

UNIVERSITY OF CALIFORNIA

Los Angeles

The Ties that Bind:

The Experiences of Women of Color Faculty

in STEM

A dissertation submitted in partial satisfaction
of the requirements for the degree Doctor of Philosophy
in Education

by

Ashlee Nichole Wilkins

2017

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ABSTRACT OF THE DISSERTATION

The Ties that Bind:
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in STEM

by

Ashlee Nichole Wilkins

Doctor in Philosophy in Education

University of California, Los Angeles, 2017

Professor Sylvia Hurtado, Chair

As women of color (WOC) enter the science, technology, engineering, and math (STEM) pipeline with aspirations to join the faculty ranks, it is important that the academy is prepared to address their unique needs to ensure they are supported as they engage in scientific and technological research, support students, and advance in their career. Thus, the purpose of this study was to test the theoretical constructs included the Science identity model, and determine how the relationship among the concepts are moderated by race and gender (Carlone & Johnson, 2007). Moreover, the study examines how identity shaped WOC's navigation of the STEM academic

workplace. This study employs a convergent mixed methods design, using Higher Education Research Institute surveys of 272 underrepresented WOC, compared with 544 White men and women, and interviews with 10 WOC participants.

The findings indicate the ways that stress from discrimination impacts the dimensions of *performance* and *recognition* in the science identity model. WOC encounter racism and sexism as they navigate the academy, requiring them to maneuver through hostile work environments. Specifically, participants shared that they had to legitimize their role as a STEM academic because colleagues, leadership, and even students challenged their competence and tried to invalidate their contributions and ideas. Although the WOC who participated in this study experienced challenges, their passion and the intrinsic rewards they received through their roles as professors and mentors added to their strength, resiliency and commitment to STEM.

This study illuminates the voices of an understudied demographic and expands theory about scientific identity development, thereby significantly contributing to both higher education and gender studies. This research has implications for institutional practice because it helps academic leaders understand how WOC STEM faculty navigate the academy and recommends changes that increase the support available for WOC faculty. This research also suggests that department chairs and colleagues have the capacity to challenge the existing culture in STEM so that it becomes equally supportive for all faculty.

The dissertation of Ashlee Nichole Wilkins is approved.

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Dedication

To my Mother

Thank you for your unconditional love and support.

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ACKNOWLEDGEMENTS

I believe that it takes a village to develop a scholar, and I would like to take this time to recognize the many individuals who have supported me throughout my educational career, as well as my time here at UCLA. First and foremost, I would like to give all praises and honor to my Heavenly Father. Without Him, I would not have overcome the obstacles and challenges.

I also would like to acknowledge my mom. Thank you for just being you. You have been my greatest supporter and my most outgoing cheerleader throughout this whole process. I told you one day that I would be a doctor, although I was unsure which type of doctor. I just want to thank you for your wisdom, and for your thoughts and prayers. Also, I would like to thank you for your interest in everything I do. I could not ask for a better mother, nor a better friend like you.

To my grandma: I now see where my fight comes from. I am blessed to have inherited your fierceness. Thank you for your advice and always keeping it real with me.

I am fortunate to have the best uncle ever. Uncle Michael, YOU ARE THE BEST!!! Thank you for always being willing to drive 100+ miles in L.A. traffic, even if it just was to give me a piece of homemade pie and prayer. You have been one of my hugest supporters throughout this program. Most of all, thank you for stepping up to be the father that I never had!

In addition, my family has always inspired me to always strive to be the best version of myself. Thank you for your countless years of support and encouragement.

I certainly cannot forget Tanya, a.k.a. "Dr. Momma Bear:" You have been with me from day one of this program. You made sure that I was always taken care of, not

only through your mentorship but also through your friendship. Thank you for the countless hours and nights that you have spent with me to ensure that my analysis was right for both the project and this dissertation. You have truly served as my maid of honor for this dissertation.

To Abbie, my academic sister: thank you for always having my back both at CSULB and UCLA. It has been an amazing experience going through this program with you. Also to Maggie, my soul sister from CSULB: I am so blessed to have a friend like you who can always keep me grounded. Thank you for truly understanding who I am. Love you, Girl!

Nick, a.k.a. “Flanders,” you are amazing, period! I truly appreciate your friendship and always making me laugh, even during the times that I didn’t want to. Thank you for your countless hours of proofreading each chapter of this dissertation. Others may have faltered, but you were always up to the challenge.

To my True Vine family, thank you for your spiritual guidance. You always provided me with prayer, hugs, and words of encouragement. I’m so blessed to have a church family like you.

Also, to my HERI family, you all ROCK!!! Krystle, you are wise beyond your years and just simply amazing. Damani, you give the best hugs, hands down. Ana, thank you for your gorgeous smile and sharing your love for God with me. Katherine, thank you for your perspective and your ability to develop “sexy” titles... LOL!

To my cohort, thank you for your support throughout the years, and thank you for the birthday party—it meant the world to me!

Sylvia, thank you for your mentorship and guidance. You saw something in me that I did not see myself, and you kept challenging me. It was uncomfortable at first, but you normalized it for me. This helped me take ownership for my capacity to be a scholar. I could not imagine getting this far through this process without you!

Kevin, thank you for lending your quantitative expertise, as well as being willing and always being the person to provide some shade; I still owe you that palm tree... LOL! Most of all, thank you for always being available.

I would like to express my most sincere gratitude to my dissertation committee members Sylvia, Kevin, Jessica and Tracy. Thank you for investing your time, energy, and expertise to ensure that I developed a quality piece of scholarship.

To the individuals, who participated in this study, thank you for sharing your experiences with me. You are truly pioneers, who are blazing the path for the next generation of WOC academics in STEM. I could not have earned this degree without you.

Finally, I would like to thank the Graduate Division at UCLA for the generous fellowship that you provided for this study.

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- Wilkins, A. N.** & Locks, A. L (2014). *Marching towards equity: Access and success for African American college students*. Paper presented at the annual CSULB Educational Leadership Symposium, Long Beach, CA.
- Wilkins, A. N.** & Hamilton, J. P. (2013). *STEM: Working with African-American students from a culturally relevant pedagogy*. Paper presented at the annual Dream Deferred College Board conference, Chicago, IL.

CHAPTER 1 BACKGROUND AND PROBLEM STATEMENT

“Oh no, sweetie, put [your] hand down. We are looking for actual physicians or nurses or some type of medical personnel. We don’t have time to talk to you.”

Although Dr. Tamika Cross (an African-American female physician from the University of Texas) was the first to respond to a medical emergency, the airline attendant prevented her from potentially saving the life of a fellow passenger who began experiencing chest pains during a flight to Detroit. Within seconds after the interaction with the attendant, Dr. Cross heard a request over the loudspeaker for medical professionals to identify themselves by pressing their service button, to which Dr. Cross responded. Perplexed, the attendant reacted to Dr. Cross by saying, "Oh wow, [you are] an actual physician? Let me see your credentials. What type of doctor are you? Where do you work? Why were you in Detroit?" As Dr. Cross explained her title as an OBGYN, a white male identified himself as a physician, prompting the attendant to reply, "Thanks for your help, but he can help us, and he has his credentials."

Although both physicians were qualified to treat the ailing passenger, only one was granted access to assist with the situation (Johnson, 2016). In this case, one could speculate the events that would transpire if Dr. Cross was the only qualified medical professional on board and was prevented from treating the passenger based on her racial and gender identity. This is not just a thought exercise, but rather a real life situation that was featured in the *Washington Post*. Unfortunately, Dr. Cross’ experience was not an isolated incident (Cantor, Mack, McDermott, & Taylor, 2014); rather similar situations are widely-reported by women of color (WOC) faculty in science, technology, engineering, and mathematics (STEM) (Ford, 2011; Johnson, 2011). According to Wible

(2016), “at 30,000 feet, the pressure of an emergency may intensify underlying implicit bias — a deep-seated, unconscious prejudice that affects our behavior.” This acknowledges that there are stereotyped notions of who can be a scientist. Thus, racial and gender identity matters, particularly for WOC STEM faculty. Identity includes access to a certain social world; it is rooted in lived experience based on a specific and collective history of interactions where one is seen and heard as well as seeing and listening (Alcoff, 2006). Social identity is integral to WOC’s socialization, how they see themselves in the world, engage in STEM, and negotiate an environment dominated by white male norms.

Institutions of higher education are drivers of talent and innovation in the fields of STEM (Etzkowitz & Leydesdorff, 2000). However, despite the contributions colleges and universities have made to advancing the production of knowledge in STEM disciplines, WOC face the consequences of severe underrepresentation in STEM fields (Ong, Wright, Espinosa, & Orfield, 2010), which requires them to negotiate their identity as they navigate the academy (Towns, 2010; Turner, González, & Wong (Lau), 2011). Although there has been an increase in WOC entering the professoriate and eventually achieving tenure over the last 30 years, the growth of WOC faculty in STEM is substantially slower than their male and female counterparts who are white (Ong et al., 2010). For example, WOC represent only 2.3 percent of the tenured or tenure-track faculty and 5.1 percent of non-tenure-track faculty, but constitute 12.5 percent of the U.S. population (Ginther & Kahn, 2012). WOC make up an even smaller proportion of faculty in STEM. In all STEM disciplines, Black, Latina, and Native American women make up less than 1% of the faculty body (Towns, 2010). In response to the

underrepresentation of WOC in academic STEM positions and national calls to better support WOC who achieve entry into the professoriate, federal agencies and institutional leaders have urged for policies and initiatives aimed at bolstering the representation of WOC (Torres, 2011). Indeed, WOC represent a pool of untapped talent that can help drive scientific and technological innovation and significantly support the United States' position as a global leader (CEOSE, 2011).

There is a wealth of literature regarding the factors that perpetuate the general underrepresentation of women of color (WOC) within the STEM disciplines, which includes recommendations for developing initiatives and interventions at the undergraduate and graduate levels that facilitate their pathways into careers in academia (Kisselburgh, Berkelaar, & Buzzanell, 2009; Mills, Franzway, Gill, & Sharp, 2014; Putnam et al., 2009). Thus, the assumption is that once they achieve a faculty position they are on the pathway to success. However, it is equally important to explore how the intersection of race and gender shape experiences of WOC as they navigate their faculty roles in order to generate innovative solutions to support their success throughout their academic careers. Underrepresentation is exacerbated by stalled progress among WOC. For example, WOC experience lower rates of achieving the rank of tenured full professor positions than their male and white counterparts (Ponjuan, Conley, & Trower, 2011). They also encounter systemic issues such as climate barriers (e.g., working in unsupportive work environments), and earning lower pay than male colleagues for equal work (Metcalf, 2015).

There is minimal scholarship that documents the ways identity impacts the career trajectories of women of color in STEM fields in academia (Ong et al., 2010). Moreover

the existing literature related to the faculty careers of STEM WOC is more qualitative in nature, and this phenomenon has not been examined using quantitative and mixed-method studies (Ong et al., 2010). Previous research indicates that factors that serve as barriers to persistence for WOC in STEM, including hostile STEM departments, absence of support systems, and time management conflicts (Gappa, Austin, & Trice, 2007). Issues related to the tenure process, including the criteria committees use in determining tenure and promotion and the focus on productivity, are also challenges that WOC faculty encounter (Gappa et al., 2007).

Given the lack of literature that focuses on WOC in the academy, particularly in STEM, this study draws from different bodies of literature related to women and faculty of color in STEM to get a sense of the ways social identity impacts WOC faculty in STEM. Women faculty in STEM disciplines are required to meet high expectations to acquire and maintain significant levels of grant funding—in addition to navigating workplaces where they must encounter various forms of discrimination (Anderson, Ronning, De Vries, & Martinson, 2007). These expectations can add pressure that can detract from their intentions from persisting within the academy. Moreover, women experience barriers resulting from implicit bias (Burrelli, 2008; Gappa et al., 2007), unequal access to resources (such as lab space), and for some, familial responsibilities that may interrupt the tenure clock (Rosser & O'Neil Lane, 2002). Furthermore, faculty of color report other challenges that impede in their abilities to persist within the academy. For example, they often encounter cultural taxation, which refers to the implicit responsibility that is placed on faculty of color to address issues related to minority affairs (Padilla, 1994); tokenism—feelings of isolation that is typically

associated with belonging to a “society of one” (Essien, 2003) as the sole underrepresented racial minority in a department; and the tensions that arise from feeling the need to code switch—a term that describes the modification of “parts of their separate value system to different situations as appropriate” (Sadao, 2003, p. 410).

In general, previous scholarship has revealed extensive barriers women and faculty of color confront in academia and strategies they use (e.g., becoming astute of the workplace politics, and participating in shared governance) (Austin, Sorcinelli, & McDaniels, 2007; Gappa et al., 2007; Stanley, 2006). However, this often aggregates men of color with WOC or White women with WOC treating both groups the same when in fact WOC represent a distinct group with distinct needs and challenges. Indeed, a major limitation of these types of studies is that they lack a nuanced understanding of how race and gender identity shapes their experiences as STEM academics (Gappa et al., 2007). More specifically, the literature fails to address how WOC faculty in STEM act upon their intentions to remain in the academy given the unique barriers they encounter, especially at research institutions. The limitations found within the literature presents an opportunity for this study to investigate the personal, structural, and disciplinary related barriers WOC face and their strategic response to these barriers as in the academy.

Thus, it is critical to clarify the mechanisms that support WOC faculty in STEM if institutions of higher education are committed to creating an environment that is conducive to fostering the scientific talents and persistence of all STEM faculty. Notwithstanding the absence of scholarship on WOC faculty in STEM disciplines, much investment and significant financial resources continue to be appropriated at national, institutional, and individual levels to ensure their success within the academy (CEOSE,

2011; NSF, 2012a). Thus, it is possible that such resources are not being utilized to their fullest potential, given that they are not informed by empirically-based studies.

Purpose of the Study

As WOC enter the STEM-pipeline with aspirations to join the faculty ranks, it is important that the academy is prepared to address their unique needs to ensure they are supported as they engage in scientific and technological research, support students, and advance in their career. Although the benefits of expanding the pool of talented women within the academy are well documented (Buzzanell et.al, 2015), few studies have explored how WOC STEM faculty make meaning of their multiple identities in relation to their professional experiences. Thus, the purpose of this study is to examine how the theoretical constructs included with the Scientific Identity model (i.e. *competence*, *performance*, and *recognition*) are related, and how the relationship among these three concepts are moderated by the intersection of race and gender roles (Carlone & Johnson, 2007). Gender refers the collection of socially-constructed perceptions an individual holds about their membership in a gender category (Settles, O'Connor, & Yap 2016). Racial identity is grounded in the perception that an individual shares a common racial heritage with a specific group (Helms, 1995; Jernigan, Green, & Helms, 2016).

Moreover, the study will attempt to understand how WOC navigate the STEM academic workplace. This study will provide information to identify and explain how to minimize the barriers that can cause WOC to exit the academy, and better leverage those mechanisms that promote their success. Considering the purpose of this study, the specific research questions I seek to address are:

- 1) Given identified theoretical dimensions of science identity (*competence*, *performance*, and *recognition*), how are these interrelated concepts moderated by race and gender? Which aspects are central to WOC?
- 2) How does racial and gender identity shape WOC experiences as faculty in STEM?
- 3) What strategies do WOC use to successfully navigate the academy?

Scope of the Study

To meet the aims of this study, I employed a convergent mixed methods design to provide a richer understanding of the ways participants make meaning of their identities as they navigate the academy. Quantitative data was drawn from the HERI faculty survey, which includes a sample of 272 underrepresented WOC, which was compared with White women and men in similar fields and institutions. Theory was used in this study deductively to verify the factors and test the theoretical constructs of *competence*, *performance* and *recognition*, proposed by Carlone and Johnson (2007) in their scientific identity model for WOC. Additionally it was used inductively as a guide in terms of expanding the current science identity model to reflect the experiences of WOC during their careers (Creswell, 2009). The original model examines the experiences of WOC over the span of their undergraduate and graduate studies into their careers, and suggests that WOC in STEM are required to uniquely navigate their academic and work spaces. Further, according to the theoretical model, science identity is shaped by the interpretation WOC ascribe to their unique experiences in science domains. The model highlights the interplay of *competence*, *performance*, and *recognition*. Given the theoretical model focused on the undergraduate and graduate academic experiences of

WOC in STEM, I investigated aspects of the model that could be validated with a sample of WOC faculty; and seek to modify or extend the model where necessary so that it more accurately captures the career experiences of WOC and the ways that race and gender identity is integrated with a science identity.

Scope of Quantitative Phase

I will use a national sample to identify comparable groups from data. The sample includes 816 STEM faculty (i.e. WOC, White men and White women), 272 of which were identified as WOC. It also included data on faculty employed in 78 institutions of varying selectivity who are at various career stages. I selected a comparative sample of STEM faculty at the same campuses where WOC are and who are in similar disciplines, drawing from two administrations of the faculty survey that had 11,039 faculty.

Using items from the faculty survey to serve as measures for the theoretical constructs of *competence*, *performance*, and *recognition*, I conducted structural equation modeling (SEM) to investigate how the constructs are interrelated. Previous research posits that there may be a link between *performance* and *recognition* (Carlone & Johnson, 2007), but this finding has not been confirmed by empirical data, nor has it been validated using a national sample of WOC STEM faculty.

Scope of Qualitative Phase

Interviews included 10 WOC faculty in STEM at two institutions, with specific questions focused on identifying how the theoretical constructs of *performance*, *recognition*, and *competence* are informed by their dual identities as being underrepresented across both racial and gender lines in a environment traditionally dominated by White males. The participants are tenured, or employed in tenure-track

faculty positions, within STEM disciplines (e.g. biological sciences, physical sciences, mathematics and engineering) at Ace and Paradise Universities.

Mixing of Methods. Quantitative data do not provide sufficient contextual information about identity in context, and qualitative data alone are typically not sufficient for producing generalizable findings. Together they help to fill the gaps in research (Creswell & Plano Clark, 2011). The *convergent approach* is described as the simultaneous collection of both quantitative and qualitative data (Creswell & Plano Clark, 2011). Findings from the qualitative analysis were compared to findings yielded from the quantitative analysis. Thus, an equal amount of emphasis was placed on both types of analysis. Hence, qualitative analysis integrated within the study's design was equally rigorous and was used to confirm, counter, and expand on the results yielded within the quantitative analysis (Creswell and Plano Clark, 2011). In addition, the qualitative strategies used in study significantly deepen our understanding of the relationship between aspects of the science identity model. Future scholarship can use the findings from this mixed methods study to advance theory and improve studies that are statistically generalizable across various institutional contexts. Furthermore, this convergent design was ideal for examining the understudied topic of the experiences of WOC who enter and navigate their positions as faculty in STEM departments, so that it may spur the adoption of practices unique to supporting their persistence within the academy.

Significance of the Study

To ensure that nation is able to compete globally, it is critical that the US “draw on the minds and talents of all Americans, including minorities who are

underrepresented in S&E [science and engineering] and currently embody a vastly underused resource and a lost opportunity for meeting our nation's technology needs” (NRC, 2011, p. 2). Also, the anticipated large retirement wave of White males presents an opportunity for WOC to increase their representation within the STEM workforce, especially in faculty roles (Chubin et al., 2005; Millett & Nettles, 2006). Therefore, this study is significant because it offers recommendations that bolster the success of an understudied demographic group that contributes to technical and academic excellence within the STEM disciplines. More importantly, this study denotes the ways that WOC are not like other scientists, but they are *still* scientists and play a pivotal role within the academic and scientific community.

