

**Significance of the Research Question**

STEM is a significant focus in the U.S. and ensuring that there are enough individuals in STEM fields who are well-trained is essential to our future in technology (Mack et al., 2013). Careers in STEM in the U.S. are facing a shortage of qualified individuals, especially people of color and women who remain underrepresented in STEM fields (Finkel, 2016), while the population of people of color continues to rise in the country (Taylor & Cohn, 2012). Despite the numbers of women doubling in STEM fields over the last twenty years, the improvement has been modest (National Science Board Science and Engineering Indicators [NSB S & E Indicators], 2016). Women makeup half of the college-educated workforce but only represent about 29% of the STEM workforce (NSB S&E Indicators, 2016). Whites make up 66% of the population and 67% of STEM occupations, while Hispanics make up 14% of the population, yet only 6% of STEM occupations (NSB S & E Indicators, 2018). Research has shown that ability
does not predict which women persist in STEM fields (Kerr, Multon, Syme, Fry, Owens, Hammond, & Robinson-Kurpius, 2012). Women are well prepared for entering STEM fields and have the grades and academic course work to persist in STEM fields; however, they face many barriers that can make persistence a challenge (Kerr et al., 2012). By developing programs and initiatives that support women of color in higher education settings, institutions can create comprehensive and sophisticated STEM programs that are empowering students, specifically women of color, to have some social mobility while supporting the U.S. economy.

STEM fields will provide careers and job opportunities for a large group of individuals in the future (Musante, 2012). The opportunity to provide jobs to students who may not have had access to a career in other settings creates a situation where students in previously marginalized communities have a chance to “move up” (Basile & Lopez, 2015) — giving women of color the opportunity to improve their lives and those of their family benefits women and students of color as individual communities while benefiting the country economically.

Creating programs that more effectively support women of color in STEM would benefit the persistence rates in higher education settings. Addressing higher education institutions on better support initiatives for STEM students allows for communities at large to benefit too. Support initiatives have the potential to give students from diverse backgrounds access to an engaging and sophisticated STEM curriculum and an encouraging, inclusive environment. Public community colleges allow students from different backgrounds to fund their education (American Association of Community Colleges, 2017; NSB S & E Indicators, 2016), which gives access to higher education to a larger group of students and highlights the importance of this issue at every level. Increasing persistence helps students reach their goal of getting a degree
in a STEM field, which many women of color see as a way to improve their socio-economic standing (Jackson, Starobin, & Laanan, 2013).

Supporting diverse communities provides opportunities to improve through education (Basile & Lopez, 2015) and representation. Increasing the success of women and diverse populations creates a supportive network within a community (Finkel, 2016) and influences a younger generation to pursue a STEM career. Giving women of color access to cutting-edge jobs and higher salary positions can improve minority communities and the independence of women in their communities.

Supporting women of color taps into an untapped labor force in the U.S. (NSB S&E Indicators, 2016), which benefits our nation across all communities. The U.S. can boost its status in STEM fields across the globe while creating a situation economically to support social mobility for women of color. Tapping into this labor force has the potential to access new ideas, techniques, and develops and return the U.S. to its former place at the top of technological innovation across the globe.

**Research Problem and Research Question**

As a result of women of color not completing STEM degrees at comparable rates to their white female counterparts and men, the issue of persistence of women of color in STEM fields has emerged in higher education institutions (Malcolm et al., 1975; Rodriguez et al., 2017). The lack of diversity at the intersection of gender and race means there is a significant voice and perspective in the U.S. that is not represented in STEM fields (NB S & E Indicators, 2016). Diverse perspectives and experiences which can contribute to solving difficult questions or problems (Basile & Lopez, 2015) are a critical component of innovation in STEM (Basile &
Lopez, 2015). Gloria and Kurpius (1996) noted that there is a need to continue to examine the perceptions of students of color of their university environment.

The purpose of this quantitative study was to employ a survey, the University Environment Scale and the Cultural Congruity Scale, to understand what factors affected the perception of a university environment by female students of color in STEM degree programs, and the ability of researchers or educators to predict their persistence. Utilizing the University Environment Scale (UES) and Cultural Congruity Scale (CCS) added to the literature of the perceptions of women of color of their university environments and noted how that relates to their persistence in STEM fields.

The research question that this researcher explored was: Does students’ perceptions of the university environment predict academic persistence among women of color in STEM fields? From this question, several follow-up questions were investigated: Are women of color in culturally accepting (CCS) higher education environments associated with the persistence of women of color in STEM fields? Are women of color in academically supportive (UES) higher education environments associated with the persistence of women of color in STEM fields? Do women of color with faculty who offer support in the form of mentorship persist in STEM fields? Do women of color in institutions that sponsor ethnic affinity groups to persist in STEM fields?

The main question focused on the supports that women of color may or may not feel they have in their higher education settings which were explored through the UES and CCS (Gloria & Kurpius, 1996) specifically rating the availability of faculty and staff as well as the expectation to change themselves to fit into the predominantly white university environment (Gloria &
Understanding what works and does not work for keeping women of color in STEM is essential to encouraging higher education institutions to put into place initiatives and programs that increase the number of women of color in STEM fields. The importance of mentorship and culturally accepting environments are vital to the success of women of color (Fries-Britt et al., 2010; Labov, 2012). The second question zeroed in on mentorship, as mentioned in the UES, and how mentorship could benefit a woman of color in a STEM program. The third question focused on culturally accepting environments in a higher education institution, as explored with the CCS, and the perception that many women of color felt about changing to fit into their university, hiding who they were, or exclusion from activities (Malcolm & Malcolm, 2011; Wilson & Holmes, 2012).

Based on these questions, the following hypotheses were developed using the UES and the CCS as a guide.

**Hypotheses**

- Women of color who perceive their environment as *culturally accepting* are more likely to persist in STEM fields.
- Women of color who perceive their environment as *academically supportive* are more likely to persist in STEM fields.
- Women of color who participate in ethnic affinity groups persist in STEM.
- Women of color with formal mentors are more likely to persist in STEM programs than those with informal or no mentors.

The first two hypotheses connected to items two, three, seven, and twelve of the CCS address the student’s perception of whether they felt they hid their ethnic heritage at their institution (“I
try not to show the parts of me that are ‘ethnically’ based) and if they would behave differently based on the ethnicity of the person they were interacting within a situation (“I often feel like a chameleon, having to change myself depending on the ethnicity of the person I am with at school”). Item seven, “My ethnic values are in conflict with what is expected at school,” specifically asked the participant how they perceived their ethnicity was not welcomed or accepted in the institution. From the UES, questions about the feeling of the university being a cold, uncaring place (item 11) and a sense of being valued as a minority (items 4 and 9) contribute to how a woman of color perceives her university environment.

Several items in the CCS and the UES addressed connections to staff, faculty, and the value placed on ethnic minorities from the last hypotheses. In the CCS, perception of appearance (item 9), along with a sense of belonging (item 12), connects to having mentors and groups that give women of color that sense of being part of their higher education institution. The UES more directly addresses whether the university environment sponsored or encouraged ethnic groups (item 7) and whether staff were friendly, welcoming, and helpful to students (items 2 and 3). Items 5, 10, and 12 connect directly to faculty and their availability to students directly impacting the ability to create a relationship with faculty that could become mentorship, whether formal or informal. Utilizing the CCS and the UES in conjunction, as Gloria & Kurpius (1996) suggested, gave a fuller picture as to how the participants perceived their higher education environment and its impact on their persistence in a STEM field.

Since this study was viewed through a Critical Race Theory and QuantCrit, understanding the racial undertones and cultural understandings, or lack thereof, within institutions gave this researcher a deeper understanding of whether this is a significant issue for women of color or not
when it comes to persistence in STEM fields. The final question sought to understand whether affinity groups are supportive to women of color in STEM fields (Ong et al., 2011) and explore whether these groups are sponsored by their higher education institutions and how that impacts their persistence (Gloria & Kurpius, 1996). Again, this was to gain a better understanding of what affinity groups should be available to women of color that could support their persistence in STEM fields (Gonzalez, 2003; Museus, 2008).

Understanding the importance of affinity groups ensures that women of color feel comfortable in their institution, so they have access to success like their white counterparts, which is the basis of CRT – analyzing how our institutions currently discriminate against people of color (Dixson & Anderson, 2018). The purpose of this quantitative study was to employ a survey, the University Environment Scale and the Cultural Congruity Scale, to understand what factors affected the perception of the university environment for female students of color in STEM degree programs, and the ability of researchers or educators to predict their persistence. The information from this study will be utilized to provide and encourage the appropriate changes at institutions of higher education needed for women of color to persistence in STEM fields.

Definitions of Key Terminology

Critical Race Theory (CRT): CRT developed in the 1970s and 1980s from legal scholars challenging how race was dealt with and discussed based around five central tenets based on the permanence of white supremacy and racism, and the need for social justice (Lopez, Erwin, Binder, & Chavez, 2018; Garcia, Lopez, & Velez, 2017).
**QuantCrit**: is an expansion of CRT when applied to quantitative methods and analyzed through a CRT lens (Gillborn, Warmington, & Demack, 2017).

**Intersectionality**: is the theory that several forms of oppression intersect like gender and race/ethnicity oppression (Ong, Smith, & Ko, 2018).

**The Double Bind**: was coined in the mid-1970s about the specific challenges of racism and sexism faced by women of historically underrepresented minority groups in STEM fields (Malcom et al., 1976).

**Microaggressions**: incessant, subtle, yet stunning racial assaults (Yosso, Smith, Ceja, & Solórzano, 2009).

**Counter storytelling**: is when participants can use their experiences to counteract the stories of the dominant group (Delgado, 1989; Dixson & Anderson, 2018).

**Deficit orientation**: the focus on what students or a group lack rather than what they possess or can do (Gillborn, 2010).

**Experiential knowledge**: the lived experiences of individuals through counter-storytelling methods (Yosso et al., 2009).

**Meritocracy**: the idea that if people work hard enough, nothing can stop them from achieving their dreams (Museus, Palmer, Davis, & Maramba, 2011).

**Colorblind meritocracy**: a person’s dreams can be achieved no matter their racial background if they work hard (Museus et al., 2011).

**White supremacy**: the belief of white superiority and utilizing legal and extralegal means to maintain whiteness as property and exclude people of color from access to resources and power (Chen & Buell, 2018).
**Interest convergence:** developed by Derrick Bell (1980, 1987, 2004), the practice of allowing people of color to benefit from society’s institutions only at the convenience of white culture (Yosso et al., 2009).

**Campus culture:** deeply embedded patterns of values, beliefs, and assumptions (Bauer, 1998; Museus et al., 2011).

**Campus climate:** current perceptions, attitudes, and expectations that define an institution and its members (Bauer, 1998; Cole & Espinoza, 2008; Museus et al., 2011).

**Near-peer mentor:** an undergrad or post-baccalaureate student who completes a summer teaching internship along with a research internship (Tenenbaum & Anderson, 2014).

**Code-switch:** adapt to the values of the environment to succeed educationally (Gloria & Segura-Herrera, 2004).

**Cultural incongruity:** individuals who belong to two or more cultures that do not fit together because of different values, beliefs, and expectations of behavior (Gloria & Kurpius, 1996).

**Cultural congruity:** individuals who perceive that they fit into space despite their different values and beliefs (Gloria & Kurpius, 1996).

**Social justice:** the argument that the opportunity to pursue personal and professional success in STEM (and other fields) is a right for all individuals in this country (Mack, Taylor, Cantor, & McDermott, 2014).

**White fragility:** when the white individual becomes the victim when something is done to a person of color (Tate & Page, 2018).
Chilly: An unwelcoming, exclusive environment in which students of color do not feel part of the community (Joseph, 2012).

Racial battle fatigue: The exhaustion faced by many students of color when faced with microaggressions, exclusion, and chilly campus environments (William & Smith, 2004).

Cultural capital: An attempt to explain the role of arbitrary cultural distinctions in defining positions in social spaces that vary in power and privilege and determine who gets to be in those positions (Cole & Espinoza, 2008; Olneck, 2000).

Culturally responsive classrooms: A classroom setting that explicitly acknowledges the presence of culturally diverse students to find connections among themselves and their subject matter (Montgomery, 2001).

Women of color: The definition of a woman of color is a woman that identifies as Latina, African American, Asian (including Pacific Islander and Southeast Asian), and Native American (NSB S&E Indicators, 2015).

Microassaults: What most would consider old fashioned, overt racism (Dortch & Patel, 2017).

Microinvalidations: Unconscious (often) exclusions of a person’s identity and disregard for the lived experiences of marginalized communities (Dortch & Patel, 2017).

Microinsults: Often, unconscious messages in an environment that rely on stereotypes and demean a person’s marginalized identity (Dortch & Patel, 2017).

Structural racism: Systemic Racism and advantages Whites in economic, political, social, ideological, and educational settings (McGee & Bentley, 2017).
**Impostor syndrome**: The normalization of being perceived as a fraud despite high achievement in academic domains (McGee & Bentley, 2017).

**Double marginalization** is like the previously mentioned double bind and centers on race and gender discrimination (Dortch & Patel, 2017).

**Weathering**: A phenomenon characterized by the long-term physical, mental, emotional, and psychological effects of racism living in a society characterized by white dominance and privilege (McGee & Stovall, 2015).

**Organizational climate**: How individuals perceive organizations' policies, practices, and procedures (Settles, Cortina, Malley, & Stewart, 2006).

**Retention**: Who chooses to persist in a STEM major or occupation (Diekman, Weisgram, & Belanger, 2015).

**Recruitment**: Who chooses to enter a STEM pathway (Diekman, Weisgram, & Belanger, 2015).

**Self-efficacy**: The ability to persist in a specific task even when not necessarily able to persist in another task (Marra, Rodgers, Shen, & Bogue, 2009).

**Positive marginality**: The idea that minority group members may adaptively reflect on and redefine their nondominant cultural or demographic group as a source of advantage (Morganson, Major, Streets, Litano, & Myers, 2015).

**Fit**: The perception of a match in the required abilities (Morganson et al., 2015).

**Links**: The connections to others and activities in a community, whether a school or employment (Morganson et al., 2015).

**Sacrifice**: The cost of leaving a job (Morganson et al., 2015).
**Mentoring/Mentorship:** When a person seeks the guidance of a person who is often in a superior position, has higher achievement and prestige to help them develop and grow towards a successful position/career (Odell, 1990).

**Theoretical Framework**

This study strived to understand the factors that supported or hindered women of color in their university environments from persisting in STEM fields. Persistence factors were analyzed through the lens of CRT and QuantCrit. Both the perspectives of women of color and the issue of persistence were explored through statistical analysis to enact social justice (Gillborn et al., 2017). CRT was first developed in the 1970s and 1980s as a new way to discuss race and racism in the United States (Gillborn et al., 2017). These theories were first applied in the field of legal studies and have expanded into other subject areas, including education. With the concern about STEM education deficits moving to the foreground of education discussions in the U.S., CRT and QuantCrit allows for the exploration of persistence factors for women of color in STEM. CRT and QuantCrit have developed and changed over the last forty years. The following sections overview the history of CRT and QuantCrit and their importance in bringing the discussion of race into education. Along with the history of how CRT and QuantCrit developed, critiques of the theories are discussed and how both approaches support the research on persistence factors of women of color in STEM.

**Critical Race Theory**

CRT developed in the 1970s and 1980s from legal scholars exploring new ways to challenge how race was dealt with and discussed (Lopez et al., 2018). Despite the growth of civil
rights after the 1960s and the continued expansion of liberalism during those decades, there was little critique about how institutionalized race and racism permeated our society (Gillborn, 2006). There was also little discussion about how race and racism affected people of color daily in this country (Gillborn, 2006). The silence on race and racism led to scholars working to bring these issues to the forefront to challenge existing narratives (Bell, 1980a; Crenshaw, 1988; Delgado, 1989; Matsuda, Lawrence, Delgado, & Crenshaw, 1993). Crenshaw (1988) pointed out that the force of racism in the United States was ignored and that racism had been repackaged. Another aspect of racism reform is that the overt stance of racism has been addressed, but not the subtle microaggressions that permeated much of society (Crenshaw, 1988).

From the 1970s and 1980s, CRT moved out of the area of solely legal studies into the field of education by Ladson-Billings and Tate (1995). Expanding the application of CRT to education, and other fields push to expose race and racism and how the status quo benefits the whites of society rather than people of color (Ladson-Billings & Tate, 1995). Despite how much race affects people of color and our society, Ladson-Billings and Tate (1995) felt that there was not enough theoretical discussion of race in education. Ladson-Billings, an educator, and theorist, and Tate, also an educator, had experience in the world of education and wanted to create a way to analyze race in education (Ladson-Billings & Tate, 1995).

While Crenshaw, Delgado, Matsuda, Bell, and Lawrence developed CRT through legal studies, it is scholars like Gillborn, Lynn, Dixson, Solorzano, Yosso, Ladson-Billings, Tate, and Parker that have expanded the focus and scope of CRT into education, STEM, and quantitative methods of study. CRT consists of five central tenets (Garcia et al., 2018): the permanence of white supremacy and its connection to other forms of oppression, using counter-storytelling to
challenge white supremacy, commitment to a socially and racially just praxis, centrality of
experiential knowledge, and the trans-disciplinary perspective. These five tenets are intended to
be fluid and flexible, as they support CRT’s goal to expose the oppression and racism of a white
supremacist society by allowing the oppressed to tell their stories. It is through the stories and
experiences of people of color that race and racism, and its impact on people of color, are
revealed.

Moving from these flexible tenets of CRT, Dixson, and Anderson (2018) developed six
guiding principles of how CRT specifically applies within education. These six principles are
meant to be a guide for modifying CRT’s development in legal studies and allow for its movement
into the area of education research (Dixson & Anderson, 2018).

• Racial inequity occurs due to a system of achievement based on competition.
• Examines the role of education policy and educational practices in the creation of
  racial inequity and the perpetuation of normative whiteness.
• Rejecting the dominant narrative that people of color are inferior, and that white
  people are superior.
• Examines the historical links between contemporary educational inequity and
  historical patterns of racial oppression.
• Intersectional analyses that recognize the way that race is mediated by and interacts
  with other identity markers like gender, class, sexuality, etc.
• Agitates and advocates for meaningful outcomes that redress racial inequity, not
  merely documenting disparities.
Dixson and Anderson (2018) developed these principles to distinguish how CRT in education is different from CRT applied to legal studies. Seriki (2018) discussed the need for CRT in science education because as Ladson-Billings and Tate (1995) had mentioned race was not addressed in education, Seriki (2018) says the same is true for science education. However, the conversation of race and racism is essential to address the continued lack of diversity in STEM fields (Seriki, 2018). The combination of CRT and education works to focus on how race and racism are systemic in our education system, which directly affects students of color and their ability to succeed. The constant focus on the supposed deficits of students of color rather than the system and how these students are affected by the institutionalized racism and white supremacy is part of what CRT is working to expose. CRT also addresses the double bind (Malcolm, Hall, & Brown, 1975) along with the intersectionality (Crenshaw, 1989) of being a woman and a person of color in STEM.