As mentioned earlier, the federal governments and universities invested resources with the aim of supporting the persistence of WOC STEM faculty. However, given the limited body of literature that empirically addresses the experiences of WOC faculty in STEM, it is probable that most initiatives aimed at supporting their persistence are grounded in and developed in part on approaches largely based on anecdotal examples. Thus, it critical that this topic is rigorously investigated using empirically-based evidence to distinguish the ways that identity shapes WOC faculty experiences in STEM.

Although studies have investigated factors predicting the success for WOC in STEM by looking at completion of undergraduate and graduate programs, few have examined their career experiences in academia through the use of a mixed method research design. A research design that includes both quantitative and qualitative data is needed to understand the barriers they face and the strategies they use once they

enter the STEM faculty pipeline. This study illuminates the voices of an understudied demographic and expands theory about scientific identity development, thereby significantly contributing to the literature base. This research has implications for institutional practice because it helps academic leaders understand why their WOC STEM faculty may decide to leave academy and allows them to begin making changes that increases institutional support available for WOC faculty. This research also highlights the capacity of institutional leadership to challenge the existing culture in STEM so that it becomes equally supportive for all faculty members.

CHAPTER 2: LITERATURE REVIEW

This study seeks to understand the role race and gender play in WOC STEM faculty navigation of the academy and workplace. Thus, it is important to discuss how existing scholarship has contextualized the current state of academia that often perpetuates the obstacles WOC face. The previous chapter discussed the emergence of WOC as a group whose contributions to both STEM and the academy have captured the attention of institutions of higher education and the government alike. Although the recruitment and retention of WOC as STEM academics has garnered national interest, colleges and universities have yet to achieve their goal of attaining full representation of WOC faculty in the STEM disciplines. To develop a more robust understanding of the interplay of WOC's identity on their experience as STEM faculty, it is important to unpack the multiple contexts that impact their realities. Thus, the literature review has been divided within major sections. The first section will review the experiences that largely impact STEM faculty. In the second section, I will discuss the outlined experiences that are common to women within the STEM disciplines. Third, I will expound on the institutional and workplace factors that present barriers for faculty of color. Fourth I will discuss issues related to identity for WOC STEM faculty. When taken together, this review of the literature will not only provide an in-depth understanding of existing studies that focus on how WOC's multiple aspects of their racial and gender identity shape their experiences faculty, but it will also will highlight the critical areas that have been excluded from the literature and address questions that have gone unanswered.

STEM Faculty

The focus of the literature review is first to describe the environmental context that impacts faculty in the academy, particularly highlighting the challenges and culture that is characteristic of the STEM disciplines. Although these sections address faculty in general, it still has implications for WOC faculty. The challenges that WOC uniquely face will be discussed in-depth later in this literature review. Scholars suggest that faculty in STEM have a set of unique experiences and challenges that are not typically encountered by their colleagues within the arts, humanities, and social sciences. Although the challenges faced by STEM faculty are varied, this literature will focus on issues related to workspace, expectations in research universities (e.g. securing grants), and traditional STEM culture.

Workspace Challenges

Existing studies suggest that faculty in the science and engineering disciplines experience issues related to workspace. In general, STEM research typically necessitates lab space that is equipped with high-tech equipment and current technology (Austin et al., 2007). Acquiring sufficient laboratory space, adequate equipment and materials to carry out research are crucial for STEM faculty, especially for those who are in the process of earning tenure. Yet, faculty research indicates that their work is often disrupted and time is lost due to the process of purchasing and the installation of the equipment—when the labs should be already established and supplied with adequate equipment prior to the hiring of a faculty member (Austin & Rice, 1998). Hence, faculty's eligibility for tenure and/or promotion can be impacted when a department is unable to provide faculty with the appropriate equipment, materials, or

space required to carry out their research (Austin & Rice, 1998; Austin et al., 2007). As a result, faculty are likely to exit the academy because they are not provided the resources needed to support their performance. Many faculty choose to enter industry where space and material resources are provided (Austin et al., 2007).

Stressors related to funding and scholarly productivity

Aside from the issue of being provided an adequate workspace, STEM faculty experience stressors resulting from the strong expectations to secure external funding through grants contracts, in addition to maintaining their scholarly productivity.

Anderson et al., (2007) qualitatively explored the lived experiences of 51 early- and mid-career science faculty in an effort to understand the impact of competition on relationships and work. Findings from the study suggested that the emphasis that was placed on scholarly productivity supports a competitive culture within the science discipline and departments. To clearly articulate this phenomenon of competition, a participant within the Anderson et al., (2007) study reported: “You’ve got to have a billion publications in my field. That is the bottom line. That’s the only thing that counts. You can fail to do everything else as long as you have lots and lots of papers” (p. 443). Another participant added: “If you need one more grant to solidify your rank and tenure package, you may [need to] violate your personal integrity” (Anderson et al., 2007, p. 456).

As previously mentioned, there is a constant pressure for STEM faculty to secure external funding to support their research agenda (Anderson et al., 2007) and as a means to produce rigorous scholarship. This places faculty, especially those in the early stages of their career, in a peculiar situation, given that funding for STEM research is

becoming increasingly scarce due to heightened competition of both academic and STEM professionals in industry who compete for it (Austin et al., 2007). The issue of securing external funding and scholarly productivity are often heavily weighted in tenure and promotion decisions. Given the value that is placed on funding, it is not uncommon for STEM faculty to manipulate their grant proposals in a way that leads the reviews to believe that their research aims and skillset reflects the call for proposals (Anderson et al., 2007). Faculty are particularly subjected to gaming the system “in order to get funded” (Anderson et al., 2007). In a corresponding example, a participant in Anderson et al.’s (2007) study noted that one of the faculty is “really a breast cancer researcher, but they go after the prostate money because that’s where [the funding] is at. And they don’t have the theoretical knowledge and skills, but they end up going down that path” (p. 447). Scholars document that the dynamics found within the STEM community and disciplines are steadily shifting, where the act of attaining grants and other sources of external funding (previously considered to be an intellectual exercise) has now evolved to a concentrated battle of scarcity (Goodstein, 2002; NSF, 2012b).

STEM Culture

The competitive nature found within the STEM disciplines shapes the experiences of faculty. Competition typically promotes adversarial, departmental, and institutional politics; the deterioration in collegial interactions that lead to the sharing of information and resources; sabotage within the tenure and review process; and unethical research practices (Anderson et al., 2007). The development of a collegial environment can be challenging due to the competitive culture. A report within the Institute of Medicine (2002) stated that since “science is a cumulative, interconnected,

and competitive enterprise, with tensions among the various societies in which research is conducted, now more than ever researchers must balance collaboration and collegiality with competition and secrecy” (p. 25).

Competition among STEM faculty for external funding, positions and reputation are typically characterized as fixtures in the United States. This emphasis on prestige has negative effects on the scholarship, research and relationship with other colleagues (Anderson et al., 2007). Scholars contend that the conditions of the STEM disciplines that leads to hyper-competition can also be attributed to the Euro-centric and Western influence, which historically has favored socially constructed ideas of masculinity (Ong, 2005; Xu & Martin, 2011). Despite the fact that gender and racial/ethnic diversity in STEM has improved within the previous decade (Ong et al., 2010; 2011), inequitable treatment regarding women and faculty of color, and WOC still exist due to their underrepresentation (Burrelli, 2008; Gappa et al., 2007; Ong et al., 2010; 2011; Rosser & O’Neil Lane, 2002).

The STEM environment has the potential to complicate how faculty navigate the academy, and how these challenges work to counter their efforts to carry out their work responsibilities. Issues related to workspace needs, stressors related to the strong emphasis placed on funding and scholarly productivity, and factors that play a pivotal role in influences the culture within the STEM areas. However, it is important to consider how other aspects of WOC’s identity shape their experiences within the academy, specifically the role of gender within the STEM disciplines. The subsequent section will review the experiences and challenges that are unique to women faculty in STEM.

Women Faculty in STEM

There has been substantial progress in the recruitment and retention of women faculty members within the STEM disciplines. Within the span of the last three decades, women in STEM have increasingly climbed the ranks to achieved their position as faculty. The proportion of women STEM faculty that are in full-time tenured or tenure-track positions has risen from ten in 1970 to 26 percent in 2006 (Burrelli, 2008). The promotion of women to the full professor level within the STEM disciplines has also increased from five percent in 1973 to 19 percent in 2006. However, female STEM faculty still appear to be largely represented within instructor and assistant professor ranks (42%) than associate (34%) or full professor (19%) ranks, in comparison to their male counterparts who hold the similar positions (Burrelli, 2008).

Obstacles Faced by Women Faculty in STEM

Notwithstanding the increase in representation for women faculty in STEM, scholars suggest that two key obstacles are detrimental to their performance within the academy: the failure of achieving an effective work-life balance and the quality of their professional networks (Rosser & Taylor, 2009).

Work-life balance. The literature defines work-life balance as the aptitude to manage one's professional and personal responsibilities in a congruent way. The traditional strict nature of the tenure-track structure is reflective of norms that are more accommodating for male faculty (Gappa & MacDermid, 1997). However, in modern society and the academic work environment, dual income households replaced the standard of the "ideal worker"—traditionally characterized as a male with a wife to manage personal and familial responsibilities) (Gappa et al., 2007). It is now common

for both men and women faculty alike to be a part of households where both partners are in professional careers and must manage striking a work-life balance (Gappa et al., 2007). Parts of this balance include: managing familial obligations such as being a good partner, a parent, or a caregiver of a relative(s); and an active member within the community. Thus, these stressors significantly impact women faculty in STEM given that they must also deal with the demands of working in a very competitive discipline (Gappa & MacDermid, 1997; Austin et al., 2007). For example, studies that examine the impact of a workplace stressor on faculty's personal life found that women report they carry work issues into home life (Oslen, 1993; Sorcinelli & Near, 1989).

Women faculty also encounter tensions that exist between pursuing academic careers in STEM that are structured for individuals who have an unrestricted availability to work, which often calls for sacrifices in terms of one's personal life or family (Brown et al., 2003; Trower, 2008). Thus, taking time off for personal or family reasons—such as taking care of children or elderly relatives — puts one at risk of being perceived that her career goals are not a priority (Rosser, 2004). Work-life balance problems also impact the family planning decisions of female professors (Rosser, 2004; Trower, 2008), particularly for WOC who are inclined to have more obligations to their extended relatives and communities (Edmondson Bell & Nkomo, 2002). Women who exit the STEM career pipeline often report struggles with balancing both work and family responsibilities as a key reason for their decision to leave (Preston, 2004).

In general, it is important to note that both men and women faculty report the need to better manage their personal and professional affairs. However, when it comes to personal matters such as the decision to have children, women are more likely to be

placed at a disadvantage career-wise compared to their male faculty counterparts (Gardner, 2013). Women faculty often face the dilemma of whether or not to delay their intentions to start a family, especially having children, until after they earn tenure (Liang & Bilimoria, 2007). This provides additional stressor for many women, given that they are expected to meet the at-times ambiguous performance measures associated with the tenure process—all within a rigid timeframe due to the fact that their peak fertility years often overlap with their pursuit of tenure and promotion (Ceci & Williams, 2007; Handelsman et al., 2005; Rosser, 2004). According to Mason and Goulden (2002), male faculty members who had children within five years of earning their Ph.D's are 38 percent more likely to attain tenure than compared to their women peers who shared similar career and familial trajectories. Furthermore, only one-third of women who started the tenure process at research-intensive institutions before starting a family actually had children children (Mason & Goulden, 2002).

The ability to manage both work and personal responsibilities is particularly a major challenge for women faculty within the STEM disciplines (Schiebinger and Gilmartin (2010),). Rosser(2004) found that the majority of the women STEM faculty in the study reported that the most salient barrier to promotion is the desire to manage a healthy work-life balance. Furthermore, the literature on women faculty in STEM suggest promotion was impacted for women STEM faculty with younger children as a result of prioritizing familial obligations over work, a finding that significantly differs for their men faculty peers (Xie and Shauman, 2005). Factors that complicate the challenges for women faculty in STEM are related to preconceived gendered norms and institutional/departmental cultures. More specifically, the academy continues to utilize

traditional hierarchical structures and support cultures that benefit men faculty members (Schlehofer, 2012). These structures are especially ingrained within the male dominant disciplines such as the science and engineering disciplines (Schiebinger and Gilmartin (2010). The myth that great scientists and engineers prioritize their work responsibilities over home-life, have minimal external obligations or interest, and the mono view of how research ought to be conducted has been dispelled, but is still very much pervasive within the STEM academic disciplines (Fox, Fonseca, & Bao, 2011).

Moreover, female STEM faculty are often subjected to work in an environment that perpetuates implicit bias, since many institutional policies fail to acknowledge the span of common issues that a majority of tenured and tenure-track faculty encounter. In comparison to other countries, STEM professionals and academics in the United States “have limited federal and institutional supports for childbearing and or raising a family, such as paid leave for men and women, daycare resources, and the preservation of academic positions while faculty are on leave” (Rosser and Taylor, 2009). This is also reflective of the current terrain, which can be observed through policies and practices at many research-intensive universities. Moreover, socially constructed gender roles and norms associated with managing home-life intensify the challenges of work-life balance for women. While men are increasingly undertaking a greater proportion of domestic duties than in previous years, the bulk of the responsibilities of child-rearing and caregiving remain assigned to women (Nelson-Gray, 2012; Schiebinger & Gilmartin, 2010).

Although women have experienced significant career improvements in career advancement within recent years, the aforementioned gender norms are still true for

women faculty in STEM. Indeed, research indicates that there is still a visible division of household duties (Schiebinger and Gilmartin, 2010). Scholars note that women faculty in STEM undertake nearly 50 percent more of the duties related to housework than their male faculty peers . More specifically, female STEM faculty who are in committed relationships at elite research-intensive institutions report doing 54 percent of the cooking, cleaning, and laundry in their households; while their male faculty peers reported doing 28 percent of the same duties. This equates to a little over 10 hours a week for women— in addition to the 60+ hours a week that they allocate to their work— compared to five hours of housework for men (Schiebinger and Gilmartin, 2010). Research implicates housework and personal responsibilities as being major for the academy, because the additional hours per week may have influenced women faculty's career trajectories, including impeding their performance that eventually leads to tenure or promotion (Schiebinger and Gilmartin, 2010).

Developing Networks. Women STEM faculty often experience challenges in building and preserving professional networks. Disparities in receiving referrals from networks to engage in industry as a consultant, serve on advisory boards, and interact in other ways within their respective fields of expertise remain a reality for women faculty in STEM (Rosser & Taylor, 2009). Even though research suggests that both formal and informal mentoring structures provide access to resources, and opportunities are crucial in advancing the careers of faculty (Gorman, Durmowicz, Roskes, & Slattery, 2010; Karukstis, Gourley, Wright, & Rossi, 2010), women faculty are less likely to enter within mentoring type relations, which typically has a disparate impact on outcomes related to promotion (Bhatia & Amati, 2010; Rosser & Taylor, 2009). There is also a

limited pool of women role models for faculty members, especially within the physical sciences and the engineering community (Bhatia and Amati, 2010). This is unfortunate, especially since the physical sciences and engineering have been known to be highly demanding disciplines (Karukstis, Gourley, Wright, & Rossi, 2010). Female faculty may perceive engineering as an unwelcoming discipline due to the lack support and mentorship from other women (Gardner, 2013). This issue of mentorship appears to be an issue that is found across the STEM disciplines. For example, Blood et al. (2012) cited that of the 1,179 women faculty who responded, “54% had a mentor, and 72% without a mentor desired mentoring. The most important mentor characteristic identified was availability” (p. 1).

Hostile environments. Aside from the pressure of managing work-life balance and the lack of mentorship, women faculty in STEM often encounter both overt or subtle discrimination, sexual harassment, implicit gender bias, exclusion from research opportunities and leadership roles and decision-making, and departmental climates that are unreceptive, or “chilly” (Bode, 1999; Bystydzienski & Bird, 2006; Ceci & Williams, 2011; Hill, Corbett, & Rose, 2010; Liang & Bilimoria, 2007; Rosser, 2004; Settles, Cortina, Stewart, & Maley, 2007). These adverse experiences shape female STEM faculty’s propensity to expand their collegial relationships. Hence, this may influence their opportunity to build beneficial professional networks within the STEM community, which is typically dominated by men.

Faculty of Color

Scholars argue that faculty of color encounter an array of challenges as they navigate academia. Although the literature highlights that these challenges are unique

to specific context, it is important to note that common barriers exist that contribute to their decision to exit the academy. Racism is the primary barrier, which manifest in microaggressions and stereotype threat (Jean- Marie & Lloyd-Jones, 2011; Stanley, 2006), in addition to racial battle fatigue. These are just a few of the of the many issues they encounter. It is these racialized experiences that feed in to institutional and departmental climates, which in turn cultivate workplace environments that are hostile and unwelcoming for faculty of color (Turner & Gonzalez, 2008). Noteworthy, existing research on faculty of color in academia often consolidates their experiences which are then evaluated within a White/non-White binary. Perhaps due to their small numbers in academia, faculty of color are often perceived to be a singular group, which neglects the diversity that is found within each major racial group. This is unfortunate given that other bodies of literature (e.g. sociology, psychology, etc.) acknowledge the heterogeneity found within the experiences of people of color (Tuner & Gonzalez, 2008). It is imperative that education address this limitation within the literature exploring the unique narrative of faculty of color, which recognizes the intersection of gender, race, and field of expertise, academic rank, and institutional context. However, given that very few studies examine the experiences of faculty of color in STEM, let alone the disaggregation by race and gender, this section will focus on the literature as it relates to the issues that faculty of color generally face in academia.

The collectivizing of faculty of color as a group can contribute to the insights of several historically marginalized groups, and can aid in a broad understanding of the experiences of WOC. More specifically, there are three major challenges that transcend across scholarship on faculty of color in academia: microaggressions, stereotype threat,

and tokenism. This section will begin by providing an in-depth description of each major challenge and how it relates to faculty of color. Next, a discussion centered on how these challenges shape the experiences of faculty of color will also be included.

Microaggressions

Literature that explores the underrepresented populations within the academy often points to unsupportive institutional and departmental climates as primary factors that people of color's decision to continue or abandon their academic position (Tuner & Gonzalez, 2008). Specifically, faculty of color often are encounter racial microaggressions—"brief and commonplace daily verbal, behavioral, and environmental indignities, whether intentional or unintentional, that communicate hostile, derogatory, or negative racial slights and insults toward people of color" (Sue et al., 2007, p. 271). Hubert-perez and Solorzano argue that microagres manifest in " everydayracist events that are systemically mediated by institutionalized racism (i.e. structures and processes), and guided by ideologies of white supremacy" (p .298).

It is important to highlight that microaggressions can be very elusive; however, faculty of color must navigate spaces where they are constantly receiving messages from colleagues and leadership which can lead them to feel isolated and devalued (Solorzano, Ceja, & Yosso, 2000). Scholars propose the racism and discrimination still permeates within structures; however, covert racism is more prevalent wherein individuals engage in behaviors and practices that support implicit bias (Sue et al., 2007).

Individuals often use microaggressions often when they interact with underrepresented racial minorities (Sue et al., 2007). It is important to note that

microaggressions can be unintentionally perpetuated by colleagues and leadership, particularly from the dominant group, who view themselves as being liberal and/or aware of the racialized interactions that people of color encounter (Goodman 2001; Wise, 2008). Sue et al., (2007) suggests that, “most White Americans experience themselves as good, moral, and decent human beings who believe in equality and democracy. Thus, they find it difficult to believe that they possess biased racial attitudes and may engage in behaviors that are discriminatory” (p. 275). Thus, acts of microaggressions are typically rationalized using reasons that may appear to be unbiased or valid—a consequence of the covert nature of this subtle discrimination (Sue et al., 2007)

Microaggressions are categorized within the literature divided in three distinct areas: microassault, microinsult, and microinvalidations. According to Sue et al., (2007) microinsults and microinvalidations are usually subtle and happen at the unconscious level, while microassaults are typically intentional and directed at persons of color. More specifically, microassaults are obvious racial derogations that are typically carried out by a verbal or nonverbal attack and deliberately aimed to harm the victim via name-calling, isolation, or directed discriminatory practices (Sue et al., 2007). Microinsults are messages that are disrespectful or insensitive and degrade an individual’s race or any aspect of their identity. Microinsults are defined as subtle offenses that undoubtedly communicate an insulting message regarding people of color (Sue et al., 2007). Lastly, microinvalidations are “characterized by communications that exclude, negate, or nullify the psychological thoughts, feelings, or experiential reality of a person of color” (Sue et al., 2007, p. 274). For example, forms of microaggressions for Black people include

being ostracized or intentionally excluded, being referred as a divergent (in terms of success), and misjudging their knowledge, skills and abilities (Torres-Harding et al., 2012). Latino/as are also often microaggressed wherein they are subjected to unfavorable messages associated with the Spanish language or speech quality, inaccurate generalizations and stereotypes about the Latino/as population, and interrogation about their credentials and qualifications (Torres-Harding et al., 2012). As a result of navigating environments where microaggressions go unchecked, persons of color experience larger degrees of racial tension and increased stress resulting from microaggressive acts, mistrust, and reduction in self-esteem (Torres-Harding, Andrade, & Diaz, 2012; Sue et al., 2007).

Stereotype threat

Steele and Aronson (1995) defined *stereotype threat* as the vulnerability of affirming a negative stereotype given to the group with which one identifies. Research indicates that people are more likely to experience lower performance when they internalize the stereotyped ideas of their racial or gender reference group, in comparison to their peers who are in spaces that mitigate the impact of stereotype threat (Aronson & McGlone, 2009). Furthermore, the scholarship suggests that the presence of stereotypes cultivates an unsafe environment for historically marginalized groups, for fear that their actions or input could be analyzed through the lens of low expectations (Inzlicht & Schmader, 2012). However, the level of threat that one might experience is determined by individual differences, including awareness levels (Aronson & McGlone, 2009).

Aside from its effects within the educational context, stereotype threat affects African Americans' willingness to seek and receive constructive feedback within the workplace (Roberson, Deitch, Brief, & Block, 2003), and researchers found a significant relationship between being the only minority within a work setting (solo status) and perceived prevalence of stereotype threat. The authors attributed the findings to the absence of other individuals from the same minority group within the workplace, which often led to a profound awareness of one's ethnic identity and increasing their susceptibility to stereotype threat. Indeed, faculty of color are susceptible to internalizing stereotype threats that may negatively affect their performance because of their experiences of being the only member of their race that also involves discrimination and stigmatization (Niemann, 1999). Hence, the challenges faculty of color encounter comprise of two types of undermining: intentional sabotage on the behalf of others, and the self-undermining of competence and performance (Nieman, 1999).

Tokenism

Scholars contend that tokenism happens when individuals from minority groups comprise 15 percent or less of the total employee population within the work environment (Neimann, 2011). Faculty of color experiences are shaped as a result of their token status (Turner & Gonzalez, 2008). Tokenism contributes to many negative outcomes for people of color, including isolation and loneliness, hyper visibility, and placement in roles on the basis of representation (e.g. diversity committee) (Niemann, 2011). As a result of being underrepresented within the academy, faculty of color are often choose to self-censor or negotiate their ideas and thoughts due to their tokenism (Nieman, 2011). Existing research on the recruitment and retention indicates that faculty

of color share common experiences related to being tokenized, even though the academy is preserved as a progressive context wherein individuals are encouraged to freely convey their thoughts (Thompson, 2008). This occurs because the conversations and actions of those who are tokenized are “easier to recall than are those of more homogenous group members, placing them on constant guard about the implications of their words, behaviors, and very presence” (Niemann, 2011, p. 218). In many cases, faculty of color decided to engage behaviors that mirror their White colleagues in an effort to establish their legitimacy (Aguirre, 2000).

The tokenized status of faculty of color impacts both their professional and personal domains (Gutierrez y Muhs, Niemann, Gonzalez, & Harris, 2012). Furthermore, the effect of tokenism is especially prevalent in predominantly White institutions (Niemann, 2011), since faculty of color are typically the only academics within their disciplines who identify with their racial and/or ethnic background (Stanley, 2006). Tokenism has also been cited to contribute to increased participation within service-type responsibilities of faculty of color because they reflect diversity on committees within classroom setting (Cooper & Stevens 2002; Stanley, 2006). Hence, exhaustion and marginalization is commonplace within the academy, given that the same faculty are typically called upon for these diversity efforts (Turner & Gonzalez, 2008). Tokenism also compromises the cognitive health of faculty who belong to minority groups (Stanley, 2006). The academy fails to provide safeguards for faculty with tokenized statuses; therefore the effects stemming from tokenism are compounded with the existing stressors of integrating or assimilated to the institutional or departmental culture, and time is given to reflecting to these experiences (Niemann,

2011).

Women of Color Faculty in STEM

Women are disproportionately underrepresented both within the STEM disciplines and the academy. However, a disparity exists between the representation of White women and WOC in the professoriate overall and in the STEM fields specifically (Ponjuan, Conley, & Trower, 2011). The gap in representation for WOC (7.9%) becomes more visible when compared to White females (34%), White males (41.3%), and males of color (8.4%; Mertz, 2011). In STEM, women's representation in the professoriate decreases as faculty rank increases (Trower, 2011). Additionally, WOC encounter challenges more frequently than men of color and White women faculty (Mertz, 2011). Given that WOC are in a unique position of having a multiple marginal status, they face greater service responsibilities, such as being called to participate on committees, because they symbolize racial and gender diversity (Stanley, 2006). Furthermore, STEM faculty members that are WOC must navigate students' narrow perceptions of their authority and academic credentials (Aguirre, 2000). They are frequently met with hostile class environments and are challenged by students that question their competence and authority within the STEM community (Gutierrez y Muhs et al., 2012). WOC are also virtually invisible within the leadership ranks within academia. Historical and deeply rooted power structures within the academy perpetuate the marginalization of WOC. For instance, senior leadership positions within the academy are traditionally male dominated. This lack of diverse perspective results in biased hiring decisions that oftentimes favors men over women, and Whites over underrepresented racial populations (Allen et al., 2002; Keith-Spiegel, Whitley, Balogh,

Perkins, & Wittig, 2002). Thus, WOC are placed at a disadvantage during the faculty hiring process because they are not male, and come from underrepresented racial populations (Mitchell and Miller, 2011).

To illustrate the underrepresentation of WOC within the STEM academic areas—specifically Black, Latina, and Native American women—makes up less than one percent of STEM faculty positions (Towns, 2010). Moreover, when accounting for tenured or tenure track faculty at the top 100 research-intensive institutions, there were only 55 Black women in STEM faculty roles. Latina faculty appears to be slightly more represented with 89 scholars who are in the STEM disciplines at the top research institutions (Towns, 2010). Thus, it is highly likely that some top institutions have zero women of color within their faculty ranks. When the scope is narrowed to 50 US STEM departments at research-intensive institutions, only 88 out of 14,400 tenured or tenure-track positions are assumed by women of color faculty—the same group was composed of 1,590 faculty who identify as White women (Nelson and Brammer's, 2010). It is important to note that women of color are visibly underrepresented as members of the faculty body in the STEM disciplines. As previously mentioned, women in general have experienced significant gains in terms of their visibility in the academic STEM discipline. However, the academy had experienced the higher degree improvement with respect to White women's representation within STEM, compared to women of color STEM scholars (Turner, Gonzalez, & Wong, 2011). The aforementioned brief statistical overview illuminates how women of color are disproportionally underrepresented within the professoriate overall, and especially within the STEM disciplines.

Issues Women of Color Faculty Encounter in STEM

The foundational study on the experiences of WOC in STEM, *The Double Bind: The Price of Being a Minority Women in Science*, indicates that women of color are subject to significant stressors as a result of them concurrently experiencing gender-related issues as faculty women, and racial-related barriers as minority faculty in STEM (Malcom et al., 1976). Findings from subsequent studies that followed the landmark report thirty-five years later found that “now, it is less about rights versus wrongs and more about support versus neglect; less about the behavior of individuals and a culture that was accepting of bias... and more about the responsibilities and action (or inaction) of institutions” (Malcom and Malcom, 2011 p. 163).

The Double Bind: Dual Minority Status. Given that WOC’s experiences are traditionally deciphered from the literature related to women faculty or faculty of color, scholarship on WOC’s dual minority status as both women and persons of color provide an alternate perspective of the professoriate. (McClellan’s (2012). For instance, the concept of racial identity looks differently for WOC compared to their White female counterparts. Gardner (2013) found that race is not a salient factor for White women in terms of the barriers they encounter within their workplace and academia in general. Furthermore, scholars contend WOC navigate the academy as the “other” because they do not fit in the confines of the dominant culture, which has been historically white and male (Turner, Gonzalez, & Wong, 2011). This also has an impact on WOC experiences within the classroom (Ford, 2011; Turner, Gonzalez & Wong, 2011). For example, WOC’s efforts to incorporate a culturally responsive pedagogy within the classroom settings are often perceived by White students as “white culture bashing” (Vargas 1999,

p. 366). Noteworthy, studies have shown the students' resistance to WOC faculty's authority within the classroom is often supported by White faculty (Malcom & Malcom, 2011), and often reinforced by their interactions with WOC faculty (Vargas, 1999). WOC report that being devalued by colleagues cultivates a hostile climate that fosters student resistance for WOC faculty (Turner, Gonzalez, & Wong, 2011; Vargas 1999); this especially includes the devaluing of foreign-born WOC who have accents (Vargas 1999). Other studies have revealed the ways WOC's gender intersected with their race within the context of diversity-related classrooms, particularly at predominantly White institutions (PWI) (Castañeda, 2009; Duarte, 2009). The significance that PWI's place on the "intellectual capital" of WOC and their addition to the diversity of the faculty body often presents obstacles both in and out of the classroom setting, stemming from the lack of structural diversity and allies at their institutions (Duarte, 2009). Moreover, the intersection of WOC's gender and racial identities can complicate the professoriate because it disrupts traditional ideologies of who can be a scholar/professor and expands the restrictive "Black/White binary that dominates most dialogues that are situated in race" (Mata, 2009).

Previous research has examined the major challenges WOC faculty encounter in the academy, which Turner (2002) categorized as "the lived contradictions and ambiguous empowerment" (p. 75). Indeed, WOC do attain tenure and promotion within the academic ranks; however, their racial and gender identities have the potential to minimize their legitimacy as a scholar and faculty member in the eyes of their colleagues and senior leadership (Hess, Gault, & Yi, 2013; Turner 2002). To address these obstacles, Turner (2002) suggested that institutions of higher education "provide

professional development experiences that assist a new faculty woman of color to overcome challenges of multiple marginality” (p. 85). This would require colleges and universities to implement structures that would assist WOC in their navigation of departments that are primarily White and male. Researchers also contend that WOC should not have to bear the total responsibility of developing strategies for counteracting a hostile work environment (Armstrong & Jovanovic, 2015; Tuner, Gonzales, & Wong, 2011). Furthermore, administrators and policymakers must become more astute about how their institutional climate and diversity (or lack thereof) can influence the experiences of WOC faculty in STEM (Hess, Gault, & Yi, 2013; McClellan’s, 2012; Turner, 2002).

Having a dual minority status also has implications in terms of WOC having to compromise their identity in order to perform or receive positive recognition within academia. Marbley, Wong, Santos-Hatchett, Pratt and Jaddo (2011) suggested that WOC “often find themselves ostracized from their colleagues and departments, which impedes their efforts to successfully advance within the academic and leadership ranks. They must also develop innovative ways to navigate academia due to the “Eurocentric and male lenses” that are used “to frame standards and dictate certain cultural, behavioral, and professional norms” (Santos-Hatchett et al., 2011, p. 166). Thus, it is critical that institutions adopt targeted policies and initiatives that invest in the recruitment and retention of WOC, because it will lead to an environment where WOC contributions are valued and more likely to succeed (Marbley et al., 2011). In addition, WOC can benefit from finding creative ways of bridging their various identities (e.g. gender, racial, etc.), and truly understanding their position as a unique asset to

academia because of the capital that is sourced within those multiple identities.

Scholars have defined WOC's role in academia as being the "other," given that WOC do not typically fall within the dominant culture of being White and male. The theme of WOC as the "other" was examined in Ford's (2011) qualitative study on WOC faculty. Ford (2011) suggests that WOC faculty "represent a series of raced and gendered contradictions in academia" (p. 472) that is counter to the White male norm and being subjected to microaggressions that are deeply rooted in race and gender "impinges on the performance, retention, promotion and tenure of WOC (women of color) faculty" (p. 473). Although Ford (2011) illuminates the lived realities of WOC faculty, more scholarship is needed to examine the impact of WOC's identity has on their navigation in academia that uses additional sources of evidence that extend beyond participant narratives. Given that WOC encounter "marginalization, subtle discrimination, racism and institutional racism, gender-bias and institutional sexism, and difficulties with students who do not expect to be taught by women of color" (Turner et al., 2011, p. 209), it is imperative that that colleges and universities invest in WOC faculty through departmental and campus-wide inclusion policies and programs.

Although previous studies highlight important parts of WOC faculty's experiences, additional scholarship is needed that untangles the intersection of gender and race and its impact on their experiences within academia. Furthermore, the majority of the literature on WOC faculty's dual minority status is grounded in data that uses one method of data collection and analysis. The literature on WOC faculty in STEM would benefit from a thorough understanding of the impact of gendered and racial experiences, using a mixture of faculty survey data and in-depth participant interviews

that are both grounded in a strong conceptual framework. Also, given the fact that the scholarship of WOC in STEM faculty is very much limited, the issue of tensions that arise when the culture within workplace context is incongruent with the values of women of color.

Tensions with Context and Culture. Ong (2005) contends that “matters of gender, race, ethnicity, social class, immigration status, and sexual orientation have no acknowledged place” (p. 598) in the culture of science. Silencing such important issues serve as a basis for chilly departmental climates and cultures. Consequently, WOC in STEM are subjected to gendered and radicalized experiences, which foster excessive stress in having to continually negotiate their ethnic identities with their professional identities (Jean-Marie & Lloyd-Jones, 2011). WOC are often forced to negotiate their multiple identities because scientists are legitimized and are given prestige in their respective fields by preserving science’s traditional values as being objective, universal, and context free (Haraway, 1991; Harding, 1991). Often, women are perceived to not embody these values.

The literature documents the negative impact that both sexism and racism has on WOC in STEM, especially at research universities (Malcom & Malcom, 2011; Turner, 2002; Turner & Myers, 2000; Stanley, 2006). Issues of subjectivity and social justice such as discrimination that occurs based on citizenship status, gender, race, religion, social class, immigration status, and sexual orientation are typically not acknowledged within the STEM fields (Ong, 2005). The absence of dialogue situated around these issues significantly contributes to the reasons why WOC academics in STEM report hostile departmental climates (Hess, Gault, & Yi, 2013). Thus, WOC faculty in STEM

strategically balance their ethnic identities with their professional identities due to the both overt and covert gendered and racialized encounters with their colleagues. This is also conflated by work environments that do not recognize the attributes that are salient to the identities of STEM women of color (Armstrong & Jovanovic, 2015). Furthermore, WOC strategically maneuver between their multiple identities—and in essence, take on different personas. WOC must negotiate the different aspects of their identity given that STEM academics and professionals gain much of their reputation and recognition in their fields by reinforcing the perception that STEM is objective and unaffected by context (Haraway, 1991; Harding, 1991; Latour, 1987). Traits such as assertiveness and egotism (Georgi, 2000; Gibson, 2003), principles such as individuality and competition, and demographic characteristics such as being White, male and mid to high socio-economic status (Margolis & Fisher, 2002) are typically tied to legitimacy and authority within the STEM fields (Ong, 2005). In sum, these are the driving forces which significantly shape and perpetuate the chilly climates and cultures that are characteristic of STEM departments within the United States.

Additionally, the culture within STEM promotes a meritocracy and promotes beliefs of being more rigorous intellectually more often than non-STEM disciplines because of the technical abilities required to be successful in the field (Johnson, 2011). According to Johnson (2011), the values adopted by the culture in STEM often work counter with the cultural values for WOC who indicate that their racial and/or cultural backgrounds are salient. For instance, “la cultura Latina” values Latinas that are passive, submissive, and who refrain from acts of aggression (Hernandez-Truyol, 2003). Moreover, Latinas are expected to assume gendered responsibilities within the

Latino community, wherein cultural norms such as familial obligations (including extended family) are both deeply coupled with the rich tradition found within the Latino community that holds respect for parents and elders to a high regard (Ginorio, Guierrez, Cauce, & Acosta 1995; Hernandez-Truyol, 2003). Thus, Latinas often encounter tensions stemming from work and cultural responsibilities, as a result of the demands that are placed on STEM academics that often detract from time and energy dedicated to family (Austin et al., 2007).

Black women faculty in STEM also must navigate departments that are not typically in alignment with their cultural values. For example, Black women have a unique communication style that comes off as “too direct”—which interestingly is a trait that is valued if it is only adopted by White men (Edmondson, 2012), but for Black women it can have an adverse impact on tenure and promotion (Shuter & Turner, 1997). Despite the fact communication styles are acquired through multiple contexts (i.e. home, school, work, etc.) (Edmondson, 2012), Black women in academia may be often tasked with the challenges of modifying their native communication style to assimilate with the values that are central to the dominant culture. Similar to their Latina counterparts, this likely feeds into the hostile climates that in turn negatively impacts their performance within the academy (Armstrong & Jovanovic, 2015). These examples, along with other scholarship on barriers that shape the experiences of WOC in STEM, highlight the issues they face in order to be accepted within the STEM community and academic departments wherein they must possess the savvy to appear that they have shed their cultural and gender identities as a means of reinforcing the idea of scientific objectivity (Ong, 2005).

Existing research indicates that WOC manage various challenges and tensions that extend beyond the scope of their responsibilities as STEM faculty. They also have the added pressure of negotiating their cultural values within a space that favors white-male-dominated norms (Jean-Marie & Lloyd-Jones, 2011). The literature reviewed within this section highlights the unique challenges WOC faculty in STEM manage, which are entrenched in their lived experiences that are heavily influenced by an intersection of race, gender, and STEM. Notwithstanding the barriers that they cross within the academy, ultimately it is critical for all WOC STEM faculty to persist within the academy so that STEM fields do not suffer from the loss of talented professionals and their contributions to the field that advance society as a whole. The literature review will now delve deeper into the specific tactics that assist WOC in their success within the academy.