QuantCrit

Today, CRT has expanded to other countries, including the United Kingdom, other European nations, and Australia (Gillborn, 2006) as well as expanding to QuantCrit, CritQuant, and Critical Race Quantitative Intersectionality (Gillborn et al., 2017). QuantCrit is an expansion of CRT when applied to quantitative methods and analyzed through a CRT lens (Gillborn et al., 2017). QuantCrit has its origins in the work of DuBois (1899), who conducted a mixed-methods study addressing inequities in statistics. DuBois developed descriptions of power along with institutional and structural origins of social inequalities (DuBois, 1899; Garcia et al., 2018). Another notable individual in the development of QuantCrit is Zuberi (2001), who addressed racism within statistics and called for researchers to remove the inherent bias in
numbers (Garcia et al., 2018; Zuberi, 2001). Other scholars including Velez (2013), Covarrubias (2011), Huyser (2010), Sakamoto (2010), Takei (2010), and Irizarry (2015) moved into the quantitative realm and addressed the intersectionality of CRT along with descriptive statistical analysis to explore these issues from a variety of datasets (Garcia et al., 2018).

Gillborn (2017) is the most recent scholar addressing institutionalized and systemic racism through CRT and QuantCrit and discusses how data has been misused in the past (Garcia et al., 2018). Gillborn and colleagues (2017) laid out a set of assumptions connected to CRT for QuantCrit, specifically highlighting how it relates to quantitative analysis. QuantCrit developed assumptions that guide CRT research through quantitative methods (Gillborn et al., 2017): the centrality of racism as a complex issue that is difficult to quantify, numbers are not neutral and must be examined so as not to promote deficit perspectives, units and forms must be critically analyzed because categories are not natural or given, data cannot speak for itself and should be critically analyzed along with the experiences from marginalized groups, and statistical analyses do not have inherent value but can be utilized in struggles for social justice. These five assumptions emphasize the importance of addressing racism within statistical analysis, which is often used to prove something through its supposed objective nature while considering the stories and experiences attached to those numbers (Gillborn, 2010). CRT and QuantCrit have developed over the last forty years to address the continued systemic racism within our legal system, education system, and other significant institutions within our society.

**Critics of CRT and QuantCrit**

Despite its presence in scholarly discussions for the last forty years, CRT is underutilized as a theory (Dixson & Anderson, 2018). However, many would argue that CRT is problematic
for a variety of reasons, such as the importance of meritocracy, that CRT is legal racism, colorblindness, and even anti-Semitic and anti-Asian (Farber & Sherry, 1997). Some theorists, critics, and researchers say that it has murky boundaries (Carbado, 2011; Dixson & Anderson, 2018). One critic, Randall Kennedy (1989) states that there should not be any particular assignation to minority voices on racial issues because some minorities are not interested in ethnic movements, some do not offer insights, but that white people can also offer vital insight (Kennedy, 1989; Delgado & Stefancic, 2001, pp. 122-123). Kennedy felt that liberal scholars had not explored the premises of a variety of sources and had made the charge of exclusion without examining the quality of the supposedly excluded articles and voices (Kennedy, 1989; Delgado & Stefancic, 2001, p. 123). Kennedy, as with many scholars, searched for quantifiable proof, which is explicitly what CRT states are an issue that scholarship does not address for race and racism (Delgado & Stefancic, 2001, p. 124).

Another set of critics are Rosen (1996), Farber (1997), and Sherry (1997), who state some of the most serious charges against CRT. They questioned the usefulness and importance of storytelling in law, that CRT was based on racial essentialism, and that it excluded Jews and Asians because they had succeeded through conventional standards (Farber & Sherry, 1997; Delgado & Stefancic, 2001; Rosen, 1996). Farber and Sherry (1997) suggest that CRT is implicitly anti-Asian and anti-Semitic because it implies that Asians and Jews must have succeeded through unsavory means or mimic. The issue of storytelling in law Farber, Sherry, and Judge Richard Posner suggests that it has no place in law (Delgado & Stefancic, 2001). The argument is that storytelling allows for atypical stories that are not representative of the larger groups and that there is little analytical rigor in an individual’s account due to its ability to be
openly interpreted. Farber and Sherry also argued against the lack of concern for the truth in CRT because CRT states that truth is socially constructed (Delgado & Stefancic, 2001). CRT has also faced internal critique as scholars examine how to expand the theory and what the boundaries of the theory are so that it guides researchers and scholars (Delgado & Stefancic, 2001). The most recent criticism, which has not been fully explored, is that CRT does not go far enough in its exploration of color-blind racism and the view that our nation is in a post-racial era (Delgado & Stefancic, 2001).

There are several counterpoints for these arguments from critics. First, the arguments of CRT being anti-Semitic and anti-Asian are an effort to separate minorities and put minorities against each other, which often happens when race perceptions are discussed (Chen & Buell, 2018). CRT could be applied to Asians in STEM and higher education (Chen & Buell, 2018), and with the fluidity of the principles and boundaries of CRT, there is room to include all minorities (Dixson & Anderson, 2018). Asians are also often presented for their success in our culture, and CRT scholars argue that that is despite the system that has been set up against them (Delgado & Stefancic, 2001). This idea that Jews and Asians work within the meritocracy continues to perpetuate deficit thinking against Blacks, but also continues to promote racism against these groups by utilizing their success to promote policies that are advantageous to Whites and maintaining their supremacy in society (Chen & Buell, 2018).

Another aspect of that argument is that it furthers the idea of an Asian stereotype of being a specific type of individual and not rewarding those who would speak out against racism that Asians do face (Chen & Buell, 2018). Critics of CRT are doing what they are criticizing CRT scholars for when they claim they are making assumptions about an entire group. Another point
is that by discussing the struggles and difficulty faced by one group, like Blacks in America, it is not an automatic dismissal and exclusion of others in this country who have experienced the US differently in similar contexts (Delgado & Stefancic, 2001).

Many critics point to meritocracy and colorblindness as the necessary standards to succeed in our society. Giroux (2003) points out that character merit and character are how someone becomes successful economically and socially in having a decent standard of living. There is also the idea of the model minority, which Asians are placed into to further highlight the benefits of meritocracy and colorblindness (Chen & Buell, 2018). Using the model minority as an example suggests that rather than there being systemic issues within our system that this is evidence of lack of effort, intelligence, and motivation. Based on US Census Bureau data (2016), Non-Hispanic whites are more likely to have a bachelor’s degree or higher than Blacks, and the gap only increases the higher the degree. The continued implication that this is because Blacks are choosing not to participate in our meritocracy and suggesting that this is something that affects minorities that are not Jewish or Asian, ignores socio-economics, and the inherent racism built into a system where whiteness is property which has higher value than not being white (Dixson & Anderson, 2018). Alongside this are also statistics based on imprisonment and directly connected to the legal critics who tote neutrality and colorblindness in law. Yet, population and prison statistics imply something different. While the White alone group of the US makes up 76 percent (US Census Bureau, 2016) and 58 percent of the prison population (Federal Bureau of Prisons, 2018), Blacks make up 37 percent of the prison population (FBOP, 2018) but only 13 percent of the population (US Census, 2016). Based on the suggestions of critics of CRT, these statistics would imply that our legal system is merely enforcing the fact that
Blacks commit crimes at higher rates than Whites when comparing their population size rather than discussing how our legal system is not neutral when it comes to race (Crenshaw, 1988).

**Rationale for using CRT and QuantCrit**

Throughout the literature, there is a strong theme of social justice and the marked inequities between women of color in STEM fields and their lower rates of persistence (Basile & Lopez, 2015; Cooper, 1995; Malcolm et al., 1976; Malcolm & Malcolm, 2011; Smith, 1974; Vincent et al., 2013). The goal of both CRT and QuantCrit is to expose race and racism, and the detrimental institutionalized structures in place to keep people of color from progressing in society (Garcia et al., 2018; Gillborn et al., 2017). It is necessary to understand how structures are oppressing Black communities (Garcia et al., 2018; Covarrubias, 2011; Gillborn et al., 2017) so these structures are modified or eliminated to improve the conditions of people of color. Often in higher education settings, the belief is that color blindness, which is a privilege within itself, will address the issue of racism rather than address the systemic nature of it (Lopez, 2003). Many people of color are frustrated by the downplay of racism, calling it “reverse racism” (Lopez, 2003), or discounting the psychological severity of racism to students of color (Lopez, 2003). CRT focuses on counternarratives, which means the voices of many individuals are heard. However, qualitative studies struggle with the limitation of often having small studies. The small sample size should not discount the stories and information shared by participants, but by using quantitative methods with a focus on getting the perspective of women of color, it gives researchers access to stories through numbers for a larger group of participants. Quantitative studies are often limited to the structural and post-structural paradigm (Sparrowe & Mayer, 2011) by combining the CRT perspective with QuantCrit; the researcher can get a nuanced
analysis of statistical data. CRT is still developing and fluid; therefore, integrating more quantitative methods with a social justice focus can lead scholars on a new path to deepen the exploration of racism and unpack the ideas of colorblindness and meritocracy.

Women of color have a different experience in graduate STEM programs that are often overlooked or seen as not having the ability to handle the workload, but in truth women of color interested in STEM are well prepared and had positive K-12 educational experiences (Thiry et al., 2007; Welde & Laursen, 2011). Literature often centers around the K-12 experience, deficits in the preparedness of women of color, and their inability to utilize the resources around them, however, many women of color have stated that it was their experiences in STEM that convinced them to leave (Welde & Laursen, 2011). Racism is something discussed as a specialty class rather than a systemic issue, which furthers the invalidation of the experiences and perceptions of women of color (Lopez, 2003). Racism in the modern era is far more subtle, and colorblindness invalidates the experiences of people of color (Lopez, 2003; Parker, Dayhle, & Villenas, 1999).

The hypotheses of this study are best explored through CRT and QuantCrit to validate the experiences of women of color in STEM education settings. CRT in education centers around revealing the historic and systemic inequalities in our system, but also searches for ways to address these issues head-on to change our education system (Dixson & Anderson, 2018). Exploring how women of color perceived mentorship, inclusivity, the value placed on minorities, access to faculty, and availability of affinity groups actively addresses the systemic nature of oppression for women of color and finds possible solutions to the issue in the future.

This study used two Likert-like scales to understand the perspectives and perceptions of women of color, along with an open-ended question that allowed participants to share their
experiences. Utilizing CRT to understand the stories of women of color through their notes about their experiences, while also applying their stories to the quantitative data with a QuantCrit lens, allowed this researcher to use the stories of women of color along with quantitative data to further support their narratives.

**Applying CRT and QuantCrit**

Quantitative data is held in higher regard than qualitative data because it is seen as valid, consistent, and trustworthy because it is ‘neutral’ (Gillborn et al., 2017). QuantCrit brings to light the lack of neutrality in numbers and making sure that researchers are considering this from the outset of their research. Gillborn (2010, p. 253) highlighted a quote from Albert Einstein that stated, “everything that can be counted does not necessarily count; everything that counts cannot necessarily be counted,” which highlights the importance of hearing the stories of those who consistently ignored. QuantCrit and CRT together allowed this researcher to explore and expose how women of color feel in higher education settings along with their struggles to find a place in their institutions. By using quantitative measures, there is still a counternarrative, but their stories are being told by numbers to address a social justice issue along with their own words to following up their responses by number. The participants were given the agency to contextualize their perceptions and responses. Sharing the stories of women of color by using quantitative methods makes essential data and information easier to present to those in higher education settings, which can change policy. CRT and QuantCrit are unpacking the quantitative data to reveal the oppressive structures the participants are facing. Showing the layers of oppression and how women of color feel they do not fit into their university environment should be guidance for implementing supportive practices and programming in institutions of higher education aiming
to diversify STEM fields and have active STEM programs. Central to CRT and QuantCrit is the need to hear the story from the individuals who are experiencing the oppression. As part of the study, the open-ended question at the end of the survey allowed participants to explore their ratings and their own experiences in their words to contextualize the quantitative data.

**Conclusion**

STEM fields are part of the future of this country, as is the diversification of our population. As the number of women of color increases in our society, they are an important workforce to train and educate for the innovation and maintenance of our technological place in the global economy. Beyond the economic importance is the need to address the social inequalities that have found women, people of color, and specifically the intersection of those two, women of color further behind in their persistence in STEM higher education programs. Utilizing CRT and QuantCrit to delve into what factors are keeping women of color from finding cultural congruity with their peers, faculty, and general university environment is essential so that higher education institutions can begin to address the social inequities in their spaces. Addressing these inequities will benefit not just women of color, but higher education institutions. Understanding the factors that support or hinder women of color in STEM degree programs is a step in the direction of implementing change in our institutions, which so heavily lean toward what benefits the dominant culture of Whites in this country. The themes of the double bind faced by women of color, faculty and peer relationships, and the importance of social justice run consistently throughout this study and the literature on the topic of the persistence of women of color in STEM.
Chapter Two: Literature Review

Women of color face unique challenges in STEM (Rodriguez et al., 2017). As women, they encounter the struggles of making their way in a male-dominated field (Litzler, Samuelson, & Lorah, 2014; Malcolm et al., 1975), and as people of color, they must work against structuralized racism (Molina, Borror, & Desir, 2016). Women of color are the intersection of where gender and race discrimination meet (Litzler et al., 2014). There is a lack of representation within STEM fields of women of color, which does not represent their percentages in the general population (Rodriguez, Cunningham, & Jordan, 2017; Wladis, Hachey, & Conway, 2015).

Addressing the roadblocks that women of color who complete STEM degrees from higher education institutions face is vital. Economically, the United States’ position is slipping as the technological powerhouse of the globe (Ong et al., 2011), while other countries are advancing economically and working to improve their STEM programs (Ong et al., 2011; Palmer, Maramba, Elon, & Dancy II, 2011). STEM fields are the fastest-growing industries in the global market (Molina et al., 2016). Therefore it is necessary to understand why, in the coming year, STEM fields will lack the required number of qualified individuals (Espinosa, Gaertner, & Orfield, 2015; Musante, 2012).

Several databases were used, including ERIC, EBSCO, Education Research Complete, Education Index Retrospective, Academic Search Complete, SPORTdiscus, PsycInfo, and ProQuest, to search for variety literature. Some of the search terms included women of color in STEM, the persistence of women in STEM fields, CRT, QuantCrit, women of color persistence in STEM fields, academic persistence factors for women of color in STEM, culturally responsive classrooms for women of color in STEM, and women of color persistence factors.
Five themes emerged related to the topic of women of color persisting in STEM fields. First, the STEM workforce is a central issue in the literature, specifically the lack of diversity and retention of women of color in STEM fields, which affects the equitable access to economic opportunities for women of color (Johnson, Starobin, & Laanan, 2016; Musante, 2012; Smith, 1974). Second, persistence in STEM education, especially in undergraduate and graduate settings, is the first step to moving on in a STEM field (Cole & Espinoza, 2008; Thiry et al., 2007; Welde & Laursen, 2011), and women of color benefit from faculty support (Starobin et al., 2008), work-based experiences (Gayles & Ampaw, 2016), and student transition support to ensure their needs are met at their institutions (Starobin et al., 2016). The third theme that emerged is challenges within STEM education lead to academic persistence in higher education institutions (Espinosa, 2011) some factors are supportive, but some are barriers to persistence for women of color in STEM (Adelman et al., 2016). Finally, exploring the importance of the university environment and how it can support or hinder women of color in STEM programs from continuing in STEM fields (Starobin et al., 2008; Starobin et al., 2016).

**STEM Workforce**

The STEM workforce is changing due to demographic shifts in race in the U.S. from majority white to non-white (US Census Bureau, 2015). Without proper education and training, this country will be leaving a large part of its workforce untapped, especially for women of color (Johnson et al., 2016; Ong et al., 2011). Diversifying STEM is a step towards addressing the possible economic shortfall of STEM-trained individuals in our country for future professions (Johnson et al., 2016; Musante, 2012). This section will discuss the lack of diversity in STEM fields for women of color (Malcolm & Malcolm, 2011) then followed by the challenges in
retaining women of color in STEM fields (Malcolm & Malcolm, 2011). A strong economy benefits the country as a whole, and part of that requires a qualified workforce.

**Lack of Diversity**

Nationally, there is a lack of gender, racial, and ethnic diversity in U.S. STEM fields (NSB S&E Indicators, 2018). The study for the National Science Board Science and Engineering Indicators tracked the growth and changes within science and engineering fields. In the area of demographics, the study found that women remain underrepresented but less so than in the past. People of color, specifically Blacks and Latinos, are represented are lower levels than their levels in the general population, while Asians and foreign-born individuals are represented at a higher rate.

Women remain underrepresented in STEM fields, making up only 48 percent of the life sciences, 15 percent of engineering fields, 28 percent in physical sciences, and 26 percent in computer and math fields (NSBS&E Indicators, 2018). Women make up 50 percent of the college-educated workforce yet only represent 28 percent of science and engineering occupations (NSBS&E Indicators, 2018). Latinos account for 6 percent of STEM occupations, which is below their representation in the population, which is true for Black individuals too, at only 5 percent represented in STEM fields while non-Latino Whites account for 66 percent for these fields (NSBS&E Indicators, 2018). Asians are represented at higher rates in STEM fields than their population in the U.S., representing 6 percent of the population but 21 percent of STEM fields, specifically computer science and engineering fields (NSBS&E Indicators, 2018).

A larger pool of educated individuals gives the United States more qualified individuals with diverse perspectives that can address unique problems that come up in STEM (Foltz et al.,
The ability for companies to pull from a diverse pool of employees gives the United States the ability to solve situations that will inevitably require creativity and different perspectives (Foltz et al., 2014; Musante, 2012; Palmer et al., 2011). It is crucial to diversify the American born STEM workforce (Committee on Prospering in the Global Economy of the 21st Century, 2007; Perna et al., 2008) and offers access to a better life for people of color and this study, specifically, women of color. Access to jobs that pay well, which helps people move up in society at the socio-economic level (Mack et al., 2014; Smith, 1974). Beyond the economic focus is the need to address the inequity of a system in which groups of people are significantly underrepresented when compared to their populations in our country (Basile & Lopez, 2015).

The grouping of women of color centers on African-Americans, Latinas, and Native Americans, but it is important to include Asian women as well (Malcolm & Malcolm, 2011). Yosso and colleagues (2009) discussed the importance of speaking beyond the White/Black binary and include other communities. To that end, diversifying STEM fields both gender-wise and racially addresses this social justice keystone, especially when it comes to women of color who face discrimination on two counts. Institutionalized oppression in STEM manifests in a lack of representation of people of color and women (Molina et al., 2016). Women, especially women of color, deal with constant oppression not only from the structures of white male society but also from men of color (Cooper, 1995; Smith, 1974). As a result, there continues to be uneven growth in STEM fields and their diversity with women of color in these programs because of individual departments and their cultures (Malcolm & Malcolm, 2011). These issues compound for women of color, making it challenging to enter competitive STEM programs and fields.
Malcolm, Hall, and Brown (1976) highlighted the difficulty of becoming a scientist and pointed to the increase in becoming a scientist once any obstacles put in the path of an individual, including race and gender. Women of color, specifically, are treated as less than and as having fewer skills since they are both women and people of color (Malcolm et al., 1976). Even Asian women, who are often touted as a counterpoint in these discussions because they hold more degrees in STEM fields, are underrepresented when it comes to tenure-track positions (Ong et al., 2011). Crenshaw (1994) discussed that women of color face class and gender oppression that is compounded by race discrimination, which exacerbates poverty for women of color. All of the obstacles slow down the rate of diversification in STEM fields.

Retention of Women of Color in STEM

The retention of women of color in STEM fields is a complex issue. Women of color in STEM face challenges with sexism and racism (Malcolm, 1975; Malcolm & Malcolm, 2011). Some of the ways that institutions have attempted to address retention of women of color is access to financial aid and scholarships (Kruse, Starobin, Chen, Baul, & Laanan, 2015), and formal and social supports to ease the transitions into STEM fields (Jackson & Laanan, 2015; Starobin & Laanan, 2008). Despite these initiatives, the unique experience of a woman of color in a STEM program has not been successfully addressed.

Kruse, Starobin, Chen, Baul, and Laanan’s 2015 study explored the importance of social capital and finances being a factor in women of color continuing in STEM fields. Access to work-study programs and other financial supports are essential to the retention of women of color in STEM. An important factor is debt aversion when possible and not creating a financial burden on their families. If institutions consider these factors more when creating a class, then
these students will feel more supported in their institution (Kruse et al., 2015). Jackson and Laanan’s 2015 study explored different factors that could foster a thriving transfer environment for community college students transitioning into four-year institutions. The study zeroed in on the fact that the university environment is an integral part of the retention of women of color in STEM. Both with their peers and with faculty, women often felt that their abilities were underestimated (Jackson & Laanan, 2015). The “Double Bind” (Malcolm et al., 1976) addresses women of color in STEM and the unique challenge of being a woman of color who faces both sexism and racism in their field while attempting to further their career (Ong et al., 2011). Women of color, especially Black women, have to fight the myth of inferiority that so often is part of how women of color are perceived (Robinson, 2013).

A strategy to support women of color in STEM fields is to consider their needs, which is vital to diversify STEM fields. One way to do this is by giving access means offering financial aid and scholarships (Jackson & Laanan, 2015). Many students are unaware of what job options are available to them (Strayhorn, 2010), so having formal supports to assist in those transitions into STEM fields. Since the concept of the “double bind” (Malcom et al., 1976) came into the literature, it is clear that the initiatives to increase the number of women or people of color in STEM have not helped women of color. These initiatives have supported white women in STEM and men of color in STEM, but have excluded women of color from making strides in the same fields (Riegle-Crumb & King, 2010). As researchers delve more into the underrepresentation of women of color in STEM fields, they have realized that women of color do not merely fit into the group of women and people of color, their unique experience in STEM must be addressed separately (Ong et al., 2011).
Conclusion

STEM will be a significant source of employment in our future economy (NSB Science and Engineering Indicators, 2016). Currently, STEM fields lack diversity across racial and gender lines (Peralta et al., 2013; Ong et al., 2011; Reyes, 2011). Diversifying STEM by ensuring that women of color gain access to STEM jobs and persist in STEM benefits our economy as a whole (Foltz et al., 2014; Musante, 2012; Palmer et al., 2011; NSBS&E Indicators, 2016). Supporting women of color in STEM creates a space for these women to improve their socio-economic status and that of their community and family (Smith, 1974).

**STEM Education**

STEM education is the teaching of science, technology, engineering, and math fields, whether in elementary and secondary schools or higher education institutions (de Vries, 2018; Ernst, Williams, Clark, Kelly, & Sutton, 2018). Debates exist about the exact nature of STEM education (Bybee, 2013), and its definition continues to evolve. STEM education is a field because STEM careers are at the forefront of the culture, and studies have explored how STEM education impacts the (Ernst et al., 2018; Riegle-Crumb & Grodsky, 2010; Ro & Loya, 2015).

Women of color outnumber men of color in the number attending college (Ong et al., 2011). By not addressing the intersection between race and gender, a large portion of our educated, potential STEM workforce is exiting STEM fields and leaving a gap in the economy of the United States (Riegle-Crumb & Grodsky, 2010; Ro & Loya, 2015). Different aspects of education institutions contribute to whether women of color feel supported. Informal relationships, school environment, and mentorship at several levels affect how women of color settle into STEM programs. Many leaders in education settings speak about equity across race
and gender in STEM, yet it is not clear that they take any policy action to make equity happen in their institutions (Strayhorn, 2010). Without a genuine commitment to change for women of color in education, then no change in STEM fields will come to fruition.

**Persistence in STEM**

Formal student support and influences from school personnel like administrators, faculty, or community role models can have an impact on the retention of women of color (Starobin et al., 2016). While women of color benefit from mentor relationships, their mentors struggle to effectively guide them through the process of becoming scientists (Reyes, 2011). Women of color find cultural congruity in positive environments like HBCUs, where the selectivity of the institution has a positive effect (Museus et al., 2011). Museus’ 2008 study on the myth of the model and inferior minority discussed the issue of cultural congruity on college campuses. Through interviews with Asian American students and a black student, Museus explored the challenges that students of color faced with racism. He found that culturally incongruent schools place the pressure of assimilation on minority students (Museus, 2008) and expect them to detach from their origins to find success at the institution (Tinto, 1993; Tinto, 1987). The expectation of becoming like the dominant white culture leaves many students of color feeling alienated from their campus environments, and while many places the blame on students of color, it is also institutions that need to reconsider why these students leave their programs (Tinto, 1993).

**Faculty Support**

Faculty support is key to women of color, feel that they have support in their field (Starobin et al., 2008). Faculty support is an integral part of the retention of women of color in
STEM (Hagedorn & Purnamasari, 2012; Labov, 2012; Rodriguez et al., 2017). Malcolm and colleagues (1976), in their discussion of the double bind, pointed out that faculty role models are an essential part of women of color’s persistence in STEM fields. Another component of faculty support is their pedagogical approaches by developing small, interactive classrooms, collaborative learning programs, curriculum relevant to real-world problems, and diverse, culturally responsive programming (Ladson-Billings & Tate, 1995; Museus et al., 2011). Students tend to persist when they have had hands-on experience in the field within STEM fields to give them a sense of what a day in the life of a scientist would look like if they followed a particular path (Wilson et al., 2012).

Support and mentorship continuously come up with a need for women of color in STEM degrees. The rationale behind developing the University Environment Scale (UES) is that students need support to persist in schools, but not just support from their families (Gloria & Kurpius, 1996). Students benefit from support from school personnel (Solberg, Valdez, & Villarreal, 1994), and having formal services along with positive informal interactions can support the persistence of students of color (Gloria & Kurpius, 1996). Without that support, women of color feel isolated and separated from their school community, especially when they are transferring from a community college environment. More supportive interactions and mentorship for guidance through a program would encourage women of color to complete degrees through difficult moments in their studies. That support would help improve the retention of women in STEM. Women of color benefit from close and positive interactions (Joseph, 2012). Joseph (2012) explored the way that African American women settled into their graduate degree programs in PWIs from HBCUs and the challenges they face with perception.
This study used qualitative interviews to connect with six women going through the experience of getting a graduate degree in a PWI.

From this study, it was clear that women of color need these supportive environments, yet it is faculty that are often the leaders in discrimination (Joseph, 2012), and they are fundamental to creating supportive and inclusive classroom environments (Joseph, 2012). What faculty say and convey matters to all of their students, and can especially negatively impact women of color (Bensimon, 2005; Fries-Britt, Younger, & Hall, 2010; Ortiz & Boyer, 2003). At HBCUs like Spelman, faculty encourage women of color in STEM programs and are heavily involved with their student's progress (Perna et al., 2008). The way that the faculty at Spelman treat their students is under the assumption that these students can achieve their goals, encourage academic success, build confidence in skills that encourages STEM attainment through curriculum structures (Perna et al., 2008). Many also do not have the support of their faculty members (Jain et al., 2011; Reyes, 2011). The interactions between women of color and their faculty is another factor in their ability to succeed in STEM fields (Museus et al., 2011).

Wilson and colleagues (2011) highlighted the importance of mentoring and strategic interventions to guide STEM undergraduates to help them succeed. Tenebaum and Anderson (2014) showed the benefit of mentorship and community in near-peer mentoring modeling in which students participated in both research internships and teaching internships. Mentors help students in their quests to complete STEM degrees. By acting as guides and a support system to students, many women of color have cited mentor relationships with faculty members as part of the reason they persisted in their degree (Lynette & Texas, 2013). Mentors offer students career advance and the opportunity to see the trajectory of their career in the future should they persist.
(Wilson & Holmes, 2012). Many students, when asked what they needed to help them continue in STEM, said knowing about potential career paths other than research (Strayhorn, 2010). Mentoring is an important part of adult development (Drago-Severson, 2006) and continuously mentioned as a critical point of supporting individuals to complete STEM degrees (Powers, Schmidt, Sowers, & McCracken, 2015).

Part of mentoring and supportive environments include students feeling that they see themselves in the faculty. There needs to be an increase in the number of Black faculty that are represented in higher education settings (Dortch & Patel, 2017). Robinson, McGee, Bentley, Houston, and Botchway (2016) found that 48 percent of engineering schools had no Black tenure or non-tenure track faculty. Without faculty that reflects a diverse population, women of color struggle to find the faculty support that understands their perspective in a STEM program (Dortch & Patel, 2017). Interactions and partnerships between people are the foundation of getting students to continue in STEM. If adults can model positive collaborative relationships, interactions, and decision making, then students can support their peers through challenging programs of study.

**Work-based Experiences**

Part of the purpose of education is economic opportunity. However, HBCUs are doing a better job of graduating women of color in STEM fields than PWIs (Perna et al., 2008). Lack of encouragement from teachers can lead to a reduction in persistence (Russell & Russell, 2015). The fact that there are fewer HBCUs, and their size is smaller severely limits women of color’s ability to move up into and progress further in STEM fields when they primarily attend PWIs and community colleges.
Women of color benefit from mentorship in school, but also for a sense of what is available to them career-wise (Russell & Russell, 2015; Strayhorn, 2010). In their study, Russell and Russell (2015) explored how four Black women attending a PWI in the southeast US switched majors and aspirations to pursue a STEM career based on their experiences. The study involved focused interviews and a demographic questionnaire and revealed three main factors that lead the women to make changes – lack of career counseling and advising, lack of early success in the science at their PWI, and finally, a sense of a lack of preparation for the program that they attend.

Russell and Russell (2015) found that career guidance was important. Women of color need information and explanation of STEM careers and how to get into those careers and succeed. These relationships are mentor relationships that take women of color to the next step in STEM careers (Russell & Russell, 2015). Strayhorn’s (2010) longitudinal study utilized national statistics to examine the influence of financial variables. The ability to defer payments, have work experiences, and tuition reduction can make a significant impact on the strength of a student of color to persist (Strayhorn, 2010). Understanding the influence of finances for students of color can be a key to addressing the lack of diversity in STEM fields.

Faculty relationships are important to the persistence of women of color in STEM fields, but a difficult interaction with faculty members can be challenging (Ong et al., 2011). Faculty members can create safe spaces, be a support, and be mentors to women of color in higher education institutions (Ong et al., 2011). Faculty mentors can be the difference between a woman of color deciding to continue in STEM fields and being available to give the support later on in a
STEM program (Ong et al., 2011). Despite the importance of these mentor relationships, they can be rare (Ong et al., 2011).

**Student Transition Support**

Malcolm and Malcolm (2011) in their review of where the double bind stands now since 1976, discussed how the shift for women of color in STEM now is not right versus wrong, but rather the issue of support versus neglect for those students in higher education institutions. There is a significant leap between elementary and high school to higher education settings (Dortch & Patel, 2017). Women of color attend universities where they are expected to be at the same level as other students from higher socio-economic backgrounds, yet they need extra support (Jackson & Laanan, 2015; Jain, Herrera, Bernal, & Solorzano, 2011). Women of color, however, are isolated by faculty and peers (Dortch & Patel, 2017) and professors often steer women of color away from STEM fields (McGee & Bentley, 2017) which means that these women are not receiving the support they need in that transition to higher education setting and within different higher education settings.

There is the expectation as a woman of color entering a STEM field to assimilate to “successfully” navigate schools (bell hooks, 1995; Gloria, Castellanos, Segura-Herrea, & Mayora, 2010; Sue, 2010). There is a lot of stigma and judgment towards women of color (Jain, 2009). Many people of color find it challenging to have conversations with their professors due to miscommunications and perceptions on both sides (Jackson & Laanan, 2015). Another component is that women of color make up a large part of the community college population, understanding how to support them in their transition from a community college into a four-year institution is essential to increase the amount of representation of women of color in STEM
fields (Jackson et al., 2013). Sixty-one percent of Latino students alone attending community colleges at some point in their education (Malcolm, 2010). Therefore, understanding community colleges and their importance to the diversification of STEM fields as well as for equitable access to good educational options is key (Malcolm, 2010).

Part of improving the retention of women of color in STEM fields requires a shift for community colleges and four-year institutions and creating spaces where women of color can focus on their careers rather than the challenges of being women who are people of color too. The onus on creating a transfer receptive culture is currently placed on community college institutions (Jain, Bernal, Lucero, Herrera, & Solórzano, 2016) instead two-year and four-year institutions would benefit students by working together to make the transition from a community college institution to a four-year institution smoother and more positive (Jain et al., 2016). In this study, Jain and colleagues (2016) explored the five elements of a transfer receptive culture connected to a specific summer program to help transfer students. The mixed-methods study involving surveys and focus group interviews tracked the program over five years. Students found the program helpful because it addressed fears and misconceptions about transferring, and they felt that the longevity of the program meant they had the experience to support them. They were also supported financially and academically, which helped them feel better throughout the transfer process. Addressing the challenges of transferring for students is an important way to support female students of color in the process of obtaining a degree, including a STEM degree (Jain et al., 2016).

Another critical part of a supportive campus environment is a transfer receptive community for community college students (Jain et al., 2011). Over half of the population of
community colleges are women (AACC, 2017), and most community college populations are of color (Jain, Bernal, Lucero, Herrera, & Solórzano, 2016) so if these students do not feel welcome in their transfer location it reduces the likelihood that they will persist once they transfer into a four-year institution. The threat of constant stereotyping (Perna, Lundy-Wagner, Drezner, Gasman, Yoon, & Bose, 2009) along with skepticism about their abilities at PWIs (Brown, 1994; Towns, 2009) makes a lot of women of color feel excluded once they reach four-year institutions from two-year institutions or even when they begin in four-year schools. Creating a transfer receptive culture with classroom environments that are supporting every student (Jackson, 2013) is vital to keep women of color in STEM field programs.

The culture of community colleges and four-year institutions differ a lot, which can make the transfer a complicated process for a woman of color trying to get a STEM degree (Lynette & Texas, 2013; Reyes, 2011). Women of color benefit from joining groups and organizations related to their majors, which is not necessarily the case for their white counterparts (Espinosa, 2011). That benefit of groups and organizations points to the need to improve program supports in higher education institutions. Museus and Liverman (2010) discussed the importance of campus culture in higher education settings in supporting students. Their study explored what factors contributed to the retention of racial and ethnic minority students in schools that generate ethnic minority success (GEMS) (Museus & Liverman, 2010). Through interviews with students, administrators, and faculty in three GEMS institutions along with and document analysis related to the institutions. Museus and Liverman (2010) found that four cultural characteristics were essential to the success of minority students – active networking, humanizing the educational experience, commitment to targeted support, and perceived responsibility for minority students.
Campus culture is something an institution has and does (Museus, 2008), and women of color need to feel like they are part of the campus culture and climate.

Community colleges are small communities with small classes and more interaction between faculty and students (Labov, 2012). In the process of transferring into four-year institutions, women of color find that they are isolated (Rodriguez et al., 2017) and dealt with microaggressions (Jackson, Laanan, & Santos, 2015). Jackson and colleagues (2015) conducted a quantitative study focused on the issues of transfer students and what factors help or hinder their progress in the transfer location. The goal of the study was to understand better the characteristics that predict success in the transfer from community colleges to four-year institutions. The need for diverse faculty calls for more research to know how to diversify faculties in a variety of higher education institutions (Malcolm & Malcolm, 2011) to create a more welcoming environment. Community colleges are a significant way that women of color attend college (Johnson et al., 2016) and it is necessary to create transfer pipelines to support minorities as well as expand opportunities for students of color in STEM (Jain et al., 2016; Wang, 2013) otherwise society is blocking the pathways for women of color to move into STEM fields.

Institutions, however, are not doing enough to support women of color as applicants and students who are in the position of trying to assimilate into the dominant culture of a campus (Malcolm & Malcolm, 2011). Women of color often describe the culture of PWIs as chilly – environments that are isolating, unwelcoming, and not expressive (Joseph, 2012). Others have described PWI institutional settings as impersonal with large classrooms with a focus on weeding out, especially in STEM courses (Espinosa, 2011). Students reported feeling a lack of
belonging and isolation (Tate & Lin, 2005), especially for those women of color who transfer from community colleges (Jackson et al., 2013). The stigma of transfer can have a significant negative impact on persistence (Starobin, Smith, & Laanan, 2016). Transferring and attending a community college contributes to the sense of feeling like outsiders in their institutions (Jackson et al., 2013; Starobin et al., 2016).