Tactics for Women of Color in STEM

Despite the challenges WOC faculty face in STEM academic disciplines, there are a number of tactics they utilize to navigate the academy. First, WOC maximize several coping strategies that help mitigate the impact of maneuvering unsupportive work environments. Such coping strategies fall under three categories: spiritual, personal, and through the help of others (Berry & Mizelle, 2006). Next, WOC who successfully navigate the STEM academy become astute about racial politics and the climate at their institutions and departments. They are often intentional in learning about the historical marginalization of underrepresented groups and understanding the bureaucracy found within the workplace (both institutional and departmental wide). Third, existing literature indicates that the development of strong networks of colleagues

and mentors play a pivotal role for WOC STEM faculty (Trower, 2011). Networks allow WOC to move through structural and cultural barriers, which help to facilitate their upward career mobility (Ponjuan, Conley, & Trower, 2011). Lastly, cultivating a personal life outside of work that is rich in intellectual and enjoyable activities aids WOC in STEM disciplines to manage with the difficulties they confront in the workplace and bolsters their achievement in STEM (Liefshitz et al., 2011).

Coping. Although the literature is limited in terms of strategies that promote WOC faculty's success within the STEM disciplines, there are few qualitative studies that point the different ways that they cope as a response to working unwelcoming work environments (Turner & Gonzalez, 2011). Specifically, scholars highlight three primary coping strategies WOC draw from, especially when they find themselves in situations where they are the only women or person of color within their department. These coping strategies usually sourced in spirituality, inner-strength/motivation, and strategic use of support systems. Spirituality also manifested within the literature in various ways. For example, some WOC STEM faculty discussed engaging in prayer, or leaning on their faith as a means to mitigate the negative effects of working in their field (Berry & Mizelle, 2006); while others discussed the importance of meditation practices in keeping them grounded. In many cases, WOC report that they pull from their inner strength as a means to cope with their work environment. Indeed, their inner strength/motivation preexists before entering the academy; however, it is also possible that WOC develop and/or bolster their sense of inner motivation from their support system, which acts as a tool of empowerment as they climb the faculty ranks—this includes family, friends, colleagues and mentors (Turner & Gonzalez, 2011).

WOC develop coping mechanisms that are situated within the gender and cultural aspects of their identity, especially when working at institutions that lack ethnic diversity (Armstrong & Jovanovic, 2015). Particularly, in these spaces, WOC actually become more aware and tolerant of their tokenized status. Thus, WOC come to terms with being the only women or person of color and the impact it has on how they engage with their colleagues or students. Others take the initiative to become more astute of institutional and departmental politics, and adjust their behaviors to align with their workplace culture. This may also include code switching, wherein they develop their faculty identity that appears to be different from their authentic self (Liefshitz et al., 2011).

Politics and Network Building. Scholars suggest that WOC utilize political tactics in an effort to navigate the academy. For example, WOC often conduct an environmental scan of their department, which is when they learn about the politics and climate within their workplace (Hess, Gault, & Yi, 2013). Before entering into the political areas of STEM departments, WOC often learn more about the history of the institution and their department (Armstrong & Jovanovic, 2015)—which oftentimes indicates a pattern of exclusion or marginalization for underrepresented groups (Liefshitz et al., 2011). Scholars also recommend that WOC become familiar with the structures and bureaucracy at both the departmental and institutional level, and try to find allies in each. This often helps WOC gather “insider” information that is not always directly disseminated to them (Armstrong & Jovanovic, 2015). Lastly, WOC should be careful not to assume allies will always be other faculty of color; rather, they should aim to diversify their support networks to include colleagues that may not look like them but

hold similar work ethics and values (Torres, 2012).

In general, this section has discussed strategies that WOC use to navigate academia, particularly at institutions where they are one of few, the only woman, or person of color within their departments. It is important to note that many strategies that are mentioned in this section were pulled from scholarship that focuses on WOC faculty in general, and research that included WOC faculty in the STEM disciplines. It is also important to note that existing scholarship on WOC faculty fails to discuss the best practices that support them as they navigate within the academy, especially the STEM fields. Rather, the body of literature provides a general understanding of how WOC cope at PWI's and not research-intensive institutions. Clearly, there is a need to expand the range of literature as it relates to empirically backed theory and recommendations that would be appropriate for WOC who desire to successfully navigate the STEM disciplines.

Critique of the Literature

The factors that perpetuate the exclusion of women faculty, particularly within the STEM disciplines, have been well documented within the literature. Within this line of scholarship, the experiences and lived realities of WOC have often been absent from the dominant discourse, given that few studies explore how the intersection of race and gender affect how one navigates within the academy (Johnson, 2011; Atwater, 2000). Researchers rationalize the aggregation of WOC with non-WOC, especially in quantitative studies, by simply stating that there are not enough WOC faculty in STEM to provide a robust analysis (Johnson, 2011). Although the origins of scholarship explored the ways that the intersection of race and gender impacted the experiences

and perceptions of faculty of color can be traced back to nearly three decades ago, the examination of faculty of color in STEM did not gain traction until about ten years ago (Turner, González, & Woods, 2008). Yet, the literature on WOC faculty in STEM remains undeveloped despite the progress that has been made in the study of faculty of color.

It is important that WOC should be included within the conversation concerning their underrepresentation in traditionally white and male-dominated academic spaces, such as the STEM disciplines (Johnson, 2011). Currently, the discussion situated on the marginalization that has been perpetuated by the culture of STEM is discussed in terms of emerging issues for women or racial minority groups (Ong et al., 2011). The issue with this simplistic perspective is the assumption that race and gender are mutually exclusive, whereas in reality they are truly fluid and dynamic (Leggon, 2006). This is due in part because “the way data on the science workforce has been traditionally collected by race/ethnicity *or* sex, but not by race/ethnicity *and* sex” (Leggon, 2006, p.325).

Failure to acknowledge the unique issues salient for WOC, which are typically grounded in both racial and gender inequalities, perpetuates ideas that all women STEM faculty navigate the academy the same way, negating the distinctive contextual and personal elements that significantly promote their success within the STEM fields (Hanson, 2004; Collins, 1999; Atwater, 2000). Furthermore, the framing of a universal understanding of women in STEM is problematic because institutions and policy makers dictate practices and policies that are often informed by research that excludes the voices of WOC faculty in STEM (Clewell and Ginorio, 1996). Indeed, the salience of

one's racial and gender identities shape their perspectives; therefore, researchers should explore how the intersection of race and gender may impact the way that they make meaning of their professional experiences. As previously mentioned, the conceptualization of familial roles may manifest differently for WOC than White women, which excludes critical elements that help support WOC faculty in STEM (Hanson, 2004). Thus, given that WOC and White women perceive familial obligations differently, then it is likely that WOC perceive tensions sourced in work-life balance differently than their White counterparts, and therefore require a different set of supports to mitigate these effects (Anderson & Collins, 1995; Collins, 1987). The absence of research that focuses on the needs and issues that are central to WOC propels the development of ineffective initiatives, policy, and practices that work to counter the aims of cultivating and supporting diversity within the pool of STEM academics (Leggon, 2003; 2006; 2010). Thus, it is important that future studies advance theoretical and conceptual frameworks that examine WOC faculty in STEM as a separate population (Ong et al, 2010).

As mentioned earlier, the current landscape of the academy is pivotal in influencing how identity shapes WOC's experiences within the STEM disciplines—a space in which they are disproportionately underrepresented. The traditional structure of the professorate includes three major rank levels: assistant professor, associate professor, and full professor. Regardless of academic rank, all faculty are responsible to carry out the core responsibilities of teaching, service, and research responsibilities as a means to earn tenure and/or promotion within the academy. Although these expectations are required for all faculty, the value placed on each specific role is

contextual and differs by institutional type and academic areas.

Thus, institutional context was included within this literature in an effort to explore the major issues that WOC faculty face both generally and specially within their respective STEM departments. For example, WOC faculty encounter challenges with navigating the responsibilities and measures that are related to tenure and promotion, developing a diverse support network, and managing a healthy balance between professional/work responsibilities and personal obligations. Particularly, WOC in the STEM disciplines encounter unique pressures resulting from expectations to secure external funding while meeting publishing expectations. This is conflated with STEM culture, which promotes competition and isolation due to the lack of diversity. WOC STEM academics also struggle with developing their professional networks and finding mentors within their fields.

Furthermore, scholarship that focuses on faculty of color suggests that WOC must navigate institutions and STEM departments wherein dealing with the negative affects that result from microaggressions, stereotype threat, and their tokenized status (Leggon, 2010). WOC are in a unique position where they more frequently experience these types of implicit bias given their dual minority status. Thus, it is unfortunate, but not surprising that WOC faculty in STEM consider that the institutional and departmental culture impedes their performance in the academy. This may help explain why a gap continues to exist between WOC and although the number of White women faculty increased over the past 30 years. When taken all together, understanding the unique challenges WOC face provides a more robust understanding as to why the academy is losing a pool of talented academics who are opting to enter into industry, or even other

fields, rather than remain in their careers as faculty. Given the issues that adversely affect WOC STEM academics, the literature provides a limited scope of the types of tactics they employ as a response to a hostile work environment. It is important to note that many of these strategies are based on anecdotal information, rather than empirically backed data. Furthermore, these strategies focus on how WOC “survive” as a STEM academic rather than thrive within the academy.

Although the span of literature on WOC lays the foundation for this study, it is imperative to acknowledge that existing studies have various limitations that impact the reliability, validity, and generalizability of the results. The limitations in existing scholarship present an opportunity for this study to rigorously explore how systematic issues and workplace dynamics affect WOC in their career as faculty. Although studies have investigated factors predicting success for WOC in STEM, few have explored their lived experiences through the use of their narratives. Existing studies primarily focus on WOC experiences within industry, rather than STEM faculty within the academy. Thus, a mixed method research design is needed to understand the barriers they face and the strategies they use once they enter STEM faculty pipeline. This study contributes to literature and institutional practice because it provides data that focuses on strategies WOC use to navigate STEM disciplines within the academy.

The next section will discuss Carlone and Johnsons’ (2007) model of scientific identity model for women of color as the primary conceptual framework guiding this study. This model takes a holistic approach in understanding multiple variables that impact WOC persistence within STEM disciplines. Additionally, this model will be used

to evaluate the three types of identities related to WOC in STEM, and how their race and gender identity shapes their navigation of STEM spaces.

Theoretical Framework

Carlone and Johnson (2007) created a model of science identity for WOC that explored their experiences over the span of their undergraduate and graduate studies into their careers. The authors suggested that science identity encompasses WOC's interpretation of their unique experiences. The authors collected primary data, which consisted of ethnographic interviews during students' undergraduate tenure, follow-up interviews six years later, and continual member-checking. With respect to this study on WOC STEM faculty, the theoretical framework suggests that identity includes WOC's interpretation of their unique experiences, as well as the socialization of their meanings.

The model contains three dimensions: *competence*, *performance*, and *recognition*. This model is grounded in Gee's (2000) theorized model on identity. He postulates identity as "being recognized as a certain kind of person in a given context" (p. 99). Thus, identity is solely socially constructed but is also flexible as it can shift over time and in specific contexts. The four components that shape identity include: (a) heredity or genetics, (b) institutional rules and regulations dictating one's position in society, (c) recognition by others through interaction and dialogue, and (d) experiences with like-minded individuals.

Gee (1999) also described identity as "the 'kind of person' one is seeking to be and enact in the here and now" (p. 13). However, Carlone and Johnson (2007) contended that it is nearly impossible for one to "pull off" enacting a particular professional identity, unless he or she proves that he or she has competence in the

relevant discipline and are recognized as credible for her performance. This may include utilizing the language associated with the field, presenting themselves in a manner that aligns with the norms, and demonstrating their competency in such a way that can be recognized by the science community. The authors argued that science identity is both situational and continuing over time and context.

Although research on science identities has implied that it is developed during practice (Holland, Lachiotte, Skinner, & Cain, 1998; Rahm, 2007), Carlone and Johnson (2007) hypothesized performance, participation patterns, and expectations become consistent over the course of time. Students are socialized from the early stages of their science education to perform in systematic ways and receive recognition based on how well they emulate the accepted formulas. The model accounted for social constructs associated with science identity, which corroborates with Lewis' (2003) critique related to the literature of the underrepresentation of African Americans in science. The author suggested that "science career attainment is a social process, and the desire of an aspirant is only one factor in this process. An aspiring scientist relies on the judgment and invitation of practicing scientists throughout every phase of the educational and career process" (Lewis, 2003, p. 371).

Figure 1 shows the three primary dimensions (i.e. *competence*, *performance*, and *recognition*) that are included within Calone and Johnson's (2007) model. *Competence* refers to the general knowledge of content related to science disciplines. For WOC faculty in STEM, *competence* may include their expertise and experience within their respective field. The *performance* dimension includes visible demonstrations of science processes and practices. As STEM faculty WOC perform the traditional

responsibilities of teaching research and service, while securing external contracts and funding. The third dimension, *recognition*, refers to WOC's self-perceptions as scientists and how others recognizes them as legitimate professional within their respective fields. This may include faculty's treatment of WOC as respected colleagues, or receiving recognition for exemplary teaching.

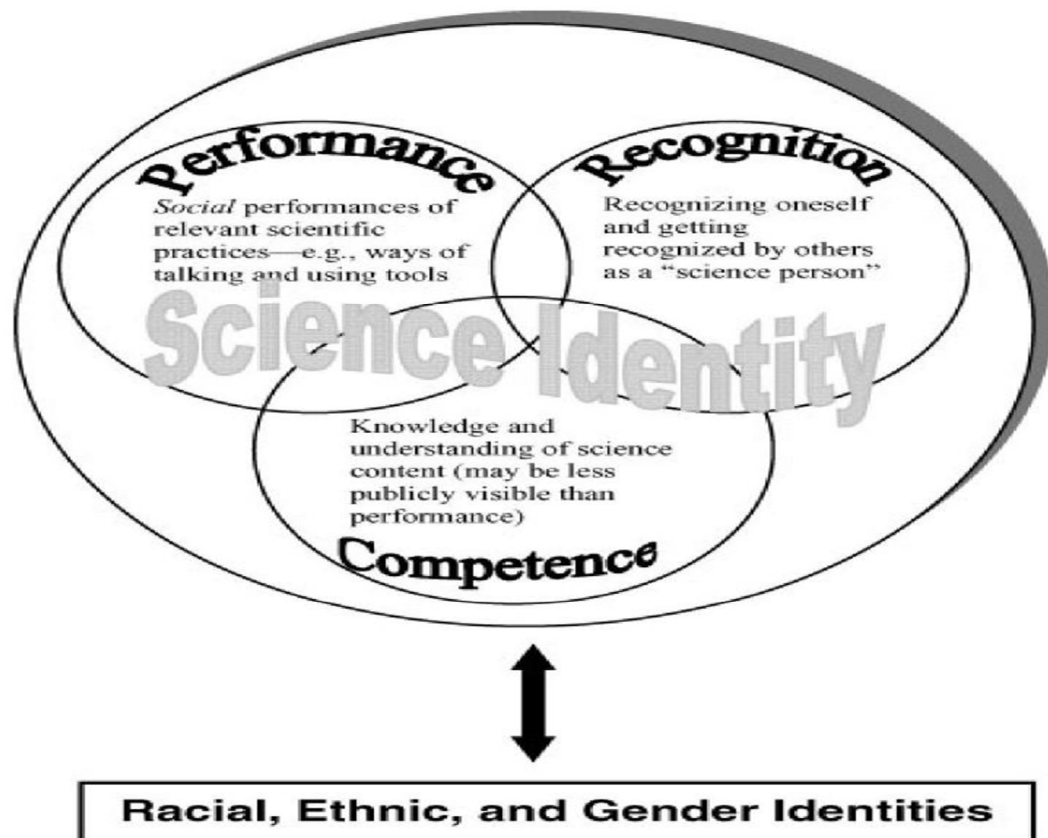


Figure 1. Model of science identity that guided our initial analysis.

Makings of a Scientific Identity

The model illustrates the three dimensions of science identity: *competence*, *performance*, and *recognition*. The authors noted that the dimensions are not mutually exclusive but are overlapping in nature. A WOC with a strong science identity would be rated highly by herself and others within each of the dimensions. However, there are various levels, which are dependent upon the self-ratings as well as ratings from others.

Tonso (2006) found engineering students who received higher levels of recognition sometimes had the lowest competency levels. In the same study, Tonso (2006) also found the inverse situation. WOC in the engineering program she studied, who were deemed competent and exceptional performers, were rarely recognized as authentic engineers by faculty or professionals.

Empirical studies have shown that WOC have different motives for entering into science fields than their male counterparts (Huang, Taddese, &Walter, 2000; Sax, 1994), and that their achievement in these fields are attributed to different factors (Fenske, Porter, & DuBrock, 2000;Wyer, 2003). However, Carlone and Johnson's (2007) model is predicated on the notion that women's gender, racial, and ethnic identities influence their science identity. Identity cannot be solely determined by what an individual says about her aspirations, competencies, and relationships concerning science (Tan & Calabrese Barton, 2007). Rather, identity is grounded in the limitations and resources available in the environment. Carlone and Johnson (2007) stressed that science identity cannot be merely distinguished by feelings and actions alone, although they constitute two of the three components of identity. WOC science identity must also include a mixture of their competence and performance, in order to be recognized by individuals who they consider significant and could validate their place in science. The results of the study indicated the significance of recognition by others for women who fell under one of three scientific identities: *research scientist*, *altruistic scientist*, and *disrupted scientist*. The subsequent sections will discuss each scientific identity in detail.

Research scientist. WOC who fit the description as a research scientist acknowledge themselves as scientists, and are able to articulate their passion for the

science discipline in terms of the content and career opportunities. Additionally, research scientists typically concentrate on prototypical facets of science. These women understand science as a stimulating approach of knowing, articulate the significance of engaging in science for science's sake, and express a genuine curiosity in examining the natural world. Women bearing this research identity see themselves as a "science person" or "scientist," and are able to integrate their interests and thought processes with the science discipline (Carlone & Johnson, 2007). A key distinguishing characteristic of women with research scientist trajectories is that they seek out authentic research opportunities (mostly within labs) during the early stages of their undergraduate career. This level of exposure positions research scientists to receive frequent recognition from reputable members of the STEM community, which informed their own acknowledgement of their scientific identity.

Altruistic scientist. The women who possess characteristics found in the altruistic scientist trajectory develop their own meaning of science. Also, they are able to discern whose *recognition* was significant, and what being a woman of color in science meant to them. Altruistic scientists often redefine the field of science to include a more humanitarian nature. This new definition of science empowers them to develop robust science identities. Essentially, these women redefine themselves as scientists, typically develop their own meanings of science. They view the discipline and practice of science closely rooted in their altruistic values. The two primary motivations for entering into science include: (a) commitment to humanity, and (b) altruistic professional goals that demand scientific ability. Altruistic scientists seek opportunities to conduct research that aims to improve people's lives, such as pharmaceutical research. Their reasons for

pursuing science solidify their space in science as it fulfills their ambitions to provide service to society.

Disrupted scientist. Women who fall under the disrupted scientist group encounter interferences in the development of their science identity. These women acknowledge themselves as scientists, and similar to the other two scientist identities, they articulate their passion for science or consider attending medical school at some point to fulfill their altruistic ambitions. However, these women are grouped as disrupted because they report negative experiences as science students. Often, WOC fitting in this category discuss multiple instances where they felt overlooked, neglected, or discriminated against by distinguished individuals within the science community. Disrupted scientists perceive that others recognize them merely as representatives of stigmatized groups. They sense that their behaviors and appearance initiate racial and gender stereotypes that impact their ability to be acknowledged. Although disrupted scientists typically continue to pursue science-related careers, they report the negative impact that their undergraduate and graduate experience had on their professional trajectory.