Many have found that the chillier environments, lack of belonging, and the negative feelings that develop from that lead to a lower level of involvement for women of color (Ancis, Sedlacek, & Mohr, 2000; Harper & Hurtado, 2007; Hurtado, 1992; Hurtado et al., 2007; Museus et al., 2008). Women of color are expected to assimilate and change to fit into the institution (Museus, Palmer, Davis & Maramba, 2011), but for these students, their culture matters, so they are pulled between the desire to fit in and their identity. The pressure to assimilate brings up feelings of isolation, alienation, and marginalization (Museus et al., 2011). It is vital to convey better this fact to those that interact with students (Museus & Liverman, 2010) to help them feel welcomed. Developing social counter spaces (Yosso et al., 2009) is necessary for these students to feel comfortable while they deal with racial battle fatigue (William & Smith, 2004) and try not to lose themselves while completing their programs of study (Yosso et al., 2009). Ensuring that women of color find cultural congruity with their institutions without having to give up their identities or cultures is another critical component to the persistence of women of color in STEM.

Conclusion

While the STEM workforce needs to retain women of color and diversify, that cannot happen without addressing the persistence of women of color in STEM education (Riegle-Crumb
& Grodsky, 2010; Starobin et al., 2008). Faculty support is key to persistence for women of color in STEM programs (Labov, 2012) and their ability to feel supported. Faculty support and mentorship is an integral part of the work-based experience, which gives women of color a sense of the economic and career options available to them with STEM degrees (Strayhorn, 2010). Part of the success of women of color is creating a transfer receptive culture (Lynette & Texas, 2013). Supporting students through the transition from high school to a four-year college is key to helping women of color persist in STEM programs and fields.

**Challenges in STEM Education**

A number of challenges related to STEM education have been reported in the literature, including lack of funding for students pursuing a STEM degree (Beekman & Ober, 2015; Young, 2005), teachers not appropriately trained for teaching STEM subjects (Mack et al., 2014), the integration of STEM subjects (Radloff & Guzey, 2017), and equitable representation of STEM disciplines (English, 2017). However, there needs to be changed to our educational system to support the diverse populations entering our workforce. Freire (2000) discussed the importance of education in the liberation of the oppressed not just being educated within the oppressor's educational system, but finding a way to break out from the oppressor's educational system. Freire (2000) stated the oppressed (in this case, women of color) must find ways to break away from traditional education and create new platforms to ensure that we give access to women and people of color. Institutionalized oppression uniquely affects women of color. Starting from elementary school, the trends of oppression follow of women of color into institutions of higher education when they attempt to pursue STEM degrees (Smith, 1974). There is the structural
racism built into all aspects of our education system, and women of color must contend with that while trying to get STEM degrees (Smith, 1974).

**Lack of Teacher Training with Diverse Populations**

Teachers often do not have STEM training and lack the knowledge to teach math and science effectively (Molina et al., 2016), which is often brought up in the K-12 context of education. Yet, a significant challenge faced by women of color in STEM is educators at every level that are not comfortable or trained to educate diverse populations (Lopez, 2003). The connections between multicultural education and teacher preparation are essential to ensure that important curriculum initiatives, like STEM, are implemented with the students that will be in the classroom in mind (Olneck, 2000). As Landsman (2001) mentioned, teachers must become part of their community to understand them, yet so many teachers try to impose their worldview and privileged expectations on the students with which they work with every day (Hayes & Juárez, 2009). But women of color in higher education settings continue to note that they feel isolated, perceived as less capable than their peers, and are marginalized at PWIs (Dortch & Patel, 2017). Those feelings of isolation and alienation suggest that white educators and leaders do not get how to support diverse students (Lopez, 2003). The sense of isolation is especially true for Black women over their White and Asian peers (Dortch & Patel, 2017), which points to the deep-seated issues of race within this country that CRT is positioned to address.

Olneck (2000) discussed the increased number of schools that are implementing a multicultural curriculum that builds on teacher and student awareness of other cultures and can support the improvement of STEM education. Olneck pointed out that different factors are part of multiculturalism that does not benefit the development of cultural capital. While
multiculturalism can be beneficial to students, as it stands now, it is not necessarily supporting the development of cultural capital (Olneck, 2000).

**Funding**

Students of color often come from secondary school settings that have a low socio-economic population, which affects the resources available to them and the teaching they receive (Young, 2005). Many low-income schools face a lack of funding for the materials and teachers that they need (Beekman & Ober, 2015; Young, 2005). Low-income schools have less funding and, therefore, less access to items like computers and other required materials for STEM education. Strayhorn’s (2010) study touched on the importance of managing funding options for students of color to progress further in school settings.

Funding is crucial for STEM because of the hands-on nature of STEM education and the need to finance materials, tools, and staff to implement that curricula (Thibaut et al., 2018), especially with the Next Generation Science Standards implemented across the country. Young (2005) found funding linked to the achievement of the students in that setting. However, it does not mean that a lot of money needs to be spent to reach these goals, but rather the funding should be focused and centered in low-income communities that would benefit from better teachers, smaller classrooms, and the materials needed to implement a new curriculum (Young, 2005). Inequitable access to technology and hands-on STEM curriculum disproportionately affects low-income and minority students, and more adequate funding policies and practices would support more achievement in STEM education for students of color (Young, 2005).
Integration of STEM Subjects

The integration of STEM subjects is a challenge in STEM education because it does not reflect a real-world perspective of STEM (Moore et al., 2014a; National Research Council, 2014). Integration has been a big topic in education fields even outside of STEM, but they need to integrate rather than teach two subjects side by side is a challenge to the expansion of STEM (Bryan, Moore, Johnson, & Roehrig, 2015). Integrating STEM requires teachers with substantial training and experience to maintain the content, yet teachers do not feel prepared to execute that type of curriculum (El-Deghaidy & Mansour, 2015). STEM integration also requires curriculum materials and tools that are difficult for low-income schools to implement or even afford, which puts them at a disadvantage (Stohlmann, Moore, & Roehrig, 2012). There is a lack of consensus on how to implement integration practices or even what are the best practices, which further the challenge of integrating STEM subjects (Thibaut et al., 2018).

Thibaut and colleagues (2018) reviewed literature and discussions on the issue of integration of STEM subjects and found that integration requires hands-on, content-based, yet open-ended activities in the classroom. This review can also be a guideline for education researchers, but there are limitations because of the need for financial, material, teacher, administrative, and policy support, which is a significant challenge STEM education faces (Thibaut et al., 2018).

Equitable Access to STEM Disciplines

There is the challenge of integrating STEM disciplines within education so that the subjects are not taught as isolated subjects (English, 2017; Thibaut et al., 2018). STEM is often used to discuss science rather than math, technology, or engineering (English, 2017).
Engineering is a field where only 9% of the labor force are women (NSBS&E Indicators, 2018) which points to the need to make engineering a greater focus in education even though it is part of the STEM acronym, engineering does not get equitable time in classrooms (English, 2017). Once students reach higher education settings, it is the women of color that are often isolated and pushed away from STEM fields to focus on the humanities or other areas by their peers and the faculty (Dortch & Patel, 2017; McGee & Bentley, 2017). The sense of isolation suggests there is not equitable access to progressing in STEM fields once women of color enter higher education.

STEM education has successfully promoted a focus on science and math, which are both core subjects. Part of reducing the challenges in STEM education is to ensure that all the subjects in the acronym are equally addressed in school curriculum (English, 2017). Shaughnessy (2013) explored the issue of the STEM acronym only being a catchy phrase that is not represented in school curriculum. Shaughnessy (2013) argued that this was true even for math, even though it is a core subject that does not get the same attention as science.

Conclusion

Persistence in STEM fields is connected to success in STEM education (Tinto, 1993). Without training and specific knowledge, a future STEM workforce will not be adequately trained (Strayhorn, 2010). However, STEM education faces challenges that makes it that much more difficult for women of color in STEM to persist in STEM fields. Funding elementary and high school programs, so students have access to Advanced Placement classes and experiences is necessary (Russell & Russell, 2015). Funding options for higher education are critical, too, to helping women of color’s perseverance in STEM programs (Strayhorn, 2010; Young, 2005).
Educators are another critical part of this process. Without proper training, teachers are not able to effectively teach STEM subjects and struggle to address the multicultural nature of the schools where many women of color attend elementary and high school (Molina et al., 2016). Students need equitable access to STEM disciplines to fully explore the STEM acronym (English, 2017; Shaughnessy, 2013) along with the integration of STEM disciplines to give women of color access to more than just science but also engineering and math. Preparing women of color early and supporting them on multiple fronts throughout their education is the only way to increase persistence and diversify STEM.

**Academic Persistence**

Academic persistence is the continuation of individuals in STEM programs (Simon, Aulls, Dedic, Hubbard, & Hull, 2015). Support throughout their time in school is something that many students of color need so they can do their best in higher education settings (Malcolm & Malcolm, 2011). Institutions must understand the barriers to academic persistence and the predictors of academic persistence as well (Simon et al., 2015). Understanding what impacts and supports academic persistence can lead to institutions of higher education, creating more effective initiatives so women of color can persist (Flynn, 2016).

Institutions need to focus specifically on women of color within their STEM degree programs to increase retention of women in these degrees through four-year programs (Carlone & Johnson, 2007). Some of the struggles of getting institutions to get specialized programs in place are that they do not have enough data (Carlone & Johnson, 2007; Ong et al., 2011). There is a lack of literature and longitudinal studies about how women of color need support in STEM fields (Ong et al., 2011). Across the field, researchers must explore the nuances of the experience
of the woman of color in STEM. In that research, the focus needs to be on quantitative research to give concrete results for policy development (Ong et al., 2011). That research can be shared across institutions to support the persistence of women of color in STEM. As research expands in the area of the double bind, studying women of color in spaces amongst predominantly white male populations can illuminate more factors in women of color’s persistence and other vulnerabilities (Ro & Loya, 2015).

**Predictors of Academic Persistence**

Predictors of academic persistence have been reported in the literature, including a variety of interactions with their peers and faculty (Espinosa, 2011), such as faculty and peer mentorship (Drago-Severson, 2006), peer support groups (Palmer, Maramba, & Dancy, 2011), and learning communities (Dagley, Georgiopoulos, Reece, & Young, 2016). Women of color benefit from a variety of interactions with their peers and faculty (Espinosa, 2011), Exploring the one-to-one and group interactions with all the people that women of color interact with at higher education institutions, especially their peers and faculty, is key to understanding how to support women of color in STEM degree programs. Mentorship does not have to be from a faculty member; it can be a fellow student (Drago-Severson, 2006), but women of color need access to positive interactions with peers. Palmer and colleagues (2011) found benefits in peer support groups for students in their ability to stay in STEM degree programs. Peer influence can be both harmful and supportive of STEM retention. Wilson and colleagues (2012) studied a mentoring program that had success in graduating students interested in STEM fields and with STEM degrees. Several students mentioned that the influence of others in a capacity of support or otherwise, determined whether they continued in STEM fields (Wilson et al., 2012). Szelényi,
Denson, and Inkelas (2013) found that students pointed to the influence of their peers, and therefore, their living arrangements most influenced their ability to stay in a STEM field.

Szelényi and colleagues (2013) found that the women did better in coed settings, which certainly points to the idea that the more dialogue and interaction between groups, a more positive outlook of the other group comes to the surface. Peer relationships offer an opportunity for women of color to make connections, find their support, and settle into their programs (Rodriguez et al., 2017). Supportive peers can lead to further science discourse and build learning communities that encourage women of color to meet, interact, and promote a female science community (Rodriguez et al., 2017). Museus and colleagues (2011) suggest that peer interaction is the most powerful of factors and that peer mentorship can have a positive effect on female students of color persistence.

Dagley and colleagues (2016) stated that learning communities are beneficial to the retention rates of women and students of color. Success was connected with positive and supportive peer relationships which is important because many students are not necessarily getting positive encouragement from those in their home lives (Starobin & Laanan, 2008) so peer mentoring and group work for women of color is clearly vital to their success in STEM fields (Maltese & Tai, 2011; Strayhorn, 2009; Strayhorn & Saddler, 2009). Peer interactions are significant to individuals at any age, which is Spillane’s (2006) position that interactions are an important aspect of relationships. Those around them influenced students, along with their thoughts about what they studied.

For students, meeting peers with similar backgrounds and experiences, affinity groups outside of their major, as well as groups within their major, helps women of color find a place in
their programs, a safe space (Ong et al., 2011). Ethnic student organizations are positive for racial and ethnic minority students (Gonzalez, 2002; Guiffrida, 2003; Harper & Quaye, 2007; Kuh & Love, 2000; Murguia, Padilla, & Pavel, 1991; Sutton & Kimbrough, 2001) because they can connect to others like them in similar experiences. Positive peer discussion groups in the context of a course and major-related clubs are highly beneficial to women of color who benefit from these interactions than white women (Espinosa, 2011). Women of color benefit from good relationships to succeed, especially if they have similar cultural backgrounds and part of the same major program (Fries-Britt et al., 2010; McCoy, Luedke, & Winkle-Wagner, 2017).

Creating positive campus environments increases the likelihood of women of color persisting in STEM (Yosso et al. 2009). A positive campus environment includes inclusion of all members of a college, a curriculum that reflects the historical and contemporary experiences of people of color, programs to support recruitment, retentions and graduation of students of colors, and finally a mission that reinforces the institutions commitment to diversity and pluralism (Yosso et al., 2009). Creating a group curriculum to build an academic community can lead to a strong study group community, which is a positive predictor (Starobin & Laanan, 2008).

**Barriers to Academic Persistence**

Women of color in STEM programs face obstacles to their academic persistence including developing positive faculty interactions (Ornelas & Solórzano, 2004; Reyes, 2011), the difference in support at a PWI versus an HBCU (Gloria, Castellanos, Segura-Herrera, & Mayorga, 2010), and feeling excluded by other students within their programs and classes (Ong et al., 2011). These barriers create obstacles for women of color in programs that are already challenging with a focus on weeding out new students (Espinosa, 2011).
Students struggle to adjust to faculty interactions in four-year institutions because of the distant and non-supportive environment as compared to community college settings (Reyes, 2011). Reyes (2011) found that racism and microaggression were coming from faculty members, which makes women of color more disenchanted with STEM programs, and faculty often perceive students of color as less committed to education (Ornelas & Solórzano, 2004). That support and mentorship continue to come up with a need for women of color in STEM degrees. Many professors teach as if the concepts are obvious and can be dismissive of the students that need further explanation and support (Hurtado, Cabrera, Lin, Arellano, & Espinosa, 2009). Within STEM programs, there is the sense that it is survival of the fittest (McGee & Bentley, 2017), and the focus instead then becomes of the failure of women of color (McGee, 2017) rather than their successes. Without support inside or outside of the classroom, continuing in STEM can be discouraging for women of color who already feel marginalized for both their gender and race. When classmates and cohorts support each other, it makes it more likely that all will graduate, but also keeping in mind that sometimes the students with the highest need for support are more likely to graduate (Jackson & Laanan, 2015).

PWIs often find supporting underrepresented minority students a challenge (Museus, 2008). McGee and Bentley (2017) found that bias occurs more frequently where women make up less than 15 – 20 percent of the students in the department. The exclusion from study groups and peer groups from others in their program can prove exhausting and demoralizing for women of color (Ong et al., 2011). The lack of students with a similar background is difficult for many women of color, and it creates obstacles for them to succeed (Litzler et al., 2014). Joseph (2012) showed that the exclusion would manifest as consistent ambivalence and peers being cordial,
being token representatives for entire cultures (Gurin et al., 2002; Joseph, 2012). These interactions erode at the success of women of color and contribute to their lack of persistence in STEM fields. Many women of color describe PWIs as chilly, spaces where they are not included in groups or welcomed socially (Malcolm & Malcolm, 2011; Perna et al., 2009) through explicit and implicit interactions (Walton, Logel, Peach, Spencer, & Zanna, 2015), and the longer they are on campus, the more negative they tend to feel (Gloria et al., 2005). In classrooms, white students know when a racial joke or statement is not okay, but say nothing (Yosso et al., 2009) which continues to foster the idea that the culture and identity of students of color do not need to be treated with importance perpetuating the view of the dominance of white culture. Throughout these interactions, women of color also doubt themselves and their abilities leading to impostor syndrome (Walton et al., 2015) as their peers and faculty continue to ignore their skills.

Often in PWIs, the collaborative, less competitive nature of women of color in classroom settings means they are perceived as having less ability (Gloria et al., 2010). A diverse faculty helps women of color see others that look like them in the field, but also give them access to support on how to make it through the more challenging parts of a STEM programming both academically and socially (Malcolm et al., 1976). There is a lot of variation between institutions (PWIs versus HBCUs) and their support levels (Malcolm & Malcolm, 2011; McCoy et al., 2017).

Racism can be subtle and insidious, which creates hostile environments that block the ability of people of color to increase their socioeconomic abilities, along with actively turning them away from educational opportunities (Gillborn, Rollock, Vincent, & Ball, 2012). Systemic
racism and oppression are part of the need for social justice for women of color in STEM. The competitive natures of PWIs and focus on the individual is challenging for women of color who do not benefit from those types of environments (Museus et al., 2011; Ong et al., 2017). The competitive nature of PWIs translates into Asian American women being excluded from many conversations about equity (Chen & Buell, 2018). The competition between minority groups further isolates groups of women of color, and as with other women of color, Asian women also need culturally responsive curriculums (Chen & Buell, 2018). The practices at institutions matter and can make a difference to the persistence of women of color in STEM (Malcolm & Malcolm, 2011) no matter how they identify.

**Conclusion**

Academic persistence is a crucial part of diversifying STEM fields. Women of color benefit from positive faculty and peer interactions (Palmer et al., 2011), and peer influence is a significant factor in the persistence of women of color (Wilson et al., 2012). Despite the benefits and needs of the need of these relationships for women of color, they do not have these kinds of positive relationships often in their higher education institutions. Women of color struggle in their higher education settings because they lack a supportive transfer receptive culture (Reyes, 2011) and because they are not welcomed or accepted by their peers (Ong et al., 2011). Without acceptance by peers and faculty, women of color are less likely to persist in STEM fields (Ong et al., 2011). The development of classroom and higher education institutions that are inclusive and welcoming spaces for women of color must be intentionally done by all members of a community to change the current dynamic.
The University Environment

Women of color often mention that the cultural climate of an institution affected the way they were able to settle into their degree programs (Starobin et al., 2008; Starobin et al., 2016). Campus culture is something an institution has and does (Museus, 2008), and women of color need to feel like they are part of the campus culture and climate to persist in their programs (Gloria, Kurpius, Hamilton, and Wilson, 1999). Gloria, Kurpius, Hamilton, and Wilson (1999) used the UES to explore the factors of persistence for African American students in PWI institutions. The study found that participants who felt university comfort and social support tended to persist. Those who had a positive perception of their environment also had other positive perceptions of their higher education institution specifically a higher sense of cultural congruity and a positive view of mentorship (Gloria et al., 1999). Peer relationships can influence a woman of color’s persistence in a STEM field (Szelényi et al., 2013). They are marginalized at the intersection of gender and race, which puts them at a disadvantage when entering higher education settings. While many efforts are made to address equity, the deep focus on equity often creates more inequity for students of color (Peralta et al., 2013), with few institutions giving support and just saying there is equity.

Culturally Responsive Classrooms

Culturally responsive classrooms are spaces where the student's culture and background are considered in the planning of the curriculum (Montgomery, 2001), which can be challenging in higher education institutions that focus on getting as many students out of the course as possible. Institutions of higher education are critical parts of the support process for women of color in STEM fields (Ancis et al., 2011) so despite the focus on funding, it should shift to the variety of
supports within this higher education setting welcoming students from challenging education backgrounds that are an essential focus for persistence in STEM fields (Ancis et al., 2011). HBCUs are more successful at creating collaborative, peer supportive environments for women of color in STEM field programs despite having less money in their endowments, lower tuitions, and fewer alumni that give back to the school (Perna et al., 2008). HBCUs are more connected to the cultural and racial background of their student population, creating an environment where students feel welcomed and accepted within their classrooms (Perna et al., 2008). Women of color benefit from a more sister-like community amongst women, and the encouragement of study groups with peer support rather than constant competition (Perna et al., 2008). Currently, PWIs do not offer this accepting environment to women of color students (Perna et al., 2008).

In classrooms, white students know when a racial joke or statement is not okay, but say nothing (Yosso et al., 2009) which continues to foster the idea that the culture and identity of students of color do not need to be treated with importance perpetuating the view of the dominance of white culture. That lack of emphasis placed on women of color and their culture creates an unwelcoming and often hostile environment. Students should be able to be themselves and express their identity without fear of microaggressions and exclusion. Part of creating a just society means that educators encourage students to promote an inclusive society (Takacs, 2002). It benefits all students to be exposed to a variety of diverse groups, perspectives, views, and classroom conditions (Gurin et al., 2002), but these students must learn to be culturally sensitive individuals too. The lack of diversity in the student bodies and faculty creates situations of discomfort and the sense of needing to become someone else, to forget one’s culture, to succeed in a degree program. Often these environments are chilly – not open to anything other than the
dominant culture and exclusive, and women of color are treated differently (Ong et al., 2011).
The students have a culturally different background to other students, and their home perceptions
of education can also differ from the dominant culture (Jain, 2009), which can make being part
of these communities a challenge

Women of color felt more connections and acceptance with others through affinity groups
(Joseph, 2012; Mack et al., 2013). These students, like all students, are looking to integrate and
find membership within their college community (Hurtado & Carter, 1997; Reyes, 2011).
Culture matters to underrepresented minority students, and they must combat negative cultural
perceptions (Museus et al., 2011). A supportive campus environment is one of the most critical
factors to success (McCoy et al., 2017) Students want to be able to express themselves, their
culture, find cultural validation, and be able to advocate for themselves (Museus, 2008).

Perceptions within the University Environment

The way that women of color perceive themselves and how others perceive them is key to
whether women of color continue in STEM fields in graduate school or as a career. McGee and
Bentley (2017) worked with Black women in STEM and through qualitative interviews, and the
use of data from two students found that Black women needed some extra support in their
university environment to combat the negative perceptions of themselves and from others. Many
women of color experience impostor syndrome because many treat Black women as having less
aptitude and less intelligence (McGee & Bentley, 2017). They found in their study that even
within the STEM departments at HBCUs, there is discrimination (McGee & Bentley, 2017).

Dortch and Patel (2017), in their qualitative study with three Black undergraduate women,
explored the participant's sense of belonging in STEM at PWIs. The participants were
interviewed three times for ninety minutes each. The results showed the need for an increase in Black faculty and institutionalized support. The participants felt their faculty members dissuaded them from continuing in STEM fields, and their peers avoided them (Dortch & Patel, 2017). They experienced microaggressions regularly and felt compared and underestimated in their programs (Dortch & Patel, 2017). In Robinson, McGee, Bentley, Houston, and Botchway’s (2016) study examined how engineering students experienced negative racial and gender experiences. There were 70 Black Ph.D. engineering participants, about half female and half male. Many students are dissuaded from continuing in academia when in these programs, which becomes a negative feedback loop because then the rising engineering students of color do not have faculty that look like them as mentors, support, and models to shape self-perception of success in the field (Robinson et al., 2016).

Women of color struggle with the perceptions of themselves and that others have of them in their university environments (Dortch & Patel, 2017; McGee & Bentley, 2017; Robinson et al., 2016). The perception of faculty and peers that women of color are less capable, less intelligent, and lack aptitude in STEM is a negative aspect of the university environment. Those negative perceptions lead to women of color-changing themselves or experiencing impostor syndrome and doubting themselves in STEM (Dortch & Patel, 2017).

**Conclusion**

The university environment is a critical factor to success for women of color (McCoy et al., 2017). Women of color need to feel accepted for who they are with peers (Yosso et al., 2009) and faculty members (Perna et al., 2008). Faculty can support this transition through culturally responsive classrooms (Montgomery, 2001) that help women of color feel like they do not need
to assimilate or give up their culture to succeed (Adelman et al., 2016; Montgomery, 2001). Women of color are perceived differently within STEM programs and then view themselves differently in these programs, often negatively (McGee & Bentley, 2017). Ensuring that women of color are experiencing positive university environments through supportive, culturally responsive settings is necessary to the persistence of women of color in STEM (McGee & Stovall, 2015). Culture is an integral part of the identity of women of color (Collins, 2018), therefore developing welcoming accepting culturally responsive classrooms, so women of color are more likely to persist in STEM fields.

**Summary**

It is only a recent notion that blacks are human beings (West, 1982), and education and science have been utilized as ways to put people down for centuries (West, 1982). Racism is so politically biased that even the classification of white changes based on the political climate (Ladson-Billings, 1998). Part of social justice is the need to call into question the view of the US as a white nation (Ladson-Billings, 1998). In STEM research, there is a lot of information and data about women in STEM or minorities in STEM, but there is a gap in the literature about women of color in STEM (Ong et al., 2011) and how they benefit from culturally responsive classrooms. Understanding all the components to culturally responsive and supportive environments that benefit women of color is essential in diversifying STEM.

The literature has shown that our system does not benefit women of color persisting in STEM. STEM education starts with a lack of funding to promote the equitable distribution of the hands-on, interactive programming necessary to give a solid foundation in STEM before students enter colleges and universities, all taught by teachers who are often inexperienced or lack proper
training (English, 2017; Russell & Russell, 2015; Young, 2005). Once in institutions of higher education, women of color, despite continuing to show interest in STEM fields, look for faculty support (Palmer et al., 2011), mentorship, peer support (Wilson et al., 2012, and a transfer receptive culture (Labov, 2012; Lynette & Texas, 2013; Strayhorn, 2010) yet they are not finding what they need to persist academically in these fields (Hurtado et al., 2009). Academic persistence for women of color struggles due to the lack of faculty support and peer inclusion due to racism, microaggressions, and a lack of understanding in PWIs of how to support these students (Gloria et al., 2010; Ong et al., 2011; Reyes, 2011). Understanding how women of color perceive their university environments can support how education researchers, policymakers, and educators predict the persistence of women of color in STEM fields so that appropriate supports and interventions are put in place.
Chapter Three: Methodology

The purpose of this quantitative study was to employ two scales, the University Environment Scale and the Cultural Congruity Scale, within a survey to understand what factors affect the perception of a university environment by female students of color in STEM degree programs, and the ability of researchers or educators to predict their persistence. The previous chapter explored the literature and how women of color are not represented in STEM fields and how their higher education institutions are essential factors in whether they choose to persist in STEM fields or not. While much of the research on this topic is qualitative, few of the studies explored the issue of persistence of women of color in STEM fields from strictly a quantitative lens.

This chapter will begin by restating the guiding research questions and hypotheses, followed by the research approach and design, then population and sampling, data collection, procedures, data analysis, validity, reliability, and generalizability, protection of human subjects, ethical considerations, and limitations of the study.

Research Questions and Hypothesis

Utilizing descriptive statistics, the following questions were explored in this study: Does students’ perceptions of the university environment predict academic persistence among women of color in STEM fields?

From this question, several follow-up questions were investigated:

1. Are women of color in culturally accepting (CCS) higher education environments associated with the persistence of women of color in STEM fields?
2. Are women of color in *academically supportive* (UES) higher education environments associated with the persistence of women of color in STEM fields?

3. Do women of color with faculty who offer support in the form of mentorship persist in STEM fields?

4. Do women of color in institutions that sponsor ethnic affinity groups to persist in STEM fields?

**Hypotheses**

- Women of color who do not have to hide their ethnicities are more likely to persist in STEM fields.
- Women of color who perceive their environment as inclusive and supportive are more likely to persist in STEM fields.
- Women of color with formal mentors are more likely to persist in STEM programs than those with informal or no mentors.
- Women of color who participate in ethnic affinity groups are more likely to persist in STEM.

**Research Approach**

The positivist paradigm centered on the cause and effect relationships in the world (Muijs, 2011). However, some (Albert, 2015; Karstens, 2018; Popper, 1969a) have argued that the positivist paradigm is too narrow and does not give room for understanding the relationships between humans and the way they interact with the world, which leads to a more subjectivist way of thinking (Muijs, 2011). Post-positivists understand there is bias in all that humans interact with yet strive to explore the world through objective methods (Muijs, 2011). Sir Karl Popper
was one of the first who critiqued the narrow positivist belief (Zammito, 2004). Popper felt that all should be able to present theories if they could be tested and that our views on science are impacted by our society (Karstens, 2018). He developed critical rationalism that believed that humans are fallible, critical realism, which is the human ability to make connections, and methodological revisionism in which all our assumptions can require revisions with more analysis (Albert, 2015). Thomas Kuhn also critiqued the idea of positivism, suggesting there were more ways to see the world (Zammito, 2004). Kuhn took the critique of the narrowness of positivism one step further than Popper with the idea that paradigms and theories shift based on the historical context and the times (Hanby, 2018). Both Kuhn and Popper felt that scientific knowledge should be questioned and analyzed based on a variety of factors (Karstens, 2018).

This study is framed in the post-positivist paradigm which understands that the world cannot be viewed objectively, but that there is an objective reality that can be explored through quantitative methods and mixed methodology (Muijs, 2011). The focus of quantitative methods is gathering information on a topic through numerical data, which is analyzed through math, often statistics (Fraenkel et al., 2015; Muijs, 2011).

**Research Design**

A quantitative approach using a correlational research design was used to answer the research questions posed by this study. Correlational research allows the researcher to explore specific groups and multiple variables (Fraenkel, Wallen, & Hyun, 2013) which will be beneficial for assessing the relationship between students’ perceptions of the university environment (presence of mentors, learning communities through affinity groups, and culturally competent and inclusive environments) and academic persistence. Correlational research shares
some elements with traditional experimental design (Fraenkel et al., 2013), which allowed for a focus on the performance of participants while allowing the study to explore how women of color are performing in comparison to others pursuing STEM fields. Correlational research is often used to compare gender and ethnic variables (Fraenkel et al., 2013), which are the focus areas of this study. However, causal correlation is not experimental research. Experimental research has defined independent and dependent variables, but causal correlation does not have independent variables that the researcher is changing or manipulating (Fraenkel et al., 2014). Experiments have the benefit of extreme control, which is why, for so long, people have seen them as more valid when compared to other studies (Fraenkel et al., 2014). For this study, the researcher did not want to intervene in the participant's education. The purpose of this quantitative study is to employ a survey, the University Environment Scale and the Cultural Congruity Scale, to understand what factors affected the perception of a university environment by female students of color in STEM degree programs, and the ability of researchers or educators to predict their persistence. A quantitative study allowed this researcher to compare this data on a larger scale than previous studies.

For this study, data was gathered through a participant survey (Appendices A & B). Despite the lack of specific variables, the theoretical framework of CRT and QuantCrit focused on the issues of representation and implicit bias and made it so that it is essential to consider new ways to explore the stories of people of color (Garcia et al., 2018), and a correlational design was the most applicable for this study.
Population and Sampling

For this study, the target population was women of color across the U.S. who have previously been enrolled in a STEM program, currently enrolled in a STEM program, or are working in STEM fields. Participants will be adults aged 18 and older. The exclusion criteria were non-English speakers that identify as White non-Latina. A homogeneous sample was enrolled because of the focus of the study on groups that share characteristics such as gender and identity.

The study utilized a combination of criterion-based sampling and snowball sampling, both types of non-random sampling techniques, to recruit women of color from a variety of STEM organizations. Participants were recruited through STEM groups, associations, learning communities, and listservs such as national associations for science professionals and STEM professionals of color (Appendix C). It was hypothesized that the study needed a minimum of 50 participants and a maximum of 200 to collect enough data to find important information (Faul, Erdfelder, Buchner, & Lang, 2009). With 47 participants, the researcher could have achieved a power of 0.8 to reject the null hypothesis at alpha 0.05 for Spearman's rho of 0.4 (a medium-large effect). With 194 participants, however, the researcher could have achieved a power of 0.8 at alpha 0.05 to detect a small-medium effect of rho = 0.2, dramatically increasing the sensitivity of this study to identify more modest effect sizes and profoundly expanding its potential impact (Faul et al., 2009). The researcher used linear regression to find if there was a correlation between variables to predict whether women of color would persist in STEM fields based on their perceptions of their university environment.
Recruiting participants was anticipated to be a significant challenge. The researcher posted on listservs, in STEM groups (both women-only and unisex), and associations connected with STEM fields. As mentioned previously, to keep the participants involved, it was vital that the questions were simple and to the point, that the survey protected the confidentiality of the participants, and the survey was brief. Creating an online survey increased the likelihood of participation with a younger population with easy access to computers, laptops, and even phones. The survey was accessible via mobile phones, as well. Another challenge was encouraging participation and completion of the survey in the time frame asked without turning the participants off with too many communications. Due to the positions of the researcher, along with the quantitative nature of the study, there was not any formal relationship with the participants. The goal was to maintain separation between the participant and researcher, which was critical to the participants feeling comfortable with their answers and participation.

**Data Collection Procedures**

A list of potential organizations related to people of color and STEM was created to recruit participants (Appendix C). A letter inviting potential participants was posted on the community boards and listservs of the identified organizations (Appendix E). When permission was needed, an email requesting permission to post recruitment flyers was sent to organization administrators (Appendix D). Participants who responded to the recruitment letter were directed to a brief screening survey (Appendix F). Those that were eligible continued to the UES survey at the end of the screening survey, and from the UES (Appendix A), it continued to the CCS (Appendix B). Once they started the actual survey, the participants read the consent letter (Appendix G) and accepted after reading the letter to show that they have read for informed
consent. The survey was a forced response survey to ensure that all questions were completed. A reminder email (Appendix H) was sent to any participants that had started the survey but not completed it after two weeks. By the end of one month, the last reminder email to complete the survey was sent out. After that week (a total of 5 weeks), the survey was closed.

**Instrument**

Data was collected using an online survey that was distributed via surveymonkey.com. The survey primarily consisted of questions from the UES and the CCS, with additional demographic questions. The UES and CCS are valid and reliable surveys that have been used with Chicano/a students (Gloria & Kurpius, 1996). The UES contains fourteen questions that are scored on a seven-point Likert scale, where 1 = “not at all” and to seven = “very true.” The CCS has thirteen questions that are scored on a seven-point Likert scale, where 1 = “not at all” and to seven = “a great deal.” The developer of the scales provided permission to use this instrument via email correspondence.

**Data Analysis**

Survey data will be entered in an Excel spreadsheet and uploaded into SPSS (2017). Univariate and bivariate analyses will be used to examine the relationship between the independent variables, university environment, and cultural congruity as measured by the UES and the CCS, and the dependent variable, persistence. Descriptive statistics were used to answer sub-research questions. A qualitative question at the end of the survey allowed participants to further explain the impact of the university environment in their persistence in STEM fields.
Validity, Reliability, and Generalizability

The UES and CCS were used for this study because they are validated and reliable (Gloria & Kurpius, 1996). The UES and CCS study what they say they will, and address the topics related to this study on persistence factors for women of color in STEM fields. The reliability of the UES and CCS were determined in Gloria and Kurpius’ 1996 study of academic persistence with two groups of Chicano/a students at Arizona State University. Both the UES and CCS showed consistencies that were in line with the general population of students (Gloria & Kurpius, 1996). The CCS ranged from .81 to .89, and the UES ranged from .81 to .85, which is within the range of the general student population (Gloria & Kurpius, 1996). Utilizing the UES and CCS, there was a correlation between academic persistence and university environment perceptions, and strong internal consistency was found in the validation process (Gloria & Kurpius, 1996).

The generalizability of the study is limited. The study focused on 68 participants, which are a small fraction of the population of women of color in the U.S., which limited the ability to apply to all within this population. Part of sampling from national organizations allowed this researcher to apply the results to a larger group of women of color across the entire country rather than just one specific region or state.

Protection of Human Subjects

There were minimal costs or potential risks involved with this study. Participants were informed that their information is confidential, that there was not any identifying information saved, and that the survey was completely voluntary. Participants could stop their participation at
any time if they did not wish to continue as part of the study. The participants had to read and
affirm that they had read the consent form for the survey. Informing participants this way
allowed for complete anonymity in the process.

The study was administered utilizing an online survey. It was anonymous and allowed the
participants to keep their identity hidden, so they could openly answer the questions. The
questions delved into the demographics of the participants, their gender, and completed the
University Environment Scale and the Cultural Congruity Scale about their campus
environments. The questions were general about learning communities, race/ethnic identities,
attendance of community colleges, four-year colleges, or both along with questions about
whether they persisted in a STEM field. The questions were concise and clear with an
opportunity for further comment at the end of the survey, and on average, the survey took less
than ten minutes. As a woman of color who is a STEM educator, my positionality, while present,
did not affect the data or change the facts of the participant's responses to the study.

The survey creating the platform did not collect participants' data. Any identifying
information data collected was encrypted and held in a password-protected file. The focus is on
the responses of participants on their gender and race/ethnicity about their STEM field
completion and higher education institution type that they attended, but no identifying
information was necessary. Any information about the specific institution was not asked. For the
researcher to understand how women of color persist in STEM, the survey collected the data
from the individuals themselves.
Ethical Considerations

The participants were adults 18 and over. The participants signed a consent form before they completed the survey and had to sign it to continue. All data were kept confidential, and participants were informed of that in the consent form. The survey data was anonymous. The results of the data were shared with on platforms that participated once the study was completed. Once the survey was completed, all data was deleted to protect participants.

Limitations

One limitation was self-selection bias. Since self-reported surveys collected data, there was a limit to the amount of complexity that could be collected from this topic. Another limitation was being careful not to find causation from data collected, but relationships can be found. The idea is to increase the generalizability of the study by having a larger participant group. However, it may not be able to be generalized due to issues of socioeconomics, student preparation, and personal life challenges. Other limitations included possible other factors related to the lack of persistence in STEM fields such as socioeconomics, school backgrounds, and academic preparation.