Summary

In summary, the results of the study indicated the significance of *recognition* by others for women who fell under one of the three scientific identities: research scientist; altruistic scientist; and disrupted scientist. WOC with research scientist identities are enthused with a science discipline and acknowledge themselves as “real” scientists. Also, research scientists were recognized by prominent individuals within the science community such as faculty and professionals in the field. The WOC with altruistic

scientist identities consider science to be a platform for self-sacrifice, or means to serve others. WOC falling under this identity develop inventive meanings of science, *recognition*, and being woman of color in science. The WOC with disrupted scientist identities desire, but often do not obtain, recognition by the science community that they feel that they earn. Although successful, their STEM paths are more challenging because their efforts to receive *recognition* were disrupted by gender, ethnic, and racially fueled interactions with distinguished professionals within their respective fields.

Although the *scientific identity model* significantly contributes to the framing of this study, it is important to acknowledge the limitations in terms of the applicability to this study on the identity of WOC faculty in STEM. It is important to note, that the model captures the experiences of undergraduates, graduates, and early career STEM professionals within industry. The literature posits that WOC in STEM, regardless of their trajectory, encounter both gendered and racialized experiences that impact their performance and ability to receive recognition (Carlone & Johnson, 2007). However, context matters and has a considerable influence in how WOC make meaning of their scientific identity—and in turn, that affects their career pathways. Indeed, students, early industry professionals, and STEM academics are at different places within the STEM pipeline, which requires unique responsibilities, expectations and pressures. For example, WOC faculty are more likely to encounter pressures such as publishing and securing external funding compared to WOC professionals in industry (Leggon, 2010). Thus, this study offers a contribution to theory and research by extending the model to include the voices and experiences of WOC faculty in STEM, who were noticeably excluded from Carlone and Johnson's (2007) study. Another limitation of the original

model is that is unclear how race, ethnicity and gender shape and inform WOC science identity, nor how experiences with discrimination affect the three dimensions found within the model. Rather, the model forces WOC in specific scientific identities that are more similar to typologies. For example, according to the model only WOC who fell under the “disrupted” identity experienced discrimination. However, it is very possible for “altruistic” and “research” scientist to encounter some level of discrimination. This study sheds on light the interconnectedness of the different science identity for WOC STEM faculty. Also, this study presents strategies WOC use to maintain and integrate both science and salient social group identities. The next chapter details the methodological design for the study.

CHAPTER 3: STUDY DESIGN AND METHODOLOGY

This study was guided by a pragmatic worldview, which emphasizes practicality and utilizing a sound methodology that is appropriate to answer the research questions of interest (Tashakkori & Teddlie, 1998). The research questions and scope of this study are best investigated through a mixed methods design. Although it is possible that the primary research questions can be addressed by qualitative or quantitative methods alone, incorporating a mixed methods design that allows for both quantitative and qualitative methods provides a more rigorous examination of the ways that WOC's identity influences their experiences as faculty in STEM. Mixed method designs were initially developed to aid in the triangulation of a study's data, which continues to serve important techniques utilized to validate the findings found in most mixed methods scholarship (Creswell & Piano Clark, 2007; Tashakkori & Teddlie, 1998). The collection, analysis, and merging both types of data permits corroboration and the improvement of the accuracy and relevance of the results yielded from the integration of one method with the other. Although data convergence lends an increased validity to the findings, instances where the qualitative and quantitative data diverge offer opportunities for additional layers of analysis to gain clarity, with respect to the way that the aspects of scientific identity shapes the way that WOC faculty in STEM navigate the academy.

Positionality Statement

It is critical that I acknowledge my positionality as I engaged in this study. Indeed, the nature of the topic on WOC prevented me from being a disinterested, objective, and unbiased researcher. The topic of WOC resonates with identity and

experiences both within and outside of the context of higher education. Furthermore, it is difficult to divorce the relationship to this study and the idea that I am researching the current conditions I am likely to encounter should I enter into academia and being a WOC—even as a social scientist.

As Denzin explains, "interpretive research begins and ends with the biography and self of the researcher" (1986, p. 12). As a researcher, I am a product of who I am as a person, and who I am as a person is a result of my race, class, gender, and sexuality. I am the researcher that I am because of my academic, professional, and personal experiences as a WOC. Additionally, I understand that it is difficult to untangle what I know about research from who I am (Harding, 1987). My dispositions as a researcher, such as my beliefs about research and the questions I ask are influenced by my aforementioned experience, environment, and knowledge. Given my multiple identities of being a woman of color, doctoral student and an educator, there is a possibility that the participants viewed me as an insider. This may have impacted the type of experiences they disclosed to me, and the methods I used to analyze the data. However, I was intentional to address this issue by making sure that I asked thorough questions, regardless if such questions appeared to be common knowledge among WOC.

Research Questions

The purpose of this study was to examine how the intersection and roles of race and gender identities shape science identity (Carlone & Johnson, 2007), and specifically how WOC navigate the STEM academic workplace. This study provided information to identify and explain how to minimize the barriers that can cause WOC to

exit the academy, and better leverage those mechanisms that promote their success. Considering the purpose of this study, the specific research questions I addressed are as follows:

- 1) Given identified theoretical dimensions of *Science Identity* (*competence*, *performance*, and *recognition*), how are these interrelated concepts moderated by race and gender? Which aspects are central to WOC?
- 2) How does racial and gender identity shape WOC experiences as faculty in STEM?
- 3) What strategies do WOC use to successfully navigate the academy?

Mixed Methodology

Both quantitative and qualitative inquiry was used to examine how WOC in STEM navigate the academy. The techniques utilized within a mixed methods research design rigorously addressed the primary research questions guiding the study, given that it has been adopted across disciplines to gain in-depth insight when exploring multifaceted phenomena (Creswell & Piano Clark, 2007). Mixed methods scholarship incorporates the collection and analysis of both qualitative and quantitative data within a study, whereas the findings of a single-method are a result of the use of either qualitative or quantitative techniques in isolation (Jones, Torres, & Armino, 2013; Tashakkori & Teddlie, 1998). Aside from offering more comprehensive evidence with respect to the research problems guiding the study, this design provides researchers with the opportunity to balance the limitations of qualitative and quantitative methods with the strengths of the other (Creswell & Piano Clark, 2007; Johnson & Onwuegbuzie, 2004).

Indeed, quantitative data offers precision and is effective for research that includes large populations. It is also useful for testing hypotheses about phenomena, and producing findings that are generalizable. However, limitations of quantitative research include: failure to ascertain why a phenomena transpires; not explaining the meaning and understanding of what is analyzed; and omitting significant findings due to the emphasis that is placed on proving a hypothesis (Johnson & Onwuegbuzie, 2004). Qualitative methods address several of the limitations inherently found within quantitative research, such as offering richer and more detailed understandings. Furthermore, qualitative research highlights contextual and situational factors, develops theory that furthers our understanding of the relationship of certain variables, and helps to unpack the nuances of how individuals make meaning of phenomena. Given the strengths of qualitative research, the findings for this analytical approach are typically not generalizable across contexts, are sensitive to bias of the researcher, and inefficient when analyzing large populations (Johnson & Onwuegbuzie, 2004). The incorporation of both qualitative and quantitative strategies in the study amplifies the rigor of both strategies, while controlling for the limitations of one methodology with the complimentary strength of the other. The merging of qualitative with quantitative analysis adds depth and meaning, untangling why factors and constructs are related, while statistical analyses add precision and generalizability to the themes derived in qualitative analyses.

Thus, using two methods for data collection and analysis is essential in focusing on the what, how, and why of the phenomenon of interest. The quantitative analysis lends to a conceptualization of the theoretical constructs of the scientific

identity that are central for WOC faculty in STEM, while the qualitative analysis will further our understanding with respect to the "hows and whys." For example, aside from uncovering the dimensions of the scientific identity that are central for WOC faculty (i.e., the association between *recognition* and the level of performance for WOC) this study will contribute to the literature on how scientific identity influences STEM WOC faculty's navigation of the academy. To align with the structure of a true mixed method research design, this study is a two-stage study which integrates analyses of a national faculty survey and interviews with WOC faculty in STEM disciplines to examine their career and workplace experiences.

Convergent Design

This study was informed by the *convergent* approach, which is described by the collection of quantitative data that coincides with the collection of the qualitative data (Creswell, 2013). Figure 4.1 illustrates the convergent design using 1) the National HERI Faculty Survey and structural equation modeling, 2) Semi-structured interviews of WOC in STEM faculty roles, and 3) mixing results. Findings of qualitative analysis were then compared to findings yielded from the quantitative analysis. Thus, equal emphasis is placed on both modes of analysis. Creswell (2013) contends that "the mixing during this approach, usually found in an interpretation or discussion section, is to actually merge the data or integrate or compare the results of two databases side by side in a discussion" (p. 213). Thus, the qualitative analysis within the study's design is equally rigorous and is used to confirm, counter, and expand on the results yielded within the quantitative analysis (Creswell & Piano Clark, 2007). In addition, the qualitative strategies significantly deepen our understanding of the relationship between certain

variables. In general, the qualitative methods employed in this study also broaden our understanding of contextual elements that impact scientific identity and shape the professional experiences of WOC STEM faculty that may not be captured solely using survey data.

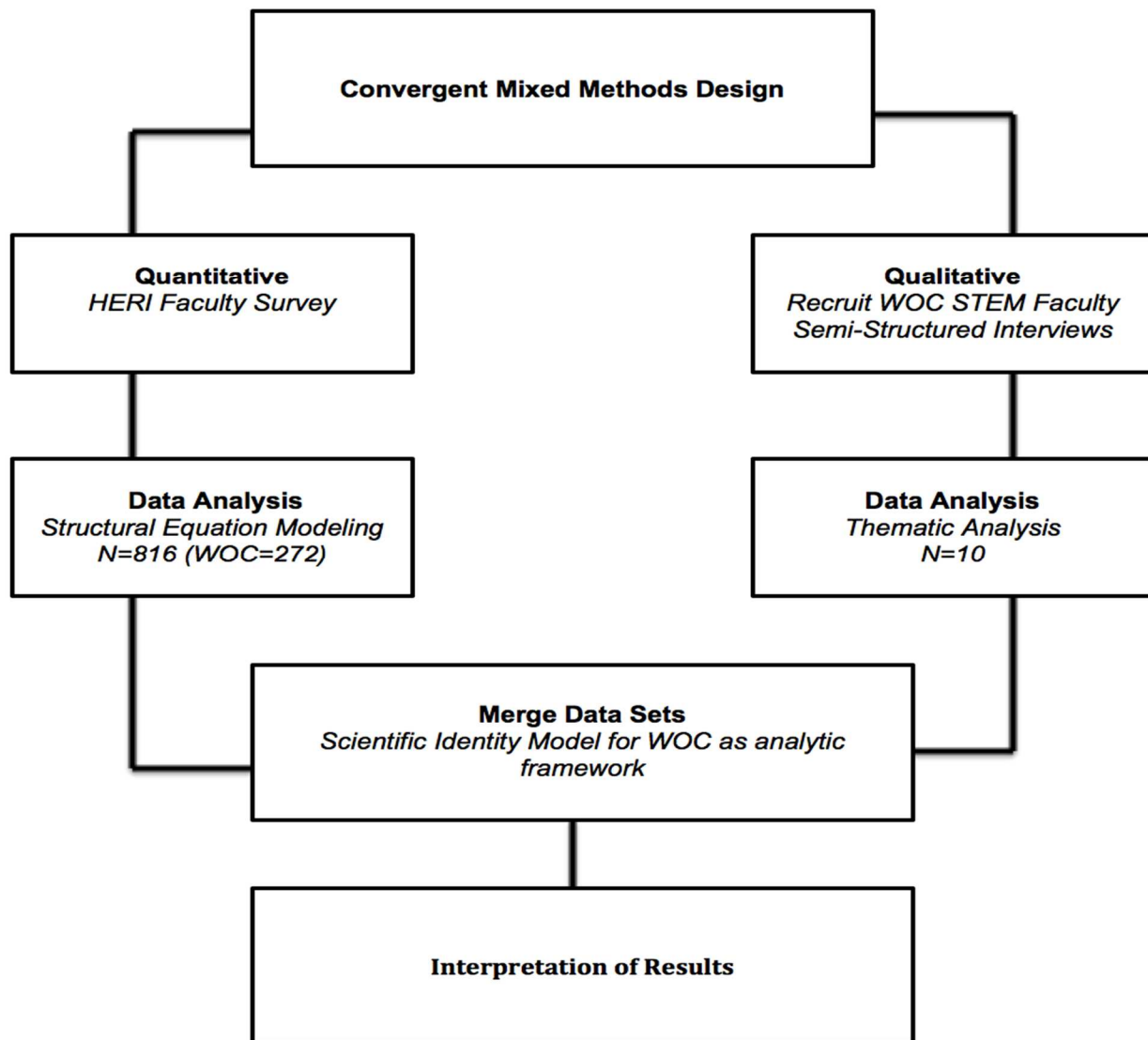


Figure 3.1. Visual diagram documenting convergent mixed methods procedures.

Quantitative Analysis

In following the recommendation for structuring a convergent design, I used

quantitative concurrently with qualitative data, and therefore analyze simultaneously. First, I used secondary data analysis to address the first research question. This analytical method provided a more robust investigation with respect to the interrelationships between *competence*, *performance*, and *recognition*—*Science Identity*— and how these relationships are moderated by race and gender. Additionally, quantitative methods was utilized to examine the relationship of the theoretical constructs of *competence*, *performance*, and *recognition* that are presented in Carlone and Johnson's (2007) model of scientific identity for women of color. Although this study seeks to examine how WOC's scientific identity affects their experiences within the academy as STEM faculty, there are two hypotheses tested within this study. These hypotheses include:

Hypothesis 1. The theoretical constructs included within *Scientific Identity* (i.e. *competence*, *performance* and *recognition*) are significantly interrelated

Hypothesis 2. The relationships of the *competence*, *performance* and *recognition* are moderated by sex and race

Data Source. Data from this study came from the Higher Education Research Institute's (HERI) 2007-2008 and 2010-2011 faculty surveys, which gathers information on the teaching, research, and service practices of faculty; their perceptions of campus and departmental climates; goals related to undergraduate education; and their personal values. HERI employed a stratified institutional sampling scheme for the faculty survey to ensure representation that reflects all nonprofit, postsecondary institutions. Before sampling occurs, four-year colleges and universities identified as part of the national population were divided into 20 stratification groups based on type

(four-year college, university), control (public, private nonsectarian, Roman Catholic, other religious), and selectivity in admissions defined as the median SAT Verbal and Math scores (or ACT composite score) of first-time, first-year students. The methodology for the surveys is described in two reports on nationally normed data by institution type, gender, and rank (Hurtado et al., 2012; DeAngelo et al., 2009).

HERI invited campuses to participate in the faculty survey and provided them with guidelines for survey administration; the survey instrument was then administered via the Internet. In cases where institutional stratification cells were insufficient for drawing conclusions, CIRP supplemented the sample by identifying faculty at those institutions and sent surveys to augment the sample. Funding from the National Institutes of Health (NIH) and National Science Foundation (NSF) allowed for a supplemental sample of STEM faculty to participate in the 2010 survey.

Sample

STEM faculty members were selected from all CIRP participating institutions and included in the supplemental sample of STEM respondents in 2010-11. This sample was augmented with STEM respondents to the 2007-08 survey from an additional institutions (non-duplicative) in order to maximize the population of underrepresented women respondents included in the data. The study used matched samples of 272 WOC, 272 White women, and 272 White men who were faculty within STEM disciplines. This resulted in a total 816 STEM faculty from 78 institutions. Matched samples of White women and White men were included to allow me to examine differences across race and gender groups. White women and white men were used as comparison groups rather than men of color and Asian faculty because the literature

suggests that experiences within academia are different for underrepresented WOC compared to White men and White women. The sample was matched on specific characteristics such as Institution, institutional type, academic rank, and STEM discipline.

WOC in STEM reporting that they were tenured and tenure-track professors (n=272) in the quantitative sample remained once all missing data were imputed. With respect to academic rank and advancement, 35.8 percent (n=93) of respondents indicated that they had already received tenure, and another 25 percent (n=65) are untenured but are in the tenure track positions. Moreover, 22.4 percent (n= 44) survey participants reported that they are full professors, while 34.2 percent (n= 67) are associate professors, and 43.4 percent (n=85) are assistant professors. There is variance in terms of the racial breakdown of the sample. Specifically, the sample includes 33.0 percent (n=90) women who indicated that they are Black. Further, there are 23.1 percent (n=63) Latina Faculty. Lastly, Native American women made up the smallest proportion of WOC faculty in STEM 0.01 percent (n=4). There was great diversity in terms of age, which ranges from under 30 to over 70, but the mean age for survey respondents is between 45 and 49 years old.

The WOC faculty represented in this study come from a wide range of academic appointments, with respondents being employed in as many as seven broad STEM-related disciplines. These categories were developed using guidelines recommended by the National Science Foundation. With respect to discipline, 3.1 percent (n= 6) were in agriculture or forestry, 27.0 percent (n=53) in the biological sciences, 9.7 percent (n=19) in engineering, 38.3 percent (n=75) in a health related

field, 9.7 percent (n=19) in mathematics or statistics, 8.7 percent (n=17) in the physical sciences, and 2.6 percent (n=5) were in a technical related field. All of the respondents were employed at four-year colleges, and four-year universities. In terms of special designations, WOC faculty employed at Historically Black Colleges and Universities comprised of 10.2 percent (n=20) of the total sample.

Competence Variables

The science identity model postulates that *competence* includes the knowledge and comprehension of science content. It is important to note that measure of *competence* is less visible to the public. Indeed individuals at the career stage have already developed the *competence* within their discipline. In terms of STEM faculty, *competence* manifests through their engagement and influence within the field, students, and the campus community. For the purposes of this study the measure of *competence* was comprised the level of importance to which WOC faculty in STEM place on: “becoming and authority in the field,” “influencing the political structure,” making a theoretical contribution to science,” “keeping up to date with political affairs,” and “mentoring the next generation of scholars.” These variables are evaluated on a four-point likert scale, which ranged from *not important* (1) to *essential*(4). Measures of *competence* also include the importance WOC faculty in STEM place on research, teaching, and service (see Table 3.1). A higher score on *competence* therefore indicated that the WOC faculty in STEM were more confident in career goals and possessed the skillset to perform their academic responsibilities.

Performance Variables

Within the theoretical framework, *performance* is regarded as social

performances of relevant science practices. Certainly, STEM faculty perform their scientific *competence* by engaging in specific activities, such as research. Thus, the dissemination of their work serves as indication of their performance. The theoretical construct of *performance* was captured with continuous variables (see table 3.1). In terms of continuous variables, WOC STEM faculty members were asked the number of articles they published in academic or professional journals, and the amount of chapters they authored in edited volumes. More specifically, this construct included the number of professional writings that been published or accepted for publication in the past two years. Hence, a higher score on the *performance* variable indicates that engaged more in work-related activities associated with publication.

Recognition Variables

The theoretical construct of *recognition* includes “recognizing oneself and getting recognized by others as a ‘science person’” (Carlone & Johnson, 2007, p. 5). Given that this study focuses on WOC faculty in STEM, it is necessary to include items that signify their recognition as STEM faculty. Several variables composed the theoretical construct of *recognition* (see table list 3.1). More specifically, WOC STEM faculty members were asked the extent to which they agree or disagree with each of the following: “my research is valued by faculty in my department,” “my teaching is valued by faculty in my department,” and “faculty of color are treated fairly here.” The extent that “faculty respected each other” will be also included as a measure of *recognition*.