Summary

This study addressed the perceptions of women of color and how their perceptions of their university environments affect their persistence in STEM fields. Combining quantitative methods of assessing women of color participants along with delving into their perceptions of their experience ensures that it is the stories and experiences of women of color that are shared and given voice as the CRT framework dictates (Dixson & Anderson, 2018). Using the UES and analyzing data with descriptive statistics, this study explored the relationships between gender
and race/ethnicity and persistence in STEM fields related to perceptions of support, inclusion, and representation in their university environments.
Chapter 4: Data analysis and results

Many studies have been done to address the issue of retention in STEM fields, but few have explored what is holding back women of color specifically from persisting. This study utilized the UES and CCS to track participant’s perceptions of cultural congruity and the university environment that will add to the existing research. The study was designed to focus on the following research questions: does students’ perceptions of the university environment predict academic persistence among women of color in STEM fields? Are women of color in culturally accepting (CCS) higher education environments associated with the persistence of women of color in STEM fields? Are women of color in academically supportive (UES) higher education environments related to the persistence of women of color in STEM fields? Do women of color with faculty who offer support in the form of mentorship persist in STEM fields? Do women of color in institutions that sponsor ethnic affinity groups to persist in STEM fields?

The study developed was non-experimental and quantitative, and the data was analyzed to determine whether these instruments can be utilized to predict the persistence of women of color in STEM fields based on their perception of cultural congruity and university environment. For this study, the Cultural Congruity Scale and the University Environment Scale were used as survey instruments. Both scales were created and validated by Gloria and Kurpius, then validated (Gloria & Kurpius, 1996). The perception of the university environment, along with a sense of cultural fit, is vital for the persistence of minority students in higher education (Gloria & Kurpius, 1996). Therefore, this study aimed to study whether the perceptions of cultural fit and university environment were able to predict whether women of color persisted in STEM fields or not.
The remainder of this chapter follows with a description of the sample and instruments, a discussion of the descriptive findings, then the data analysis procedures, results, and ends with a chapter summary.

**Description of Sample**

One hundred and twelve people started the survey. Several participants did not qualify because they had never been in a STEM program or were not a woman of color or did not consent to the parameters of the study. Of those one hundred and twelve who began the survey, only sixty-eight participants completed the UES (n=68), and sixty-one participants completed the CCS (n=61) while sixty completed the final open response question (n=60). All participants were women who identified as women of color and had been part of a STEM program, at the higher education level, during their education. Data for these participants was used to complete the analysis.

Participant demographics are summarized in Table 1. Overall, participants mostly identified as women and people of color. All participants had to be eighteen and over to take the survey. Participants identified their racial identities. The first group identified as African American/Black; the second group was Latinx of any race, so included any Latinas that identified as Black, White, and Native. The last group was made of participants who identified as Asian, Native American, and Pacific Islander. Nineteen participants identified as African American. Seventeen participants identified as Latinx of any race – Black, White, and Native Americans. The last group consists of thirty-two participants who all identified as Asian, Pacific Islander, or Native American.
For the analyses, the participants were grouped into three ethnic categories – African American, Latinas of All Races, and Asian/NA/Pacific Islander. The final group encompassed both Asian and Native American participants. These groupings were made to maintain the power of each group as much as possible while staying within historical and current parameters for identifying different ethnic groups. The first figure breaks down the participants and some of their demographic information.

<table>
<thead>
<tr>
<th>Table 1</th>
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<td></td>
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<tr>
<td>Participant Demographics</td>
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<table>
<thead>
<tr>
<th>Overall N=68</th>
<th>African American/Black N=19</th>
<th>Latinx N=17</th>
<th>Asian/NA Pacific Islander N=32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Stem Field (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>48 (70.6)</td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>No</td>
<td>20 (29.4)</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Institution Type (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PWI(^a)</td>
<td>66 (97.1)</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>HBCU(^b)</td>
<td>2 (2.9)</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Degree Type (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 year(^c)</td>
<td>13 (19.1)</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>4 year</td>
<td>61 (89.7)</td>
<td>15</td>
<td>15</td>
</tr>
</tbody>
</table>

*Note. African American/Black = (regardless of ethnicity); Latinx = (regardless of race); Asian, Pacific Islander & Native American*

\(^a\) PWI = predominantly white institution  
\(^b\) HBCU = historically black college or university  
\(^c\) 2-year = junior college or community college

Of the sixty-eight participants, forty-eight (70.6%) persisted in a STEM field, while twenty (29.4%) of the participants had not persisted. Sixty-six (97.1%) participants attended PWIs, and only two (2.9%) attended an HBCU for their studies. Fourteen of the African American
participants persisted, and five did not. Of the thirty-two participants identified as Asian, twenty-five persisted in STEM fields, and seven did not persist. In the Latinx group, nine participants persisted, and eight did not. Based on the demographics, there were not enough participants to compare STEM persistence based on the attendance of HBCU when compared to PWI attendance. Similarly, there were not enough participants who attended four-year and two-year colleges to examine persistence in STEM fields.

**Summary of Results**

The data collected focused on women of color from a variety of ethnic backgrounds who had been in a STEM program. Utilizing the CCS and UES, this study aimed to see if the two scales could predict the persistence of women of color in STEM fields. The data from the survey was downloaded to and analyzed utilizing IBM software Statistical Package for the Social Sciences (SPSS) version 22. First, descriptive statistics were generated for whether the participants persisted in STEM or not, the ethnicity of participants, if they attended a two-year college or four-year, and if they attended a PWI or HBCU. The survey instruments, the CCS, and the UES have 13 and 14 items, respectively. Each were scored on a Likert-like scale ranging from 1 (strongly disagree) to 7 (strongly agree). Some items were reverse coded. All race and ethnic groupings were compared utilizing Chi-square analysis to explore if there is any significance between ethnicity and if a participant persisted in STEM fields. Univariate ANOVA was used to compare differences between groups. The significance of the UES and CCS were compared using a t-test. Finally, the predictive ability of the scales was analyzed through a multivariate logistic regression.
The final question of the survey was an open-ended question that allowed participants to explain, in their own words, how the university environment impacted their persistence in a STEM field. Each response was read and analyzed. Using NVIVO software as well as hand-coding the responses, several themes emerged from the responses – support, self-perception, gender versus race, and university environment versus cultural congruity.

The study did not show any relationship between the UES and CCS. Gloria and Kurpius (1996) found that the UES and CCS were best used in conjunction. The scales were validated to work in conjunction (1996, 2001). However, in this study, there was no correlation established between the scales. The sample size in this study may have been too small to establish a correlation between the two scales; therefore, the relationship between the UES and CCS was not part of this analysis.

The average scores showed that the participants did not experience cultural congruity in their institutions yet perceived their university environments in a more positive light. The overall mean score for the CCS was 48.13, with a standard deviation of 8.83 and a p-value < 0.05. The mean score of the UES was 60.97, with a standard deviation of 7.97 and a p-value that did not reach significance. A detailed analysis of all the data follows.

Results

The data collected allowed the researcher to reject or accept the hypotheses for the study. The CCS was used to address the first question: Are women of color in culturally accepting (CCS) higher education environments associated with the persistence of women of color in STEM fields? The hypothesis stated that women of color in culturally accepting environments are more likely to persist in STEM fields. Based on the data from the multivariate logistic regression, the
CCS showed significance (p = .034) that when participants found less cultural congruity, they were less likely to persist. Therefore, the CCS supports the first hypothesis that women of color are more likely to persist if they find cultural congruence with their institution. The results for the CCS multivariate logistic regression also answered the central question: does students’ perceptions of the university environment predict academic persistence among women of color in STEM fields? The p-value of the CCS logistic regression (Table 2) suggests that this scale could be used to predict whether a woman of color will persist in a STEM field or not based on their perception of cultural congruence.

The focus of the next question are women of color in *academically supportive* (UES) higher education environments more likely to persist? The UES did not reach significance (p = .296) in the multivariate logistic regression (Table 2). The hypothesis that women of color in academically supportive environments are more likely to persist was rejected. The UES did not show that a woman of color who found her university environment positive or negative was more likely to persist. The lack of significance in this result suggests that the UES cannot be used as a predictive measure to understand whether a woman of color will persist or not. Despite Gloria and Kurpius’ (1996) validation of the scales for use together, this study did not find that correlation and found that the CCS could potentially be used as a predictive measure while the UES did not provide that data.
Table 2: Multivariate Logistic Regression Table of CCS and UES

*Variables in the Equation*

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>S.E.</th>
<th>Wald</th>
<th>df</th>
<th>Sig.</th>
<th>Exp(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UES</td>
<td>.04</td>
<td>.04</td>
<td>1.09</td>
<td>1</td>
<td>.296</td>
<td>1.03</td>
</tr>
<tr>
<td>CCS</td>
<td>-.07</td>
<td>.03</td>
<td>4.497</td>
<td>1</td>
<td>.03</td>
<td>.93</td>
</tr>
<tr>
<td>Constant</td>
<td>2.10</td>
<td>2.80</td>
<td>.56</td>
<td>1</td>
<td>.45</td>
<td>8.19</td>
</tr>
</tbody>
</table>

*Variable(s) entered on step 1: UES, CCS.*

Individual items from the UES and CCS were examined to find if they addressed the final two questions: Do women of color with faculty who offer support in the form of mentorship persist in STEM fields? Do women of color in institutions that sponsor ethnic affinity groups to persist in STEM fields? For the first question, the null hypothesis was that women of color who had supportive faculty were more likely to persist in STEM fields. The CCS did not have any items that corresponded with this question specifically; however, the UES had several items that addressed this question specifically. Items five, ten, and twelve in the UES specifically address faculty support. “Faculty has been available for help outside of class” (item ten), and “Faculty have been available to help me make course choices” (item twelve) had scores of 5.29 and 4.74 with standard deviations of 1.61 and 2.01 respectively. These scores suggest that participants more positively scored these items while item five, “Faculty have not been available to discuss my academic concerns,” had a score of 3.06 and a standard deviation of 2.08, which suggests that participants did not feel they had access to the ability to discuss with their faculty members. Again, the UES was not likely to be predictive of persistence in a STEM field.
Table 3: UES Items and scores

<table>
<thead>
<tr>
<th>Item</th>
<th>Score</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty have not been available to discuss my academic concerns.</td>
<td>3.06</td>
<td>2.08</td>
</tr>
<tr>
<td>Faculty has been available for help outside of class.</td>
<td>5.29</td>
<td>1.61</td>
</tr>
<tr>
<td>Faculty have been available to help me make course choices.</td>
<td>4.74</td>
<td>2.01</td>
</tr>
</tbody>
</table>

The researcher used individual items from the UES to analyze the final question: do women of color in institutions that sponsor ethnic affinity groups to persist in STEM fields? The null hypothesis that women of color in affinity groups were more likely to persist in STEM fields was rejected. No item in the CCS specifically addressed affinity groups, but item seven in the UES did mention affinity groups. “The university encourages/sponsors ethnic groups on campus” had a score of 5.07 and a standard deviation of 1.66. The high score suggests a positive view of the sponsorship of affinity groups in higher education institutions. There is no significance in this item to support the hypothesis.

The researcher also explored whether the ethnicity of the participant impacted their likelihood to persist in STEM. Table 4 shows the number of participants who persisted or did not persist in STEM-based on the ethnic groups. Of the women who identified as African American, five did persist, and 14 did not persist in a STEM field. In the group of women that identified as Latinx, eight persisted in STEM fields while nine did not persist in STEM fields. In the last group, who identified as Asian, Native American, and Pacific Islander, 20 persisted in STEM while 48 did not persist in STEM. The Chi-squared analysis ($\chi^2 = 3.51$) did not reach a p-value significance of
p < .05 (p=.173); therefore, the ethnicity of the participants did not impact the likelihood of persistence in STEM fields in this study.

<table>
<thead>
<tr>
<th></th>
<th>African/American</th>
<th>Latinx</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO STEM FIELD</td>
<td>5</td>
<td>8</td>
<td>7</td>
<td>20</td>
</tr>
<tr>
<td>STEM FIELD</td>
<td>14</td>
<td>9</td>
<td>25</td>
<td>48</td>
</tr>
<tr>
<td>TOTAL</td>
<td>19</td>
<td>17</td>
<td>32</td>
<td>68</td>
</tr>
</tbody>
</table>

Chi-Square Analysis reveals that there is no statistical difference in the likelihood of persisting in STEM fields across ethnicity

\(X^2 = 3.51, p = .173\). The result is not significant at \(p < .05\)

The multiple logistical regression (Table 2) was run to find if there was any predictive ability to utilizing the University Environment Scale and Cultural Congruity Scale to determine if a woman of color would persist in STEM or not. The UES showed no significance (\(p > .05; p = .296\)) of being predictive about whether the survey participant will persist in STEM. However, when it came to the CCS, the regression showed that the participants who had lower scores (-.073) and therefore did not feel like they had cultural congruity with their institution of higher education were less likely to persist in STEM (\(p < .05; p = .03\)).

The researcher examined if there were any correlations between persistence, ethnicity, and the UES or CCS. The analysis of race and ethnicity with the scores of the UES the p-value did not
reach of significance of p<.05 (p=.905). The same was true for the CCS in which the p-value did not reach significance of p<.05 (p=.665) when comparing persistence based on ethnicity. Therefore, despite the significance in the CCS’ ability to predict the likelihood of persistence, there is no evidence of a correlation between persistence, survey measure, and race/ethnicity.

Several individual items were further explored in the UES and CCS scales. In the UES, items five, eleven, and thirteen had the lowest scores of all the items on the scale. Participants did not feel like faculty was unavailable for discussions or that their university environments were cold, uncaring places that lacked connection. The scores on these items suggest that the participants did not perceive their university environment as unwelcoming or chilly.

Table 5. Lowest scored items on the University Environment Scale

<table>
<thead>
<tr>
<th>Item</th>
<th>Score</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty have not been available to discuss my academic concerns.</td>
<td>3.06</td>
<td>2.08</td>
</tr>
<tr>
<td>The university seems like a cold, uncaring place to me.</td>
<td>2.66</td>
<td>1.65</td>
</tr>
<tr>
<td>I feel as if no one cares about me personally on this campus.</td>
<td>3.00</td>
<td>1.91</td>
</tr>
</tbody>
</table>

For the CCS, items six, seven, nine, and ten had the lowest scores of all the items in the scale. The main theme going through all these items is how participants perceived their families viewed their school and the maintaining of their family values. The participants did not negatively perceive themselves in their higher education institutions in terms of their family values, their appearance, and the transition from being home to at school.
Table 6. Lowest scored items on the Cultural Congruity Scale

<table>
<thead>
<tr>
<th>Item</th>
<th>Score</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>I feel I am leaving my family values behind by going to college.</td>
<td>2.31</td>
<td>1.61</td>
</tr>
<tr>
<td>My ethnic values are in conflict with what is expected at school.</td>
<td>2.56</td>
<td>1.64</td>
</tr>
<tr>
<td>I feel that my language and/or appearance make it hard for me to fit in with other students.</td>
<td>2.75</td>
<td>1.61</td>
</tr>
<tr>
<td>My family and school values often conflict.</td>
<td>2.57</td>
<td>1.77</td>
</tr>
</tbody>
</table>

Qualitative Results

The last part of the survey was an open response question. Participants were asked to describe how the university environment where you were in a STEM program influenced your persistence in STEM. The data from these responses were coded with NVIVO 12 along with hand-coding to review what participants stated when asked to describe how their university environment where they studied STEM influenced their persistence in STEM. From the 112 participants that initiated the survey, only 60 completed the open-ended final response space – please describe how the university environment where you were in a STEM program influenced your persistence in STEM. Several themes emerged from these responses, including support, whether from faculty, staff or peers, gender and race discrimination, self-perception including imposter syndrome and perseverance through self-determination, mentorship, and advisement. Of the 60 participants, 41 had persisted in a STEM field, and they pointed to having mentorship through friends and faculty. While the UES did not produce a significant result when analyzed to be a predictive measure, it was clear from responses that participants felt many of the items
mentioned about mentorship, faculty support, and the university environment were important. Some participants had a positive experience, some did not, but it did not seem to predict whether a participant would persist in a STEM field.

When reviewing the responses of participants, mentorship and faculty support consistently was mentioned by the participants. Many women did not feel they had mentorship or support, but many of those women were able to persist nevertheless because of their self-determination. The question, whether women of color offered support through mentorship, were more likely to persist, was answered as no by the UES, but the responses also did not show any more likelihood of persistence. Some participants that persisted made statements that “…my professors have greatly supported me in my endeavors,” “…current teach was encouraging of people of color,” and “…professors made [it] about work[,] not ethnicity.” One participant mentioned: “Having supportive faculty and peers who did not share the same ethnicity or race was extremely helpful” but did continue later to say “…wished I had more people who looked like me to mentor me in my field.” Another participant mentioned, “A lot of my white professors were also helpful in terms of education, but it was hard to get them [to] understand the mental effects of being the only black person in classes or lab groups.” Having supportive faculty benefitted many participants even if that faculty did not look like them or have a similar background, but still felt that there were disconnects between being a woman of color in classes.

However, some women who had persisted made statements that were not positive about faculty support with statements like “…very discouraging. Professor did not respect culture,” and another said, “I don’t think my time in a STEM program influenced my persistence in STEM. It feels like luck that I’m even in the field at all after school.” One participant stated, “Rather than
being a supportive environment, my college led me to be persistent by driving me to succeed in spite of predetermined expectations admins, profs, and students held for me.” Another participant, who did persist in STEM, stated, “Very discouraging. Professor did not respect culture.” Yet another said, “It feels like luck that I’m even in the field at all after school. I feel so much like an imposter and doubt my abilities…. ” One participant who felt comfortable socially “…faced a ton of imposter syndrome due to being the only Black woman in classes that ranged from a dozen to a hundred students.” Consistently the participants expressed that they benefitted from support when they received it, and for those that did not receive support, they either dropped out of their STEM program, did not persist in a STEM field, and had to go it alone. Based on these responses, participants who persisted still faced adversity and struggled with some professors, while others felt supported, but this was not a factor that determined whether a participant persisted, which rejects the null hypothesis that women of color with faculty support were more likely to persist in STEM fields.