Table 3.1
Proposed Model for WOC Faculty in STEM

Construct	Label	Scale
<i>Competence</i>		
$\alpha: .728$	Objective: Becoming an authority in my field	1 = "Not important"; 2 = "Somewhat important"; 3 = "Very important"; 4 = "Essential"
	Influencing the political structure	1 = "Not important"; 2 = "Somewhat important"; 3 = "Very important"; 4 = "Essential"
	Objective: Making a theoretical contribution to science	1 = "Not important"; 2 = "Somewhat important"; 3 = "Very important"; 4 = "Essential"
	Keeping up to date with political affairs	1 = "Not important"; 2 = "Somewhat important"; 3 = "Very important"; 4 = "Essential"
	Becoming a community leader	1 = "Not important"; 2 = "Somewhat important"; 3 = "Very important"; 4 = "Essential"
	Mentoring the next generation of scholars	1 = "Not important"; 2 = "Somewhat important"; 3 = "Very important"; 4 = "Essential"
<i>Performance</i>		
$\alpha: .701$	Articles in academic or professional journals	1 = "None"; 2 = "1-2"; 3 = "3-4"; 4 = "5-10"; 5 = "11-20"; 6 = "21-50"; 7 = "51+"
	Chapters in edited volumes	1 = "None"; 2 = "1-2"; 3 = "3-4"; 4 = "5-10"; 5 = "11-20"; 6 = "21-50"; 7 = "51+"
	How many of your professional writings have been published or accepted for publication in the last two years?	1 = "None"; 2 = "1-2"; 3 = "3-4"; 4 = "5-10"; 5 = "11-20"; 6 = "21-50"; 7 = "51+"
<i>Recognition</i>		
$\alpha: .716$	Faculty here respect each other	1 = "Not descriptive"; 2 = "Somewhat descriptive"; 3 = "Very descriptive"
	My research is valued by faculty in my department	1 = "Disagree strongly", 2 = "Disagree somewhat"; 3 = "Agree somewhat"; 4 = "Agree strongly"
	My teaching is valued by faculty in my department	1 = "Disagree strongly", 2 = "Disagree somewhat"; 3 = "Agree somewhat"; 4 = "Agree strongly"
	Faculty of color are treated fairly here	1 = "Disagree strongly", 2 = "Disagree somewhat"; 3 = "Agree somewhat"; 4 = "Agree strongly"
Discrimination	Stress: Subtle discrimination (e.g., prejudice, racism, sexism)	1 = "Not Applicable"; 2 = "Not at All"; 3 = "Somewhat"; 4 = "Extensive"

Missing Data

By default, Mplus uses full information maximum likelihood estimation (FIML) for

datasets with missing data, which uses the raw data as input and hence can use all the available information in the data to impute missing values. Under ignorable missing data conditions (missing completely at random and missing at random), FIML parameter estimates and standard errors are unbiased and more efficient than listwise deletion, pairwise deletion, and similar response pattern imputation (Enders & Bandalos, 2001). Further, FIML yields the lowest proportion of convergence failures and provides near-optimal Type 1 error rates.

Analyses

Mplus 7.4 was the primary statistical software package used to test the validity of the hypothesized models and illustrates the interrelationship between the exogenous variables and endogenous constructs via both numerical output and a picture diagram. Building the final hypothesized model occurred in a series of steps. First, I ran descriptive statistics and tested for the non-normality of the data. Table 3.2 presents the means, standard deviation and kurtosis values for each group. With respect to kurtosis of the data, the more a value deviates from zero, the more concern it is because it impacts tests of variances and covariances, which is what structural equation modeling uses for parameter estimates (DeCarlo, 1997). Descriptives demonstrate that the highest kurtosis value for any variable is 5.05. Although there is no clear consensus regarding how far a kurtosis value must deviate from zero before it can be regarded as problematic, some say possible departure points of non-normality start at plus or minus 2.0 (Boomsma & Hoogland, 2001; Muthén & Kaplan, 1985); others say plus or minus 7.0 (West et al., 1995).

Table 3.2.

Descriptive Statistics by Faculty Group

	<i>Women of Color (WOC) (n=272)</i>					<i>White Men (n=272)</i>					<i>White Women (n=272)</i>				
	Mean	S.D.	Kurtosis	Min	Max	Mean	S.D.	Kurtosis	Min	Max	Mean	S.D.	Kurtosis	Min	Max
<i>Control Variables</i>															
Stress: Subtle discrimination (e.g., prejudice, racism, sexism)	2.09	0.05	-0.32	1.00	3.00	1.28	0.45	-1.04	1.00	3.00	1.72	0.49	-1.53	1.00	3.00
<i>Competence</i>															
Indicate the importance to you personally of each of the following:															
Objective: Becoming an authority in my field	3.07	0.90	-0.19	1.00	4.00	2.81	0.91	-0.77	1.00	4.00	2.70	0.94	-0.95	1.00	4.00
Objective: Making a theoretical contribution to science	2.70	0.95	-0.95	1.00	4.00	2.48	0.95	-0.90	1.00	4.00	2.28	0.95	-0.86	1.00	4.00
Mentoring the next generation of scholars	3.47	0.69	0.53	1.00	4.00	3.25	0.75	-0.38	1.00	4.00	3.25	0.76	-0.46	1.00	4.00
<i>Performance</i>															
How many of the following have you published?															
Articles in academic or professional journals	3.02	1.79	-0.88	1.00	7.00	3.78	1.82	-1.09	1.00	7.00	3.31	1.80	-1.21	1.00	7.00
Chapters in edited volumes	1.61	0.89	3.40	1.00	7.00	1.58	0.97	4.80	1.00	7.00	1.43	0.76	5.05	1.00	7.00
											2.02				
How many of your professional writings have been published or accepted for publication in the last two years?	2.02	1.15	1.11	1.00	7.00	2.21	1.17	-0.09	1.00	7.00	1.08	1.10	1.00	7.00	
<i>Recognition</i>															
Indicate the extent to which you agree or disagree with each of the following:															
My research is valued by faculty in my department	2.78	0.92	-0.51	1.00	6.00	3.06	0.86	-0.08	1.00	6.00	2.88	0.86	-0.45	1.00	6.00
My teaching is valued by faculty in my department	3.29	0.74	0.91	1.00	7.00	3.45	0.71	1.90	1.00	7.00	3.39	0.65	0.72	1.00	7.00
Faculty of color are treated fairly here	3.15	0.83	0.41	1.00	7.00	3.59	0.57	1.03	1.00	7.00	3.31	0.69	-0.16	1.00	7.00

Note: n=816 STEM faculty across 262 institutions.

In the second phase of the analysis, I put together the three measurement models, for constructs (e.g., *competence*, *performance*, and *recognition*), and hypothesized paths to create the full structural model, and used structural equation modeling (SEM) to simultaneously estimate the relationships among sets of variables and confirmed latent constructs, which helped account for measurement error (Bentler, 2006; Bentler & Wu, 2002). SEM is useful in that it provides coefficients that estimate the statistical significance and magnitude of the relationships between the theoretical latent constructs (i.e., *competence*, *performance*, and *recognition*).

I tested for the validity of the three latent factors using confirmatory factor analysis (shown in Figures 3. 2-4). Confirmatory factor analysis is a specific type of structural equation model. CFA starts with a set of latent exogenous variables that are assumed to have a specified effects on a group of endogenous “indicator variables” and seeks to test the relationship of the latent exogenous variable and indicator variables as a hypothesis (Mulaik, 2009). Thus, CFA does not require investigating the data for common factors via calculating the eigenvalues in eigenvectors to get the estimates of correlations, factor loadings, and variances since the hypothesis is developed before any data related to the indicator variables is revealed. Typically the hypothesis is grounded in prior literature about variables. However, it is plausible also to disrupt traditional ways of thinking about a concept and develop a new understanding of the relationship between variables.

Figure 3.2: Measurement Model for Competence

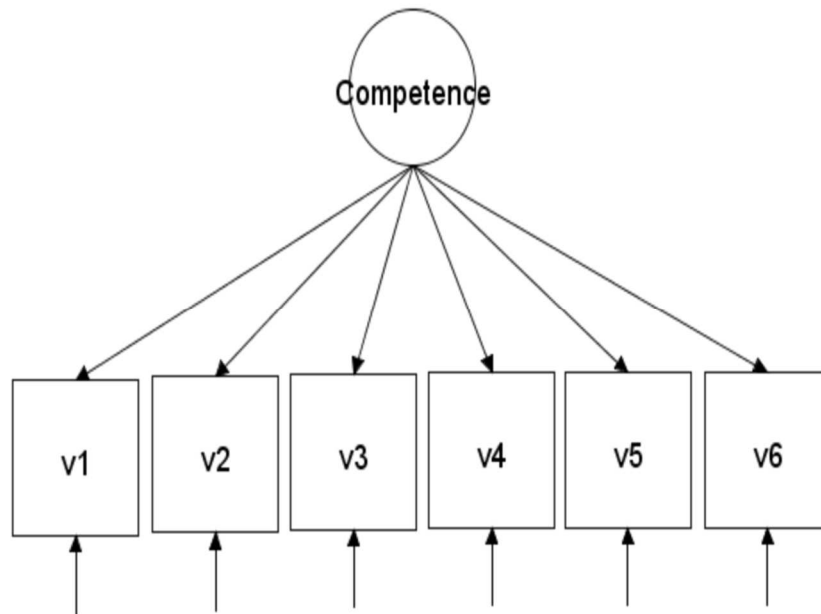


Figure 3.3: Measurement Model for Performance

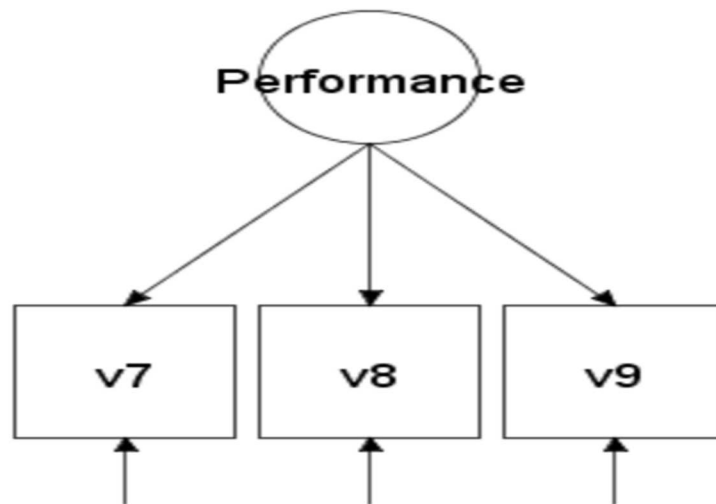
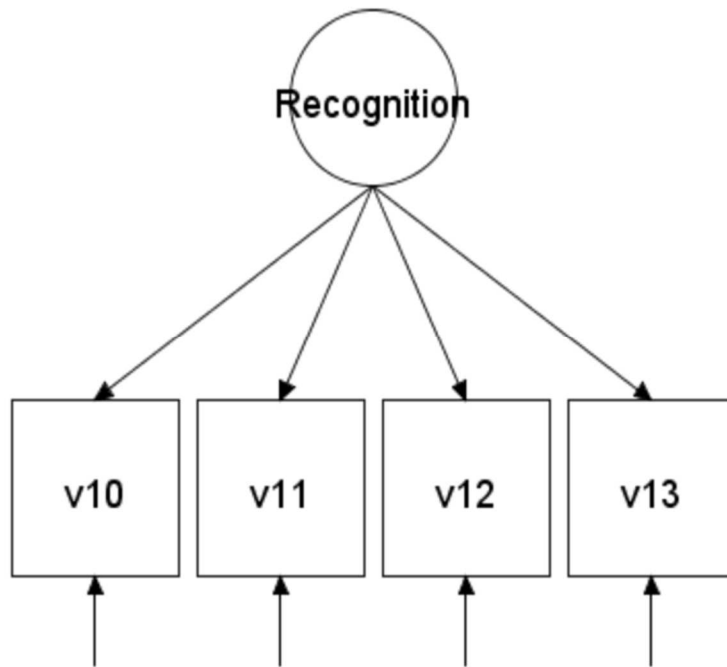


Figure 3.4: Measurement Model for Competence

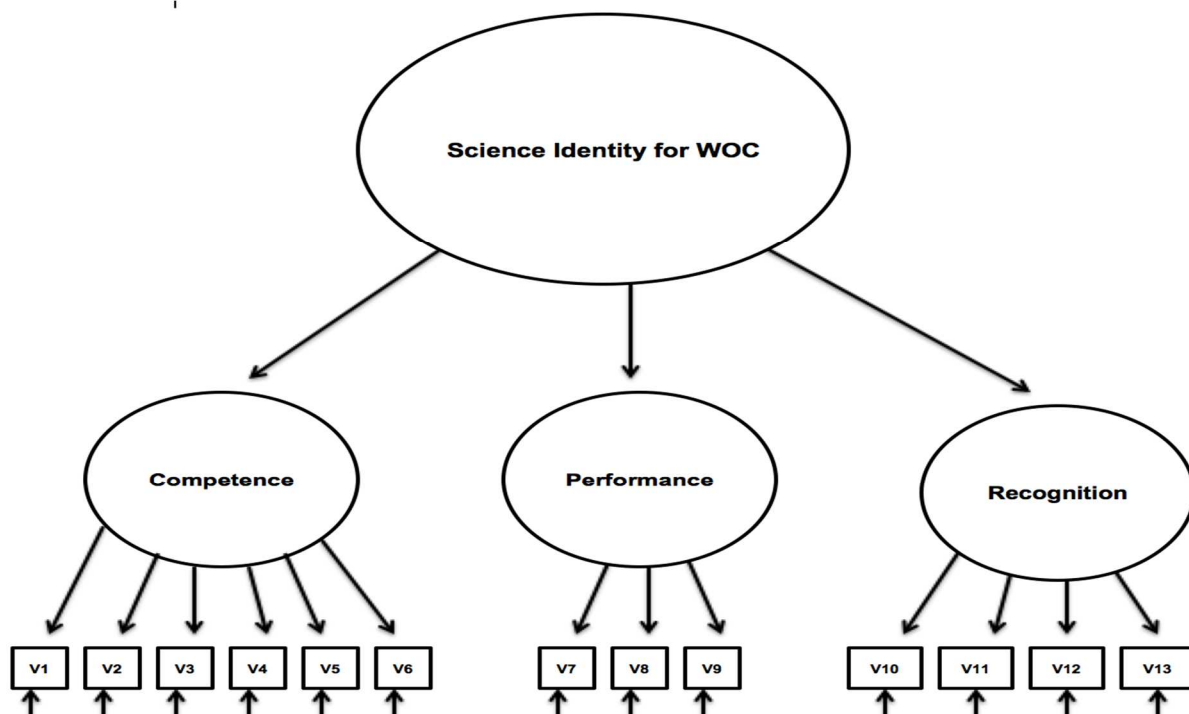


Given the complex nature of science identity for WOC, I employed Second Order SEM analysis to test the theoretical constructs depicted in Carlone and Johnson's (2007) model. This is a statistical technique that is utilized to confirm the theoretical construct in a study that has underlying sub-constructs or components (Byrne, 2012). For instance, Carlone and Johnson (2007) theorize that *Science Identity* for WOC comprise of three primary sub-constructs. I measure each sub-construct using specific items on the faculty surveys. Then, I estimated the effect of the main latent construct on its sub-constructs. Thus, *Science Identity* acted as the second order latent construct, while *competence*, *performance* and *recognition* served as the first order latent constructs or manifestations of the larger concept.

As shown in Figure 3.5, I tested the *Science Identity* model (the main construct) on *competence*, *performance*, and *recognition* (the sub-constructs). This

allowed me to observe the causal effects from the main latent construct to the three sub-constructs. This method also estimated the factor loading for every item embedded within each construct.

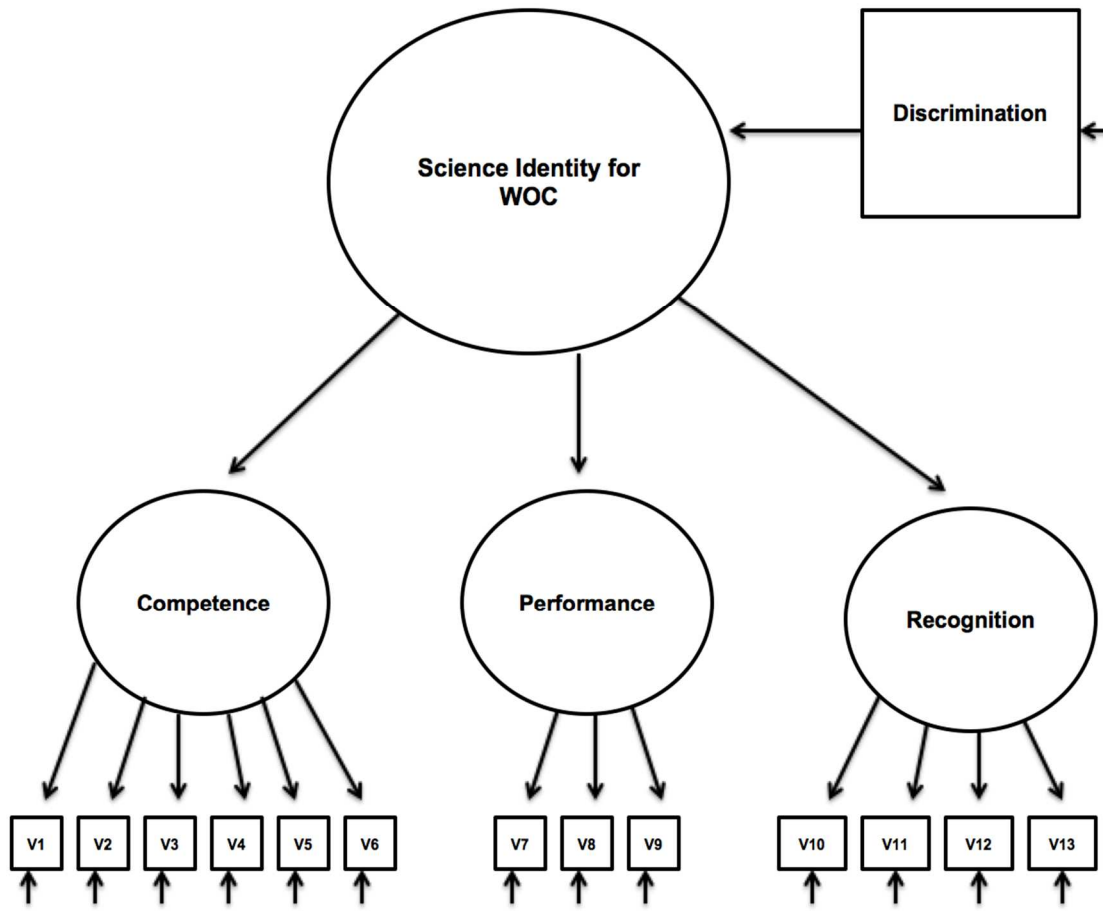
Figure 3.5: Hypothesized Model for Science Identity



Hypothesized Exogenous Variables

Carlone and Johnson's (2007) does not explicitly discuss the ways race and gender impact science identity, rather it is implied. Thus this study takes interest in how specific experiences with stress from discrimination affect science identity. After testing the initial second order model for science identity, I included discrimination as an exogenous variable, because it is related to situational influences that likely impact the science identity for faculty in STEM. See Table 3.2 for the entire list of variables included in the study and their corresponding coding scales.

Figure 3.6: Hypothesized Science Identity Model with Control Variable



As mentioned above, the measurement models include the observed indicator variables and their associated underlying latent constructs. It was necessary to understand that the measurement models were operating adequately before I could have confidence in the findings related to the assessment of the hypothesized SEM model. For each of these constructs, I constrained the variance for the factor at one, leaving the paths for the items comprising the factor free to vary. For all four factors, I hypothesize that indicators will have a nonzero loading for the factor it was designed to measure.

I used goodness of fit indices to determine the adequacy of the overall model (Laird, Engberg, & Hurtado, 2005). Prior research and theory, along with the modification indices, identified possibly ill-fitting parameters in the model and suggested the deletion or addition of causal paths to improve model fit. I used several fit indices to assess model fit during confirmatory factor analysis and structural equation modeling, which included the comparative fit index (CFI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR). Based on minimum thresholds, a CFI value above .90 indicates adequate model fit, while RMSEA and SRMR scores below .06 indicate an appropriate level of fit (Raykov, Tomer, & Nesselroade, 1991). Models considered to be extremely well-fitting have CFI scores above .95 (Hu & Bentler, 1999). I did not to rely on the chi-square test statistic as a measure of wellness of fit because the chi-square likelihood ratio test is sensitive to sample size (Byrne, 2012).

Alternate Model

Given the results from the both hypothesized higher order Science Identity model and the initial correlated Three-Factor model, which suggested a poor fit for White women and men, I opted to develop an alternate model to test across the three STEM faculty samples. This model was simpler and included only 10 indicators and provided a good fit for the White men and White women samples (see Table 3.3 for each latent variable and corresponding items). Given that the alternate model fit all three faculty samples (i.e. WOC, White men and White women) I was able to examine how the theoretical dimensions of science identity were interrelated concepts moderated by race and gender (see figure 3.7. for three-factor model with discrimination variable). It is

important to note that the alternate model was still informed by Carlone and Johnson's (2007) science identity model, it simply represents three interrelated constructs.

Table 3.3
Variables Used in Alternate Model

Variable	
Exogenous Variable	Source of Stress: Subtle discrimination (e.g., prejudice, racism, sexism)
Competence	
<i>Indicate the importance to you personally of each of the following:</i>	
	Objective: Becoming an authority in my field
	Objective: Making a theoretical contribution to science
	Mentoring the next generation of scholars
Performance	
<i>How many of the following have you published?</i>	
	Articles in academic or professional journals
	Chapters in edited volumes
	How many of your professional writings have been published or accepted for publication in the last two years?
Recognition	
<i>Indicate the extent to which you agree or disagree with each of the following:</i>	
	My research is valued by faculty in my department
	My teaching is valued by faculty in my department
	Faculty of color are treated fairly here

Note: n=816 STEM faculty across 78 institutions.

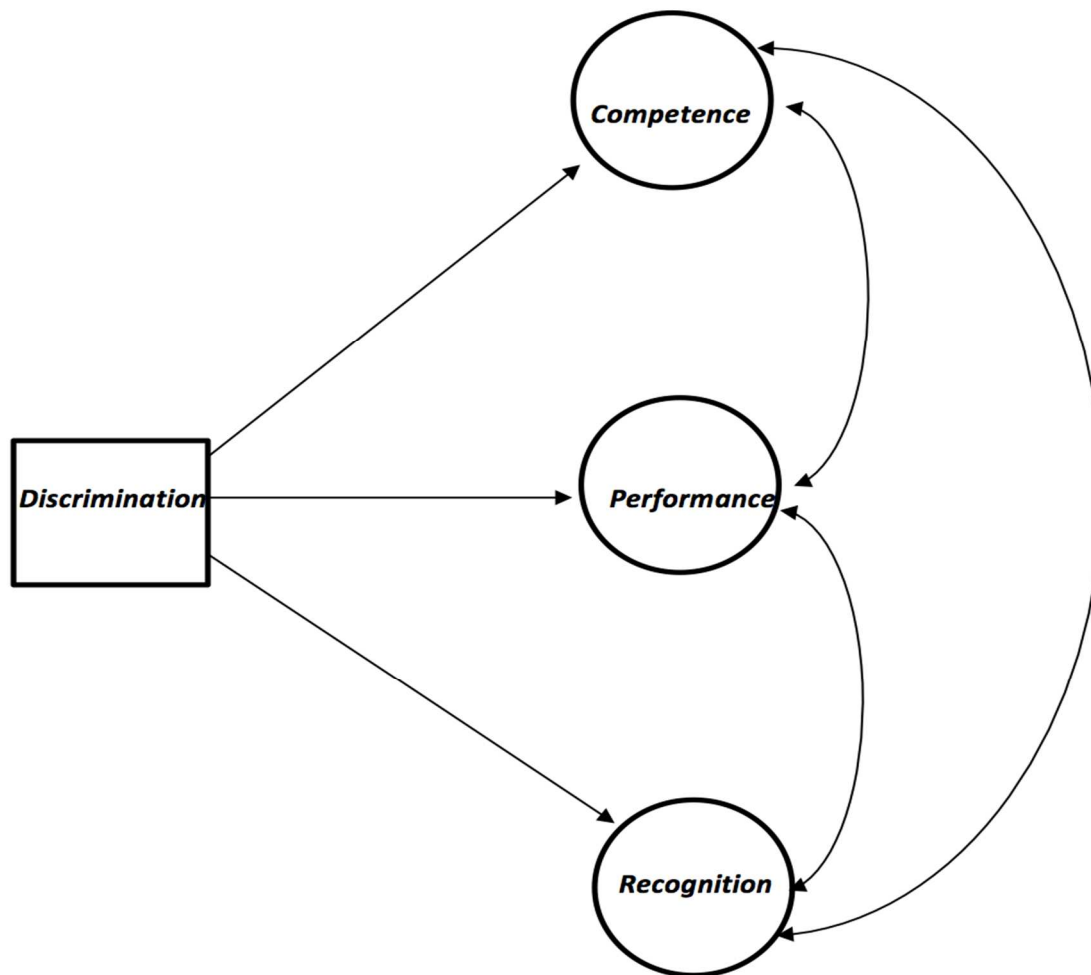
Three-Factor Structural Model Estimation with Discrimination

My next analyses focused on the relationships between three latent variables: *competence*, *performance*, and *recognition* with fewer indicators. First, I tested a three-factor model using the three modified theoretical constructs with the strongest loading measures (i.e. *competence*, *performance*, and *recognition*) for each faculty group.

Given only 13 participants (.015%) had missing data on the faculty surveys, I decided to

keep these participants in the sample and used Full Information Maximum Likelihood (FIML) as the primary imputation technique. I analyzed the data using maximum likelihood estimation in MPlus. Hu and Bentler (1999) suggests evaluating more than one fit index to assess model fit. Acceptable Type II and Type I error rates reflected cut-off values close to .95 for the comparative fit index (CFI), .08 for the standardized root mean square residual (SRMR), and .06 for the root mean square error of approximation (RMSEA) (Hu & Bentler, 1999).

Figure 3.7. Three Factor Model with Discrimination



Finally, to allow for comparisons of the effect of independent variables on the outcomes of interest, we used the equation offered by Paternoster and colleagues (1998) for independent sample to statistically test for the equality of regression coefficients to draw systematic comparisons of *Science Identity* model across the three faculty groups.

Qualitative Analysis

A qualitative analysis based on an existing pilot study was integrated to further explore the quantitative results. The analysis of qualitative data permits triangulation of the study's findings, and allows for a more thorough examination of how and why certain factors are related to scientific identity for WOC. According to Cresswell (2013), the convergent approach uses separate qualitative methods to offset the limitations that are associated with quantitative strategies. This approach also allows for triangulation of the methods by comparing both quantitative and qualitative analysis for validation of the results. Other uses for this approach include a clear depiction of quantitative and qualitative results to generate a more comprehensive understanding of a phenomenon, and comparing multiple phases of analysis within a single study (Cresswell & Plano Clark, 2007). These strategies are appropriate for this study, allowing me to make comparisons amongst participants across gender, academic rank, and institutional type.

Institutional Sites

The two institutions included within this study are predominantly white, although the states and respective sites are more diverse than the schools overall. The universities are located in areas that are known to be hotbeds of science and technological advancement within industry and home to numerous public and private universities with

strong STEM reputations. The STEM faculty is around 20% female, 8% nonwhite, and 3% WOC at the first institution, and 22% female and 9% nonwhite, and 4% WOC at the other.

I selected these particular institutions because of the initiatives and services offered for women faculty in STEM, such as programs that support them in pursuit to achieve tenure and leadership positions. In terms of diversity, the institutions have a relatively large population of WOC STEM faculty. In an effort to recruit participants, I used each STEM department website to identify WOC. I introduced the purpose of the study in the recruitment email that was sent to prospective 92 faculty who met the eligibility criteria. Fourteen individuals accepted the invitation and were interviewed. However, four participants withdrew before the completion of the study. This highlights the level vulnerability WOC STEM faculty experience when sharing their professional experiences. Thus, data collection during the qualitative phase produced ten useful interview transcripts. Directly contacting faculty minimized potential risk for the participants.

All participants in this study were full-time WOC faculty in STEM who indicated that they have teaching/advising responsibilities and were employed in STEM departments in colleges and universities. Qualitative data was collected from WOC in STEM that were employed at two different institutions: Ace University and Paradise University (pseudonyms).

Ace University is a public institution founded in the early 1900's and is located in a metropolitan area in the United States. It is a large research-intensive university with an enrollment of nearly 43,000 students—two-thirds of the student body consists of

undergraduates. The racial composition of the entire student body (both graduate and undergraduate levels) at Ace University in the fall of 2015 was as follows: 27% White, 33% Asian, 19% Latina/o, 12% International, 4% Black, and .5% Native American. Ace University offers 125 undergraduate and 200 graduate degree programs that are housed within 12 academic schools. In 2015, almost 4,300 individuals were employed as faculty members at Ace University, including 13 Nobel Laureates, 10 National Medal of Science recipients, and one Fields Medalist (a prestigious mathematic honor). In general, the majority of faculty were White, making up 66.2% of all faculty across all disciplines. Nearly a third of the faculty members at Ace University identified as faculty of color. Specifically, 23.8% were Asian/Asian American, 3.1% were Black, 6.6% were Latina/o, and 0.3% were Native American.

Paradise University is also a large public research-intensive university. Similar in size to Ace, Paradise University had an enrollment of 35,000 students of which 25,000 are undergraduates. In the fall of 2015, 24.3 percent students who attended Paradise University identified as White, 42.9 percent were Asian, 2.8 percent were Black, 3.5 percent were Latina/o and nearly .7% of students were of Native American and/or Pacific Islander descent. Furthermore, 12% were international students. Also similar to Ace University, Paradise University has a decorated faculty body that has received various awards and honors, including four Nobel Laureates. Nearly 2000 faculty were employed at Paradise University in the 2014-15 academic year, and the faculty on campus were mostly White (74%). Thus, Paradise had a slightly smaller population of faculty of color compared to Ace University (26% at Paradise and 29% at Ace). More specifically, the Paradise faculty was 12% Asian, 6% Black, 8% Latina/o,

and .1% were Native American.

WOC in tenured or in tenure-track faculty positions within STEM disciplines (e.g. biological sciences, physical sciences, mathematics and engineering) at Ace and Paradise were invited to participate in the study. Additionally, the range of different ethnicities allowed me to uncover the variability of the participants' experiences within the academy. I decided to only interview 10 participants, given the timeline that I had to conduct all interviews. This also adds to the feasibility of the study, since I transcribed the interviews, coded the data, and conducted observations. The observations included general facilities, which consist of faculty's workspaces, professional development centers, and classrooms. This method of recruitment was more effective than going through the STEM departments, with consideration to concerns over privacy/willingness to participate in the study. Furthermore, all participants will be referred to by pseudonyms and broader STEM disciplines to ensure confidentiality and protect their identities.

Five WOC faculty in STEM from Ace University and five WOC STEM faculty from Paradise University participated in one-on-one semi-structured (Bogdan & Biklen, 1998) interviews. All participants were both full-time status and either earned tenure or were in a tenure-track appointment at the time of interview. With respect to academic rank, five participants were assistant professors, four were associate professors, and one was a full professor at the time of interview. Although the participants were from diverse academic disciplines, I aggregated their respective departments into boarder categories to conceal their identities. These categories were generated using guidelines developed by the National Science Foundation. The largest proportion of participants

come from the biological/life sciences (n=4), followed by physical sciences (n=2). Two professors are in engineering departments; two reported that they are faculty within mathematics.

This study explored the narratives of ten STEM faculty who self-identified as WOC. For the purpose of better understanding the sample, Table 3.4 provides the background characteristics of each participant. Please note that some demographic information, such as academic rank, was withheld for the protection of the women who participated in this study.

3.4.

Participants Name, Ethnicity, and Broad STEM Discipline

Name	Ethnicity	Broad Discipline
Camilla	Multi-Racial	Engineering
Cordelia	Black	Biological Science
Irene	Black	Engineering
Judith	Latina	Engineering
Mary	Asian	Physical Science
Natalie	Asian	Physical Science
Pamela	South Asian	Physical Science
Tia	Black	Engineering
Valerie	Latina	Biological Science
Vanessa	Black	Biological Science

Procedures

After assembling a list of faculty who met the study's eligibility criteria (i.e. WOC faculty in STEM) at both Ace and Paradise, emails inviting them to participate in the study were sent. I used Snowball sampling (Bogdan & Biklen, 1998) to recruit other WOC faculty in STEM who could make valuable contributions by their participation in the study. Once the sample was finalized, I conducted the interviews at the institutions or over a virtual meeting space (for participants who needed additional scheduling

accommodations). All participants were interviewed individually within one 60-90 minute session. Furthermore, I used a semi-structured interview protocol, which consist of open-ended questions and probes. The protocol structure allowed the participants to respond to the questions with the level of detail that they felt was appropriate. The theoretical framework informed questions on the protocol (see Appendix A). Participants were asked about their graduate training and career experiences. In total, there were eight broad questions that required participants to reflect on their academic background, their current work environment, challenges related to their career, feelings of acceptance in their field, and future career plans—all which aimed to better understand the *competence*, *performance*, and *recognition* dimensions included in Carlone and Johnson's (2007) model. I asked for all participants consent to have their interview audio recorded for later verbatim transcription. Before the start of each interview, participants completed a demographic questionnaire. At the conclusion of each interview, I created a reflective memo that detailed my impressions of each interview. The memos will be useful as I make sense of the interviews and potential findings. Furthermore, the memos will allow me to draw a connection between participants' responses and emerging linkages between themes.

Aside from the semi-structured interviews, I collected data from site observations. Although the analysis of the study's qualitative data will focus on the interviews, the observations will serve as pivotal pieces that will allow me to deepen my understanding of the contextual factors which impact the lived experiences of the participants. I also toured the campuses as a way to familiarize myself with the types of facilities and services the institutions offer to support faculty, namely WOC. For example, I was

interested in learning if it is commonplace for faculty to share offices, or have access to a personal phone and email. Further, I visited each institution's campus-based professional development center that provides opportunities to faculty to develop their skill sets through workshops and other materials.

Measures and Analyses

Prior to the start of each interview, all participants completed a questionnaire that gathered information on their demographics, academic background, and aspects related to their scientific identity (see Appendix B - Demographic Questionnaire). The demographic questionnaires took roughly two to three minutes to complete. The faculty's narratives that were collected through the semi-structured interviews served as the primary source of data for the qualitative phase of the study. The interview protocol was informed by Carlone and Johnson's (2007) theoretical framework and also by the literature review on the experiences of WOC faculty in the academy. Participants were asked questions about: academic background and training, perceptions of their current work environment, challenges related to their career, strategies they use to navigate the academy, and future career plans (see Appendix A - Interview Protocol).

After I collected the data from the individual interviews, I transcribed the interview recording to guarantee accuracy. Although I have previously collected the data during the pilot, I had the opportunity to thoroughly analyze the interviews as a result of this study. Data was organized through a systematic coding process. Coding is a technique used to sort data, structuring it in a meaningful way that is useful for comparison and understanding (Maxwell, 2005). The codes developed in this study were generated utilizing deductive and inductive processes. All responses were coded using MaxQda,

qualitative software program, which assists with coding and organizations of the data to uncover a phenomenon and develop categories. I also analyzed the data to provide value and meaning to the responses provided during the interviews. As each transcript was analyzed, I first used deductive coding to categorize the dimensions of the scientific identities of each participant (e.g. *competence*, *performance* and *recognition*), given their responses. This allowed me to understand the nuances in how the participants make sense of their identities, and how their identities influence their navigation within the academy. Then, I coded inductively for new themes that emerge from the participants' stories. This coding technique presented an opportunity to expand Carlone and Johnson's (2007) model—which focuses on undergraduate and graduate experiences—to generate a more robust understanding of how WOC faculty interpret their unique experiences once in their careers. Aside from identity categories, other sample codes included: overview of their roles, graduate training, barriers encountered in the workplace, and coping strategies that lead to their success. I anticipated that additional codes would surface once I interviewed the participants.

Trustworthiness of Findings

To confirm the trustworthiness of the findings within this study, I documented all research procedures and forms (e.g., recruitment media, consent forms, transcripts, data analysis excel sheets, etc.). Also, I actively listened to each of the audio recordings and carefully reviewed the transcripts to confirm that the findings were consistent. Furthermore, I used member-checking to ensure the reliability of the transcripts by providing each participant a copy of their transcripts to review for accuracy. I provided access to the quotes under themes that will be in the study, to

ensure that I correctly interpreted their experiences. Participants reserved the right to edit, or prohibit use of their transcript or interview recording. Once the data was analyzed and a preliminary report of findings was finished, I conducted a second phase of member checking strategy to validate the findings (Maxwell, 2005). This step provided transparency and confirmed whether or not I captured the experiences and perspectives of the WOC involved within this study. With this in mind, I extended invitations for the participants to meet with me in person, or talk over the phone, as a means to validate the study's findings; these meetings were voluntary, as I anticipated most participants would not express an interest in meeting after their initial interview. However, I was able to communicate with several participants over email in which they provided feedback, with respect to the preliminary findings.

Limitations

The convergent mixed methods design mitigates many limitations associated with qualitative and quantitative analytical techniques; however, features of the methodological approach (e.g. limitations, measures, and sample) must be considered as the findings of this study are discussed. More specifically, this study is limited by the use of secondary data, meaning it is restricted to the questions and measures of the existing data set, which was not designed from a scientific identity perspective. Thus, relationships that were found between latent constructs and endogenous variables, and the strength of those relationships, may not be as robust as I would have liked. Another limitation is that although data collection on faculty is focused on undergraduate teaching faculty, research has observed over the years that the most vulnerable populations may not respond to surveys, and others neglect to provide identifying

information (rank, race/ethnicity or department). Thus, although I hope I am capturing relationships from a nationally representative sample of STEM faculty, I may be underestimating relationships for individuals who do not want to risk being identified by their own institution. Further weights are typically used to represent the national population of men and women faculty for all HERI reports, but I did not weigh the responses in this study because the exact numbers within STEM fields are not available in IPEDS. In the future, NSF data could be instrumental in helping to weigh responses obtained using HERI surveys. Finally, small sample sizes prevent disaggregation by underrepresented groups. Even when collapsed together, the number of individuals in the WOC category is rather small.