The final question was also addressed through the open responses: Do women of color in institutions that sponsor ethnic affinity groups to persist in STEM fields? The hypothesis was that women of color in affinity groups were more likely to persist in STEM fields. The UES and CCS did not significantly answer this question with their items, and the open responses did not have a lot of information on the subject either. Only a couple of participants mentioned affinity groups or the support of peers, but the majority did not mention this as a support or hindrance to their persistence. Based on the results from the CCS and UES, the hypothesis was rejected but would benefit from further study in the future.
A participant that has persisted in a STEM field mentioned that “Although I went to a predominantly white institution, I was a part of an organization on campus specifically dedicated to minorities in STEM. This helped because it was good to discuss accomplishments and the frustrations, we dealt with the higher we go in our STEM education.” Another participant mentioned, “…overall I was able to find my place amongst student groups, thanks to shared hobbies/interests and being able to join a few of the many ethnic groups, who all had their own spaces and funding.” Both participants found a place for themselves in their institutions through affinity groups and STEM groups of people of color. They found these to be supportive spaces to help them persist in STEM.

Some participants did not persist in STEM but mentioned affinity groups in their open responses. One participant said, “There were definitely resources, like tutoring, clubs, EOP, etc. that helped first-generation minority students like me to get help.” Despite these resources, this participant did not persist in STEM. Another participant stated, ‘The other students color helped me persist more than the predominantly white faculty did.” This participant did not persist in a STEM field. However, she felt that the support she received was from others like her and not the faculty. These statements were not quantitatively significant with the scores of the CCS and UES, and most participants did not mention affinity groups as a help or hindrance to STEM field persistence. However, of all the questions in this study, the focus on affinity groups and simply staying around other “minority students” warrants further study.

Other themes emerged in the open responses beyond the focus on mentorship and faculty support and the sponsorship of affinity groups. Several participants mentioned that they were the only people of color, and many of their faculty and peers did not understand their culture, yet
consistently, the participants pointed out that being a woman seemed to be more of an issue for them. One participant pointed out, “…I think there isn’t really discrimination against East Asians but definitely being the only woman or being accused of succeeding because it’s ‘easier for a woman.’” Another participant said, “Being a woman in STEM major, we often get ridiculed.” For many participants, the first hurdle was being a woman, and the fact that they were also people of color was secondary in their institutions and spaces. Participants gave a brief glimpse into what they perceived as positives and negatives within their STEM program environment that impacted their persistence. While this was not part of the questions or hypotheses in this study, they will be discussed in the next chapter in further detail as future areas of study.
Summary of results

The data collected in this quantitative study focused on women of color’s perception of their university environment and cultural congruity in their higher education institution and whether that could predict their persistence in STEM fields. The survey instruments, the UES and CCS, were used to explore whether they could predict the persistence of women of color in STEM. The UES did not have a significant result with its means and logistical regression analysis, but the CCS showed the potential to predict whether a woman of color would persist in STEM.

Based on the data, there was evidence that most participants found their university environment to be a positive place, or it did not negatively impact their persistence. However, despite the two scales working in conjunction (Gloria & Kurpius, 1996) in this study, the cultural congruity scale showed significance when the rating scale score was lower, meaning that when participants felt less cultural congruence, they were less likely to persist. Women in culturally accepting institutions were more likely to persist, while women in academically supportive institutions were not found to persist significantly. The open responses, along with the UES and CCS, showed there was no significance in participating in affinity groups or receiving/not receiving mentorship and faculty support. The sample size could be larger to benefit from more data and more power to further explore these questions in future studies.

Chapter Five includes a summary of the results, discussions of the results in relation to the literature, limitations, implications of findings for practice, recommendations for further research, and the conclusion.
Chapter 5: Implications and Discussion

The number of women of color has been slowing increasing over time; however, it is rising at a slower rate than their white female counterparts (Mack et al., 2013), and they still make up only a small portion of most STEM fields (Mack et al., 2013). Women of color enter institutions of higher education as or more interested in STEM fields as their white female peers, but at about 24% less likely to graduate from a STEM degree or continue in a STEM field (Museus & Liverman, 2010). There have been studies that have addressed the Double Bind that women of color face in STEM (Malcom et al., 1975) and have explored potential gaps, social obstacles, and institutional barriers (Malcom et al., 1975) that may hinder women of color from persisting in STEM fields. Despite research in these areas, there is still a lack of understanding about why women of color are not persisting in STEM. The purpose of this quantitative study was to employ two scales in a survey, the University Environment Scale (UES) and the Cultural Congruity Scale (CCS), to understand what factors affect the perception of a university environment by female students of color in STEM degree programs, and the ability of researchers or educators to predict their persistence. The study utilized the UES and CCS, which were validated by Gloria and Kurpius (1996) and can be used in future studies.

Summary of Results

This quantitative causal correlational study focuses on how the perception of cultural congruity and the university environment of their institutions impacted women of color and their persistence in STEM fields. Participants completed a demographic survey along with the UES, and CCS then responded to an open-ended question about their university environment. The study was designed to focus on the main research question: does students’ perceptions of the
university environment predict academic persistence among women of color in STEM fields? The results showed that the UES was not significant at \( p < 0.05 \) and was not predictive if a participant persisted in STEM or not. That does not mean it is not a possible predictor, but not in this study. The CCS did show a potential predictive benefit to whether a participant would or would not persist in STEM. The lower the score of the participant, the less likely to persist in STEM. The data was used to answer the rest of the research questions too.

**Research Question #2: Cultural Congruity Scale**

The follow-up question to whether or not the UES and CCS would be able to predict whether a woman of color would persist in STEM is: are women of color in *culturally accepting* (CCS) higher education environments associated with the persistence of women of color in STEM fields? Of the 68 participants, 61 completed the CCS in the survey. The CCS is a 13-item Likert-like scale with options ranging from 1 (*not at all*) to 7 (*very true*). The scores for everyone were calculated, and some items were reverse coded. Based on the scores, participants experienced some challenges in the perception of cultural congruity. The null hypothesis stated that if women of color were in a culturally accepting environment that they would be more likely to persist. The data was consistent with this hypothesis. Women of color who were in what they perceived as a more culturally accepting environment, they were more likely to persist. The overall mean score for the CCS was 48.13, with a standard deviation of 8.83. The lowest score was 34.00, while the highest was 72.00. The multivariate logistic regression resulted in a significant \( p = 0.03 \). Participants who perceive their environment as more culturally accepting are more likely to persist.
Research Question #3: University Environment Scale

The next question focused on the UES: are women of color in *academically supportive* (UES) higher education environments associated with the persistence of women of color in STEM fields? The UES has 14 items and is also a Likert like scale ranging from 1 (*not at all*) to 7 (*very true*). The null hypothesis was that women of color who were in academically supportive environments were more likely to persist in a STEM field. Based on the results, participants found their institutions academically supportive. The UES overall mean was 60.97, with a standard deviation of 7.97. The lowest score was 43.00, and the highest score was 80.00. The results of the multivariate logistic regression were not significant $p = 0.296$. The results show that the participants felt academically supported in their institutions but did not show any significance in whether they were more likely to persist or not in STEM fields.

Research Question #4: UES, CCS, and Open Responses

The next question in the study was: do women of color with faculty who offer support in the form of mentorship persist in STEM fields? The UES and CCS did not address this question in any significant way. The UES had a few items that related to this specific issue, but the CCS did not and focused more on perceiving cultural congruity. The null hypothesis was that women of color were more likely to persist in STEM if they had support from their faculty. The open responses at the end of the survey were utilized to address this question but did not reach significance about whether women of color were more likely to persist. Some participants persisted despite a lack of support, and the reverse was true that participants who had found positive support and mentorship did not persist in STEM fields. The hypothesis was, therefore, rejected based on the data collected in this study.
Research Question #5: UES, CCS, and Open Responses

The final question in this study was: do women of color in institutions that sponsor ethnic affinity groups persist in STEM fields? As with the previous question, the CCS and UES did not provide significant data to support the null hypothesis. The null hypothesis was that women of color in institutions that sponsored ethnic affinity groups would be more likely to persist in STEM. In this study, the hypothesis was rejected; however, this was a limitation in this study. The CCS and UES did not have enough items to answer this question. When analyzing the data from the final question, only a few participants mentioned affinity groups and that they were beneficial. If they were helpful to other participants, they did not mention them. The question of affinity groups was rejected in this study but would benefit from further exploration in another study.

Discussion of Results

The disparity in persistence for women of color in STEM remains an issue and closing the gap would support further diversification of STEM fields, especially in engineering and math fields (Basile & Lopez, 2015). Exploring the reasons why women of color do not persist can support change in the institutions where these women go to earn their degrees. There has been an improvement in the number of women in biological fields (NSB S & E Indicators, 2016) and the presence of people of color, including women of color over the last two decades (NSB S & E Indicators, 2018). The research on what supports or hinders women of color continues to expand, giving researchers and institutions a better understanding of what should and can change to address the gaps (NSB S & E Indicators, 2018). Participants in this study, based on their survey scores and responses, found their university environments supportive with accessible support
systems. While many participants felt there was some cultural congruity with their university, those that had a lower score and felt less congruity had a significant p-value not persisting in STEM fields which suggests that congruity would impact STEM fields if a woman of color does not feel she has cultural congruity with her institution. The survey instruments, the UES and CCS, have been found for use as predictors of persistence (Gloria & Kurpius, 1999). The results of this study indicated that the university environment does not significantly impact persistence, perhaps because institutions are more supportive, but cultural congruity does significantly impact persistence in STEM fields.

**Discussion of the Results in Relation to the Literature**

In this section, the discussion centers around the connections between the results and existing literature, along with an exploration of the themes that emerged in this study.

**Critical Race Theory**

Critical race theory (CRT) centers around the premise that racism is part of the norms of American society (hooks, 1989). CRT seeks to give voice to those who have been oppressed and marginalized where white needs are centered and addressed above all others. The main tenets of CRT are acknowledging that racism exists, analyzing the how historical and current social and institutional practices feed into the continued racism in society, challenges the existence of colorblindness and meritocracy and that the experiential experiences of people of color are valid and vital to understand better the marginalization they face in society (Carlton Parsons, Rhodes, & Brown, 2011).

CRT research focuses on qualitative methods to allow participants to share the story of their experiences. Dixson and Anderson (2017) pointed out that combining counternarratives with
other aspects of CRT to make the narratives more effective. For this study, utilizing a quantitative study allowed for a larger number of participants for a study of this size while enabling the participants to share their stories by answering an open-ended question in the survey to explain their experiences and its impact further. While this study was done from a positivist paradigm, which is in opposition to the critical paradigm of CRT, combining quantitative methodology with CRT moves the discussion of race in STEM further. Quantitative methodology allowed the researcher to capture a larger participant group while CRT critically analyzes the stories and information hidden beyond p-values and statistical significance. Utilizing QuantCrit and quantitative methods can change how researchers and institutions perceive race, gender, and class in education (Lopez, Erwin, Binder, & Chavez, 2017). Another part of using quantitative methods in CRT as QuantCrit allows researchers to rectify and re-imagine statistical analysis (Garcia et al., 2018).

The results, from both responses and survey totals, suggest that the university environment is not as significant an issue in persistence in STEM. Even with those results, participants mentioned that there were still professors that were not positive mentors, that there was a lack of representation in the administration and faculty, and that there were times they felt they did not have support. The most significant results emerged in terms of cultural congruence and the fact that women of color do not perceive themselves as belonging or being included in their environment, which a different issue than academic support and achievement. Participants mentioned impostor syndrome, not connecting with others, and representation – not seeing themselves in positions of power or high faculty achievement. Challenging institutions to address the inclusivity of their programs and the lack of belonging that participants feel in their school
cultures is a necessary part of CRT (DeCuir & Dixson, 2009). The structure of our higher education institutions, along with STEM education departments, point to the subtle but constant imposition of white supremacy and racism for students. Seriki (2018) pointed out that science education needs more CRT because of the lack of culturally relevant pedagogy and to further improve the participation of people of color.

To further the goal of the participation of women of color in STEM fields, analyzing the societal and institutional systems that are potentially holding women back is critical. CRT is an appropriate theoretical framework to analyze the systemic roadblocks that women of color face in STEM fields. CRT in education explores how even high achieving students are not able to progress in these fields because of systemic oppression (Seriki, 2018). Using CRT to improve curriculum and change pedagogical methods in STEM fields would open STEM up to a larger group of students from all backgrounds.

**Cultural congruity**

Cultural congruity is an important part of persistence for women of color in STEM fields to persist in STEM (Gloria & Kurpius, 1996). Participants who had a negative score on the CCS were less likely to persist at a significant p-value. The significant results point the need to focus persistence efforts on ensuring that all students feel seen, acknowledged, and that they find communities within their field to cultivate a sense of belonging.

**Cultural capital.** The concept of cultural capital is determined by economic and social capital that people have accumulated in a person’s life from their families (Berger, 2000). Starting with a higher status allows a person to build on those accrued capital gains, and one way a person can build on that is by attending college, which is a choice determined by a person’s
status in society (Berger, 2000). Understanding that, when women from marginalized communities enter STEM programs in higher education institutions, they are beginning with less cultural capital is essential to developing the correct support to keep these women persisting in their programs (Berger, 2000). It is necessary to support students in their transition from spaces of low cultural capital to gaining status in society, and it is the higher education institutions where these transitions happen that can put into place the necessary framework to ease those transitions. Faculty should be trained to be considerate of these shifts in students’ lives, and the psychological support to make the shifts in cultural capital in their lives.

**Belonging.** Women of color often face marginalization in their higher education settings. Mena (2016) studied how thirteen women of color faculty and staff at a PWI in the Northeast and found that women felt they were neglected, and their careers hurt because they must focus on microaggressions and marginalization. Some of the items in the CCS address participants having family support and being connected to their identity outside of their higher education institution, and in Mena’s (2016) study, many of the participants pointed to the support of family and community that motivated them to push past difficult times. If there is a sense that they belong and that there is support for their continued presence at an institution, then students are more likely to persist (Kuh & Love, 2000). Social integration and a sense of being part of the school community is essential for students in their perception of belonging and community (Kuh & Love, 2000). Institutions would benefit from examining their school cultures and how students perceive themselves from cultural perspectives so that they can better support students that feel like they are expected to assimilate into the dominant culture of the institutions they have joined (Kuh & Love, 2000). As Kuh and Love (2000) point out, school is meant to be a place for
growth and development, not for students to lose and change their values and beliefs, yet institutional communities expect students to change to fit in, adapt, and assimilate.

The CCS and UES explore the importance of how students perceive their sense of belonging and the level of support they have in their university (Gloria & Kurpius, 1996). The results did not find that the university environment was significantly impacting the persistence of participants in the study. However, the CCS showed that the perception of cultural congruence is affecting persistence. Forcing assimilation reduces scientific progress, disagreements, and diversity of perception and thought are necessary for moving STEM fields forward (Martin, 2016). Higher education institutions need to move past the belief of assimilation and having their students all accept one way of thinking, and one way to perceive the world and STEM fields (Martin, 2016).

**Faculty**

Faculty are an integral part of any institution of higher education. Throughout the study, issues of diversity in STEM departments, representation amongst faculty members, and receiving mentorship and support from their faculty members. Some participants could not find support in their faculty members, and some could and while beneficial found that it would have been helpful to have had faculty that looked like them too. The results of the UES were not significant in this study; however, with a larger sample size, the results could be different. The study size is a limiting factor and would benefit from a larger sample size to further explore this point, but participants in their open responses consistently mentioned faculty, mentorship, and the diversity of faculty in their programs.
Departmental diversity. Participants in the study mentioned how they had some mentorship, but often the mentorship was from someone from a different ethnic group. While they received mentoring, one participant pointed out that it would have been helpful to have a mentor who “…looked like me.” Many institutions are looking at diversifying faculty, which further exacerbates issues between people of color and white colleagues because white colleagues see them as “privileged” (Mena, 2016). Warren (2017) pointed out that academic institutions need to reevaluate how they hire, how they interact with faculty, and how toxic higher education is currently to the potential women of color faculty or anyone of color, which is potentially a faculty member, that enter those spaces.

Keafer and Ward (2010) wrote an institutional “how-to” for effectively hiring a diverse faculty. It is first important for institutions to address sensitivity to diverse people, which will then directly impact the hiring process so that those on hiring committees keep an open mind and are intentional about what diversity in an applicant pool means and what it looks like (Keafer & Ward, 2010). Sgoutas-Emch, Baird, Myers, Camacho, & Lord (2016) developed a cohort/cluster approach for hiring to diversify faculty in a meaningful way further. Diversity in faculty is necessary for new ideas and to have a faculty that is representative of the changing demographics in our country and our higher education institutions across the country (Sgoutas-Emch et al., 2016). Developing new ways to hire faculty will diversify STEM departments, benefit all students, and create a faculty that is more representative of the country and working towards supporting the recruitment and retention of women and women of color faculty in STEM (Sgoutas-Emch et al., 2016).
Mentorship. The process of mentorship is an important, positive part of being a STEM program or any educational program. Mentorship does not mean that a person is not capable of completing a program, but rather are seeking guidance from someone with more experience (Fields, 1999). A good mentor can lead a student to research opportunities and connect with peers in the program to study together while maintaining high expectations of all students in the program, no matter their gender or racial or ethnic identity (Fields, 1999). Students need to have a good mentor, not just a mentor of color. Therefore, a woman of color is better off with a good mentor who is White than not having one (Fields, 1999). Borum and Walker (2012) found in their study of black women in mathematics programs that mentorship was a vital part of the success of black women in math programs in undergraduate and graduate programs. Women in that study who had black and female mentors in math felt that they could make it to that level, that they could reach their goals (Borum & Walker, 2012). It is beneficial to have mentorship for students in their programs, and to see themselves in those mentors too (Borum & Walker, 2012). Borum and Walker (2012) also found that women who were in HBCUs had a more nurturing and supportive environment, which was beneficial for their progress and success.

There are different types of advisors with a range of varying involvement in higher education institutions (Noy & Ray, 2012). Women currently outnumber men in the college population. However, men outnumber women in faculty, administrative, and managerial positions, which means female students are most likely to be mentored by a man who does not understand the experience of a woman in a university setting (Noy & Ray, 2012) especially a woman of color. Male students were less likely to report an exploitative advisor and more likely to indicate support in advising (Noy & Ray, 2012). Hernandez, Estrada, Woodcock, & Schultz (2017) found
that while demographic similarities can help promote a positive mentorship relationship, that fostering a perception of shared similarities across multiple subjects and areas of life is enough to support a positive mentorship relationship between students of colors and their mentors. Hund, Churchill, Faist, Havrilla, Stowell, McCreery, Ng, Pinzone, & Scordato (2018) in their study explored explicit training of potential mentors was an effective method for improving mentorship in STEM fields. Improving mentorship programs and processes directly impact productivity, inclusivity, creativity, and equity (Hund et al., 2018). Supporting faculty through the process of effective mentoring is an affordable method that is also effective for postdocs and graduate students who will become mentors in STEM fields in the future (Hund et al., 2018). Getting students, the mentorship they needed in their junior and senior years improved their view of themselves in STEM fields (Estrada, Hernandez, & Schultz, 2018).

**Impostor syndrome.** The results of the CCS point to the fact that participants did not perceive themselves as belonging in their institutions, which impacted their ability to persist in STEM fields. Like cultural congruence, impostor syndrome is a perception by an individual that they are not capable of handling the workload ahead of them (Qureshi, Taj, Latif, Rafique, Ahmed, & Chaudhry, 2017). Better cultural support and connections within a higher education institution build cultural congruence, which in turn can reduce the sense of being an impostor in the institutional community (Qureshi et al., 2017). Impostor syndrome leads to feelings of anxiety, depression, burn out, and other effects that can impact the persistence of women of color in STEM fields (Qureshi et al., 2017). If students feel that they are not deserving of getting to that institution, then they may not think that they find any cultural connection or congruence to the institution where they are studying STEM (Qureshi et al., 2017). Developing institutional
support through multicultural interactions, supporting confidence-building activities, and offering clear psychological support and services to all students benefits every student in a community, including women of color (Qureshi et al., 2017). Impostor syndrome is linked to a lack of cultural congruence within an institution, addressing impostor syndrome could increase the amount of persistence by women of color in STEM fields.

**Limitations**

There are several limitations to this study. First, the sample size of 68 participants is small, and there was not an equal number of participants from different racial and ethnic backgrounds. There were more participants of Asian origin than any other, and there was a limited number of Pacific Islanders, Native Americans, and Latinas that identified as Black. Increasing the overall sample size as well as getting equal racial and ethnic groups would be beneficial. Second, the institution type, HBCU, and PWI should be more equally represented in the participant groups. It would be beneficial to future studies to make a better comparison when looking at the type of institution attended and how that impacts persistence in STEM. Third, a larger sample size would also be beneficial for creating a better balance between groups of participants who did and did not persistence so that the scales could give a more accurate picture of whether or not the university environment and cultural congruity were significant in the persistence in STEM fields of women of color. Fourth, sourcing from a larger number of associations as well as working with alumni and current students from a variety of institutions across the country would have benefitted this study. Lastly, the focus of this study was quantitative therefore the open responses were not quantified. In a future study, the qualitative responses could be quantified to explore how participants from different groups perceived their university environment. These factors
would give a more detailed picture of factors that can impact STEM persistence for women of color and provide more information to researchers and institutions about possible policy changes that could be implemented. A larger sample size could have resulted in more significant data for the two survey instruments and more relationships between the two surveys.

**Implications of the Results for Practice**

This quantitative study was designed to explore whether the UES and CCS instruments could be used as predictive measures for persistence for women of color in STEM fields. The findings found that the lower the CCS scores were significant and suggested that women of color who did not find cultural congruence with their institution were less likely to persist in their STEM program or a STEM field. The UES showed that participants found their environments supportive and were not significant to the persistence of women of color in STEM fields in this study. The results indicate that women of color find the resources that they need to be academically successful in their institutions, and many participants said that they persisted in difficult institutional settings because they forced themselves to persist, so the university environment did not necessarily impact whether or not they persisted in a STEM field.

Universities can use this information to address cultural congruence. Institutions have addressed the mentorship and support issue to an extent. Many participants did mention that they had negative experiences with lack of mentors, lack of faculty that looked like them, or with faculty that were not as supportive in their departments as they could have been in their programs. That information can be used by institutions to diversify their faculty and improve training faculty to be mentors and supportive of all their students, no matter their origins or background. Utilizing the feedback of women of color, who have been through STEM programs
and decided whether to persist in STEM fields, gives institutions concrete examples of how women of color felt they lacked support.

The CCS allows institutions to have a deeper understanding of their students. The results were significant, which supports the hypothesis that the CCS could be used as a predictive instrument for a woman of color’s likelihood to persist in a STEM field. STEM departments, especially in graduate programs, could use the CCS to predict whether the women of color in their program needed more support to feel a sense of belonging whether that is through further connections with classmates, building systems to maintain their relationships with their families, or developing spaces where they can express themselves based on their racial or ethnic identity. Perception is important in this study. If women of color to not perceive a supportive environment, a place with welcoming peers, and the ability to maintain a connection with their family, then it will impact their persistence in STEM fields.

This information and data should be shared with professors, especially in STEM departments, along with academic and student affairs deans. Institutions should use this data, along with other studies on persistence (Lindsey et al., 2015), to check-in with students and building programming and funding for programs that support students who are still in the minority in their programs. These programs could involve pre-college supportive programming, or more culturally interactive programming throughout the year so that students can make connections to faculty or peers who can support their sense of belonging. Creating programming that also encourages a community amongst peers in a program, rather than a competitive community where all are trying to oust the other, could change the perception and, therefore, the persistence of women of color in STEM fields.
Another point that came up consistently in the open responses was that participants wanted to see themselves represented more in the faculty. While they found mentorship in faculty that were not necessarily of their race or ethnic background, participants still wanted to see women that looked like them in faculty positions in STEM programs in the country as well as having culturally responsive professors. Having a faculty member that could understand some of the struggles that they faced was essential to many of the participants. Addressing diversity could go a long way to helping these women find cultural congruence in their higher education institutions. Faculty support was an important part of what participants mentioned in their responses. Further training for all faculty members for effective mentoring strategies and culturally responsive teaching no matter the topic or academic subjects that all students in the classroom feel connected to the curriculum and the academic community.

Another recommendation for future practice is implementing culturally relevant pedagogy in science education (Seriki, 2018). First, educators need to consider their own experiences and interactions with privilege and oppression in our society. From there, they are moving into more concrete forms of educating and not having a deficit mindset for students in classrooms (Seriki, 2018). Culturally relevant pedagogy does not focus on a specific group but instead makes the case that all should see themselves in their classes and that all groups should be seen as part of the norm (Ladson-Billings, 2012).

Institutions could also offer more psychological support in the way of counselors for women of color or support groups to discuss some of the particular social and emotional challenges faced in their institutions. Working through imposter syndrome feelings and how they perceive themselves in their university community could have a significant impact on women of color in
STEM fields. Creating spaces where women of color can go for help is important in supporting the sense of belonging at an institution, especially if an academic program is challenging. Addressing these issues can assist women of color in finding the right fit in their institutional choices so that they are more likely to persist in STEM fields.

**Recommendations for Further Research**

This study was limited to focus on whether cultural congruity or the university environment could be predictive of persistence in STEM fields by utilizing two scales as measures, the CCS and UES. The results suggest that the university environment is not a predictive measure, but cultural congruity is a significant factor in whether women of color persist in STEM fields.

The results suggest that the study would benefit from being repeated with a larger sample size and recruiting participants from a broader range of institutions, alumni groups, and organizations around the country. Future research involving a larger number of science organizations, alumni, and current students from a variety of colleges and universities across PWIs and HBCUs could yield more significant results and the ability to make more comparisons. A higher number of institutions and organizations from which to recruit participants would allow the researcher to have more balanced groups across race, ethnicity, persistence, or not in STEM fields, as well as attendance of PWIs and HBCUs. The benefit of more balanced groups would allow for more comparisons to explore if there are other relationships with persistence in STEM fields. Balanced participant groups could also increase the significance of the CCS and UES results, which can better support policy change and program implementation in higher education institutions.
More research from a qualitative perspective would also be valuable to explore where women of color feel they need more support or where they feel active hostility in their environment. A possible method to gain a broad qualitative perspective would be gathering data through a survey across multiple associations, groups, and institutions and then inviting whoever would be willing to a more in-depth interview. Interviewing participants would allow them to explain their experience and story further. A larger sample size could give a researcher access to a larger group for a qualitative study through interviews. Connecting also to CRT by conducting follow up interviews so that participants were in charge of their narratives would give researchers and institutions further insight into what women of color perceive as the supports and hinderances to persistence in STEM.

While this study allowed participants to explain how their university environment impacted their persistence, more in-depth interviews with a variety of women could yield more detailed and specific information that higher education institutions could utilize for change. Hearing from participants themselves why they are considering not persisting can be invaluable to giving women, who have not previously had a voice, the platform to explain how higher education institutions do not offer the support and sense of belonging that they need to succeed.

Another possible research study could be to focus on comparing HBCUs and PWIs to examine the persistence of women of color in STEM from these different institutions. Exploring whether students who feel more cultural congruence with their institution and if that makes it more likely that women of color will persist or not persist in STEM fields. Other possible variables to explore for future study are persistence in communities with diverse faculty, examining culturally responsive higher education communities, and further exploration of the
idea of impostor syndrome and how that impacts the persistence of women of color in STEM fields and their perception of the university environment and cultural congruence. The CCS and UES can be used for comparing women who attend both HBCUs and PWIs.

Summary

The purpose of this study was to explore the specific parts of higher education institutions that are holding women of color back from persisting in STEM fields and to apply the CCS and UES as predictive measures to better support these women in their institutions before they leave their fields. The sample allowed for a small look at the factors that would convince a woman to persist or not persist in a STEM field. The results showed that the UES did not significantly predict whether a participant would persist in STEM or not, however, the CCS did have significant results suggesting that it could be utilized to predict whether a participant was likely to persist in STEM or not.

The study was designed to add to the body of research on persistence in STEM fields for women and people of color and that intersection addressing the double bind that is still a challenge in STEM fields. Diversifying STEM fields is essential to address so that STEM faculty can reflect the diversity of our country, as well as a variety of STEM careers, reflect the diversity of our nation. Diversity brings different experiences and perspectives which are essential to solving a unique and difficult problem in STEM. The results add another possible way to look at how to predict whether women of color will persist in STEM fields or not, and it allows researchers and institutions to begin addressing the issue of persistence before a woman of color leaves the field and work to prevent women from leaving STEM fields.
Appendix A

University Environment Scale

Please respond to these next statements using the following scale:

<table>
<thead>
<tr>
<th>Not at all</th>
<th>Very True</th>
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<tbody>
<tr>
<td>1</td>
<td>2</td>
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<tr>
<td>3</td>
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<td>5</td>
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1. Class sizes are so large that I feel like a number.
2. The library staff is willing to help me find materials/books.
3. University staff have been warm and friendly.
4. I do not feel valued as a student on campus.
5. Faculty have not been available to discuss my academic concerns.
6. Financial aid staff has been willing to help me with financial concerns.
7. The university encourages/sponsors ethnic groups on campus.
8. There are tutoring services available for me on campus.
9. The university seems to value minority students.
10. Faculty have been available for help outside of class.
11. The university seems like a cold, uncaring place to me.
12. Faculty have been available to help me make course choices.
13. I feel as if no one cares about me personally on this campus.
Appendix B

Cultural Congruity Scale

<table>
<thead>
<tr>
<th>Not at all</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>A Great Deal</th>
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<tbody>
<tr>
<td>1. I feel that I have to change myself to fit in at school.</td>
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<td>2. I try not to show the parts of me that are &quot;ethnically&quot; based.</td>
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<td>3. I often feel like a chameleon, having to change myself depending on the ethnicity of the person I am with at school.</td>
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<td>4. I feel that my ethnicity is incompatible with other students.</td>
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<td>5. I can talk to my friends at school about my family and culture.</td>
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<td>6. I feel I am leaving my family values behind by going to college.</td>
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<td>7. My ethnic values are in conflict with what is expected at school.</td>
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<td>8. I can talk to my family about my friends from school.</td>
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<td>9. I feel that my language and/or appearance make it hard for me to fit in with other students.</td>
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<td>10. My family and school values often conflict.</td>
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<td>11. I feel accepted at school as an ethnic minority.</td>
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<td>12. As an ethnic minority, I feel as if I belong on this campus.</td>
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<td>13. I can talk to my family about my struggles and concerns at school.</td>
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</table>

Figure 1. Cultural Congruity Scale.
Appendix C

List of Organizations to Post

- African American Women in Technology (AAWIT)
- Association of Black Women Physicians (ABWP)
- Black Girls Code
- National Association of Black Geoscientists
- National Black Nurses Association, Inc.
- National Medical Association (NMA)
- National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE)
- National Podiatric Medical Association (NPMA)
- National Society of Black Engineers (NSBE)
- Society of Black Academic Surgeons (SBAS)
- Women of Color Research Network
- Chinese Institute of Engineers (CIE-USA)
- National Council of Asian Pacific Islander Physicians (NCAPIP)
- Society of Asian Scientists and Engineers (SASE)
- Great Minds in STEM (Latino Organization)
- Hispanic Engineering, Science, and Technology Week (HESTEC)
- Latinas in STEM
- Latino Medical Student Association (LMSA)
- Latinos in Information Sciences and Technology Association (LISTA)
- The National Alliance for Hispanic Health
- National Hispanic Medical Association (NHMA)
- National Society of Hispanic Physicists
- Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS)
- Society of Hispanic Professional Engineers
- Society of Mexican-American Engineers (MAES)
- The American Indian Science and Engineering Society (AISES)
- The Association of American Indian Physicians (AAIP)
- Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS)
- National Science Teacher Association (NSTA)
- New Jersey Science Teacher Association (NJSTA)
- American Council on Science and Health (ACSH)
- National Council for Science Education (NCSE)
Appendix D

Permission to Post Letter

Northeastern University, Department of Education

Name of Investigator(s): Quannah Parker-McGowan, Ph.D., Montana Vasquez-Grinnell

Title of Project: TBD

Dear ____________,

This letter is to request permission to post on your boards to recruit for a doctoral study. The purpose of the study is to find how the university environment impacted the persistence of women of color in STEM fields and programs. The study is a quantitative study, and the goal is to utilize the data not only for my doctoral thesis and journal articles in the future but also to push for more equity in university settings to increase the persistence of women of color in STEM programs.

All the data and information will be confidential, and there will be no identifying features of your organization or the participants.
Appendix E
Letter to be Posted on Organizations sites

Northeastern University, Department of Education
Name of Investigator(s): Quannah Parker-McGowan, Ph.D., Montana Vasquez-Grinnell
Title of Project: Persistence of Vision: Factors Influencing the Retention of Women of Color in STEM Programs

Dear Participant,

I am writing to let you know about an opportunity to participate in a research study about the persistence of women of color in STEM fields. This study is being conducted by Montana Vasquez-Grinnell at Northeastern University, Graduate School of Education. This study will explore how the university environment supported or hindered the persistence of women of color in STEM fields and programs.

This letter is an invitation to participate in the study. If you interested in participating in this study, please click on the survey link below.

Agreement to be contacted or a request for more information does not obligate you to participate in any study.

If you would like additional information about this study, please email Montana Vasquez-Grinnell at vasquez-grinnell.m@husky.neu.edu or Quannah Parker-McGowan at q.parker-mcgowan@northeastern.edu

Thank you again for considering this research opportunity.

Montana Vasquez-Grinnell
Appendix F
Screening Survey

These are the screening questions before the potential participants can move onto the UES and the CCS:

1. Have you ever or are you currently in a STEM program? (yes or no)

2. Are you currently in a STEM field (Science research, technology, engineering, and mathematics – not including education)? (yes or no)

3. Did you attend a community college? (yes or no)

4. Did you attend a four-year institution for STEM? (yes or no)

5. Did you attend a predominantly white institution or a historically black college or university?
   a. Predominantly white institution
   b. Historically black college or university

6. What do you identify as? Please select as many as apply
   a. African-American
   b. Latino – Black
   c. Latino – White
   d. Asian (Southeast Asian, Indian, Chinese, Korean, Japanese, etc.)
   e. Pacific Islander
   f. Native American

7. What do you identify as?
   a. Male
   b. Female
Appendix G

Web-based Consent to Survey

Northeastern University, Department of Education

Name of Investigator(s): Quannah Parker-McGowan, Ph.D., Montana Vasquez-Grinnell

Title of Project: Persistence of Vision: Factors Influencing the Retention of Women of Color in STEM Programs

I would like to invite you to participate in a web-based online survey. The survey is part of a research study whose purpose is to understand the factors in a university environment that help or hinder the persistence of women of color in STEM fields. This survey should take about 15 minutes to complete.

I am asking you to participate in this study because you identify as a woman of color (African-American, Latina, Asian, Pacific Islander, and/or Native American) and at some point, pursued a STEM program or field. You must be at least 18 years old to take this survey.

The decision to participate in this research project is voluntary. You do not have to participate, and you can refuse to answer any question. Even if you begin the web-based online survey, you can stop at any time.

There are no foreseeable risks or discomforts to you for taking part in this study.

There are no direct benefits to you from participating in this study. However, your responses may help us learn more about how to support women of color pursuing STEM programs in the future and improve equity in university environments.

You will not be paid for your participation in this study. If you complete the survey, you will be entered a raffle to win one of three Amazon gift cards valued at $25 each.

Your part in this study is anonymous to the researcher(s). However, because of the nature of web-based surveys, it is possible that respondents could be identified by the IP address or other electronic record associated with the response. Neither the researcher nor anyone involved with this survey will be capturing those data. Any reports or publications based on this research will use only group data and will not identify you or any individual as being affiliated with this project. Your part in this study will be handled in a confidential manner. Any reports or publications based on this research will use only group data and will not identify you or any individual as being affiliated with this project.

If you have any questions regarding electronic privacy, please feel free to contact Mark Nardone, NU’s Director of Information Security via phone at 617-373-7901, or via email at privacy@neu.edu.
If you have any questions about this study, please feel free to contact Montana Vasquez-Grinnell Email: vasquez-grinnell.m@husky.neu.edu, the person mainly responsible for the research. You can also contact Quannah Parker-McGowan Email: q.parker-mcgowan@northeastern.edu, the Principal Investigator.

If you have any questions regarding your rights as a research participant, please contact Nan C. Regina, Director, Human Subject Research Protection, Mail Stop: 560-177, 360 Huntington Avenue, Northeastern University, Boston, MA  02115. Tel:  617.373.4588, Email: n.regina@northeastern.edu. You may call anonymously if you wish.

This study has been reviewed and approved by the Northeastern University Institutional Review Board (# TBD).

By clicking on the “accept” button below, you are indicating that you consent to participate in this study. Please print out a copy of this consent form for your records.

Thank you for your time.

Montana Vasquez-Grinnell
Appendix H

Reminder to Complete the Survey Email

Dear Participant,

This is an email to remind you to complete the survey you began. Please use the link below to complete your survey and contribute to this research. You have until *insert time* to complete the survey before it is closed.

Thank you for your participation. If you would like additional information about this study, please email Montana Vasquez-Grinnell at vasquez-grinnell.m@husky.neu.edu or Quannah Parker-McGowan at q.parker-mcgowan@northeastern.edu.

Montana Vasquez-Grinnell
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