There also were several limitations to this study in terms of the qualitative phase of the study. WOC faculty in STEM were strategically invited to participate based on a need for variety within the sample by race, discipline, and academic rank. However, notwithstanding these recruitment efforts, there were a small number of associate and full professors participated in this study. This makes it more difficult to differentiate how WOC navigation of the academy changes as they are promoted within the academic ranks, although the senior faculty are likely to make these distinctions, to some extent within their narratives.

Next, this study included a racial disproportion among the potential participants studied (i.e. number Native American participants). This imbalance likely occurred due the current racial demographic makeup within the STEM disciplines. It is also possible that self-selection bias was present within this study. This means that it is possible that participants included within the study will not represent the entire target population of

WOC faculty in STEM. Nonetheless, the use of interviews to collect data will be sufficient to gather the participants' narratives, which was included within the analysis (Creswell, 2013). Lastly, it is important to note that the study may incur a degree of selection bias within the sample, and it is possible that the participants' unique experiences and responses deviate from the general population of WOC faculty in STEM. However, it is extremely difficult to study the small numbers because they are often overworked, busy, and may feel it is too risky to tell their stories that may imply racism and sexism in the department.

CHAPTER 4: Mixing Results on Science Identity

Given the purpose of the study, the integration of two phases of qualitative and quantitative data analyses was utilized to answer the overarching research questions. Structural Equation Modeling (SEM) was the primary technique for the quantitative phase analyses, using the 2007 and 2010 HERI Faculty Surveys. As discussed in chapter 3, semi-structured interviews of 10 participants served as the primary source for qualitative phase data analyses. In terms of qualitative analyses, I used thematic analysis to uncover multiple phenomena in the data. Findings from each analysis were then mixed to discuss the nuances with respect to how identity impacts the navigation of the academy for WOC faculty in STEM. The findings are discussed in five primary categories: (a) The hypothesized Science Identity Model; (b) Disrupting the “Objectivity within STEM” Myth; (c) Identity and experiences in the STEM and (d) Strategies used to navigate STEM and academia.

Results on the Hypothesized Science Identity Model

To study the first research question: “Given identified theoretical dimensions of *Science Identity (competence, performance, and recognition)*, how are these interrelated concepts moderated by race and gender? Which aspects are central to WOC?,” I sought to test whether the faculty data would support the hypothesized models, using the confirmatory factor analysis for Science Identity across faculty from racial and gender sample populations. If similar results for model fit were obtained across such different samples, then the validity of model would be better established as important not only for WOC but for White men and White women. However, because of the small sample sizes, invariance tests could not be conducted across groups. The

approach then was to identify an appropriate model, compare model statistics, and test equality of coefficients for parameter estimates across the samples. In all cases, the relationship of Science Identity or its three hypothesized constructs was significantly different for WOC compared to White men and women.

The science identity theory suggested that the hypothesized model (see Figure 2.1) includes three theoretical constructs (i.e. *competence*, *performance* and *recognition*), depicted as concentric circles that indicate correlated relationships. However, this left open a number of ways to test a hypothesized model based on theoretical assumptions. Were these concepts simply inter-correlated or do they together compose a larger concept called Science Identity? The theoretical model could be confirmed if the fit statistics, model estimates, and difference statistic signified that a hypothesized model described the sample data better than each of the alternative models.

All Faculty Analysis

This study tested two key models to determine how the three theoretical constructs of science identity are empirically related: *competence*, *performance*, and *recognition*, and also associated with to the environmental factor of discrimination. The first step was to build three separate models of the theoretical constructs. In order to build the model, I start with three separate latent factors as part of the measurement models (*competence*, *performance*, and *recognition*). This was first conducted to establish that each of these constructs are represented in the data. Unlike exploratory factor analysis, confirmatory factor analysis in SEM employs simultaneous equations to test whether there was also a measurement model consisting of a larger latent construct

(a higher order factor) called Science Identity that is composed of these three first order latent constructs based on the theory (i.e. *competence*, *performance*, and *recognition*). The first stage of model building is to determine if each of the separate components (or measurement models) of science identity have a good model fit based on data and measures in the survey.

Measurement models for All Faculty. Measures of overall fit signified the extent to which the sample data fit the measurement models for *competence*, *performance* and *recognition*. The Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA) and Standardized Root Mean Square Residual (SRMSR) were utilized to examine the overall “goodness of fit” for the models. The Chi-Square statistic, which was also calculated for model comparison purposes, was the only statistic generated for the null model. Table 4.1 presents the factor loadings for the measurement models of each latent variable.

The RMSEA signifies the absolute measure of fit that is based on the non-centrality parameter (Bentler & Bonett, 1980). The CFI is interpreted similarly as the RMSEA, but is not as influenced by sample size (Bentler, 1990). A value of .90 for the RMSEA and CFI statistics represents an acceptable fit of the data to the model. A CFI value $>.95$ and RMSEA value of $<.05$ indicates a good fitting model. The SRMSR indicates the difference between the observed covariances and the predicted covariances; thus, the smaller values represent a better model fit (Kline, 1998). With respect to the SRMR, a value between .08 and .05 indicates an acceptable fitting model (Marsh, Balia, & McDonald, 1988). A value less than .05 represents an exceptional fitting model.

The overall fit indices suggested that the measurement models for *competence* ($\chi^2=22.853$; $df=15$; CFI= .98; RMSEA= .019; SRMR= 0.023), *performance* ($\chi^2=2.569$; $df=2$; CFI= .99; RMSEA= .019; SRMR=.010) and *recognition* ($\chi^2=12.661$; $df=2$; CFI= .97; RMSEA= .046; SRMR= .024) provided an appropriate fit to the sample data (see Table 4.1). Factor loadings represent the extent to which the latent variable impacts a measured variable. Loadings close to 1 indicate that the latent factor strongly affects the measured variable. Loadings close to zero indicate that the latent factor has a weak affect on the measured variable. In terms of the measurement model, the estimated factor loadings were significant. Measurement error variance is the unique part of the indicator not impacted by the latent variable (Bollen, 1989). Measurement error variance corresponds with each indicator within the model; for example, the indicator that is best explained by the *recognition* latent variable is one where a small error variance is present. Alternatively the r square reported in Table 4.1 represents the proportion of variance explained by the latent construct.

The measurement model produced one statistically significant correlation across within the competence latent factor. Two item correlations were moderately high: “Keeping up to date with political affairs” and “Influencing the political structure” (.66). Also, first-order factors *competence* and *performance* showed statistically significant correlations, which was tested in Model 1 that follows according to the hypothesized model.

Table 4.1.

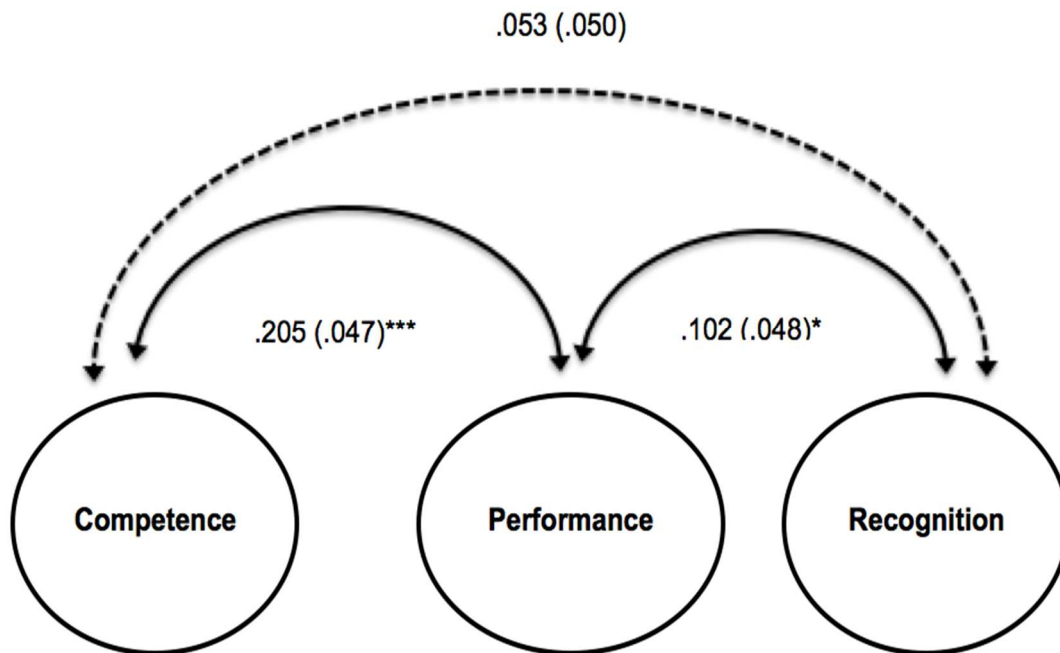
Factor Items and Loadings: All Faculty Sample Measurement Models (n=816)

Item	Standardized Factor Loading	R ²	P-Value
<i>Competence</i>			
Objective: Becoming an authority in my field	0.48	0.226	***
Influencing the political structure	0.63	0.397	***
Objective: Making a theoretical contribution to science	0.42	0.175	***
Keeping up to date with political affairs	0.47	0.223	***
Becoming a community leader	0.73	0.538	***
Mentoring the next generation of scholars	0.48	0.233	***
Fit indices: $\chi^2=22.853$; df=15; CFI= .98; RMSEA= .019; SRMR= 0.023			
<i>Performance</i>			
Received funding for your work from - State or federal government	0.44	0.19	***
Articles in academic or professional journals	0.78	0.61	***
Chapters in edited volumes	0.57	0.33	***
How many of your professional writings have been published or accepted for publication in the last two years?			
Fit indices: $\chi^2=2.569$; df=2; CFI= .99; RMSEA= .019; SRMR=.010	0.84	0.71	***
<i>Recognition</i>			
Faculty here respect each other	0.48	0.23	***
My research is valued by faculty in my department	0.60	0.37	***
My teaching is valued by faculty in my department	0.74	0.57	***
Faculty of color are treated fairly here	0.48	0.23	***
Fit indices: $\chi^2=12.661$; df=2; CFI= .97; RMSEA= .046; SRMR= .024			

Note: n= 816 STEM faculty across 78 institutions.

Model 1: Three Factor Correlational Model. Next, I developed Model 1 (see Figure 4.1, and Table 4.2 for estimates and standard errors) which posited that the three dimensions were correlated amongst each other. Carlone and Johnson (2007) use overlapping concentric circles to describe the interconnectedness of the theoretical constructs of *competence*, *performance* and *recognition*. This calls for a model that tests these hypothesized interrelationships using the three separate latent constructs.

Figure 4.1. All Faculty-Three Factor Correlational Model (Model 1)



The three-factor model had 68 distinct parameters with 68 degrees of freedom, with the chi-square of $\chi^2 = 213.444$. The model was statistically significant ($P < .001$). Other fit indices, $CFI = .95$, $RMSEA = .049$, and $SRMR = .048$, indicated the model had a good fit for the All Faculty sample. Figure 4.1 and Table 4.2 present estimates of the correlation between each latent variable. It also suggests that a significant and positive relationship exists between *competence* and *performance* ($\beta = .205^{**}$). Likewise,

performance and *recognition* share a positive and significant relationship ($\beta=.102^*$), but the relationship is a weaker. Contrary to expectations from the Carlone & Johnson's qualitative study, faculty *competence* was not significantly associated with *recognition*. Thus, even though it was a good-fitting model, this configuration in Model 1 did not support the theory of significantly interrelated concepts for All Faculty.

Table 4.2.

Parameter Estimates for Three Factor Model: All Faculty (n=816)

	b	β	Sig.	S.E.
<i>Performance</i>				
<i>Competence (covariance)</i>	0.018	0.205	***	0.047
<i>Recognition</i>				
<i>Competence (covariance)</i>	0.007	0.053	n.s.	0.050
<i>Performance (covariance)</i>	0.007	0.102	*	0.048

Note: $\chi^2=213.44$; df=68; CFI=.95; RMSEA=.049; SRMR=.048

*p<.05 **p<.01 ***p<.001

Model 2 All Faculty- Full Structural Hypothesized Model. Next, I ran Model 2 (see Figure 4.2) that depicts the theoretical constructs of *competence*, *performance* and *recognition* as indicators of *Science Identity*. Table 4.3 lists the estimates and standard errors for the model. Given the complex nature of science identity for WOC, I developed a higher-order model to test the theoretical constructs depicted in Carlone and Johnson's (2007) model on All Faculty. I estimated the effect of the main latent construct on its three sub-constructs. Thus, *Science Identity* acted as the second order latent construct, while *competence*, *performance* and *recognition* served as the first order latent constructs as indicators. This study takes interest in how specific experiences with discrimination affect science identity. Thus, I next estimated a structural model that included discrimination as an exogenous variable, because it is

related to situational influences that likely impacts the science identity of faculty in STEM.

Figure 4.2- All Faculty-Full Structural Model (Model 2)

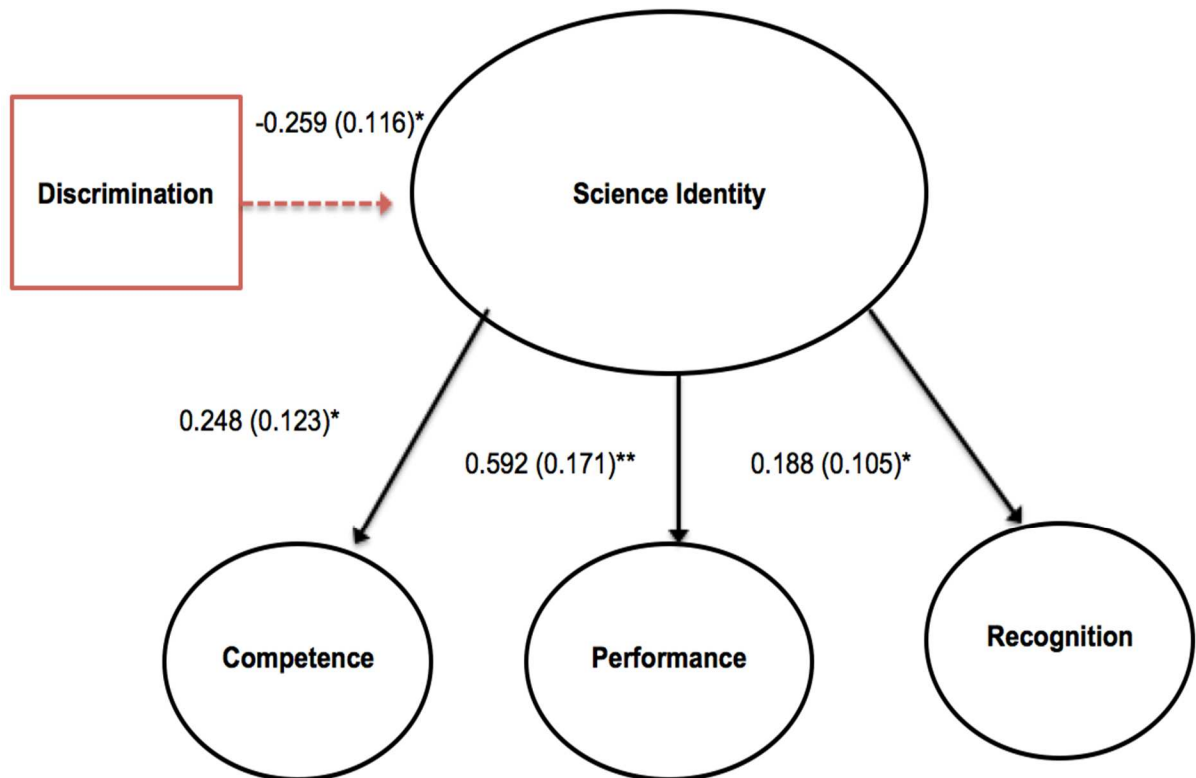


Table 4.3.

Parameter Estimates for Full Structural Model with Discrimination: All Faculty (n=816)

	b	β	Sig.	S.E.
<i>Science Identity</i>				
<i>Competence</i>	0.976	0.248	*	0.123
<i>Performance</i>	0.766	0.592	**	0.171
<i>Recognition</i>	0.403	0.188	*	0.105
<i>Discrimination</i>	-0.270	-0.259	*	0.116

Note: $\chi^2=206.988$; $df=74$; $CFI=.95$; $RMSEA=.048$; $SRMR=.050$

* $p<.05$ ** $p<.01$ *** $p<.001$

The primary objective of this study was to empirically test Carlone and Johnson's (2007) Science Identity Model using second-order confirmatory factor analysis. This can

be achieved by comparing the extent to which each of the models shown in Figures 4.1 and 4.2 fit the data. For the purposes of this study, the focal fit comparison of concern is between model 1 (correlated three factor) and model 2 (second order). The higher-order model (as seen in Model 2) aimed to describe covariation among the first-order factors in a parsimonious way (Marsh & Hocevar, 1985). It is important to compare the fit of Model 2 to the fit of Model 1. The study's hypothesis was correct, Model 2 did yield a better fit compared to Model 1 according to both the AIC and BIC values.

Second order estimates for All Faculty. With respect to the higher-order model, the chi-square was $\chi^2 = 206.988$ with 74 df. The model was statistically significant ($P < .001$). Other fit indices, $CFI = .95$, $RMSEA = .048$, and $SRMR = .050$, indicated the model had a good fit for the All Faculty sample. The estimates for the other factors on *Science Identity* were statistically significant: $.246^*$ for *competence*, $.592^{**}$ for *performance*, $.188^*$ for *recognition*, and $-.259^*$ for discrimination (see Figure 4.3). The standard errors for the *competence*, *performance*, and *recognition* factors were: 0.012 for *competence*, .044 for *performance*, and .071 for *recognition*. A factor's error variance indicates the quantity of variance within a particular factor that is not explained by the relationship to the higher-order construct. These results indicate that *performance* is a primary indicator of *Science Identity*, and the other two first order latent factors were also significant but weaker in comparison. Further, discrimination was significantly related to *Science Identity* in the All Faculty sample.

In order to improve model fit, slight modifications were made. The SRMSR for the initial model for the entire sample of STEM faculty (All Faculty) was .10, signifying a poor fitting model. Based on standardized residual covariance (SRC) and the

Modification Index (M.I.) recommendations, the model was modified as a result of an understanding of the sample's dynamics, as well as the theory of scientific identity model for WOC. Eight error variances were allowed to be correlated to form four error covariances. Those four covariances were generated to improve the model fit. The SRMSR for the final All Faculty *Science Identity* model was .045. This suggested that the higher-order factor model for the All Faculty was a good fit to the data.

Model comparisons for All Faculty. The hypothesized model of a higher order *Science Identity* concept (Model 2) was compared to the three adjusted models using the Chi-Square Difference Statistic. The hypothesized Model 2 fit the sample data significantly better than the null and three factor Model 1 that correlated *competence*, *performance* and *recognition*. Individual latent constructs fit considerably better than the hypothesized model, which indicates that each latent component of *Science Identity* is a good fit for the data, but does not follow the theory in terms of interrelatedness between the factors.

Although fit indices examine the adequacy of a model overall, model estimates offer comprehensive details about certain model elements. An in-depth assessment of model estimates can provide key information with respect to components and relationships within the overall model. It is important to note that the factor loadings for the null model were set to zero. In addition, estimates are listed in standardized form.

In examining the relationships between *competence*, *performance*, and *recognition*, Model 1 did not conform to the theory as originally proposed by Carlone & Johnson (2007), since *competence* was not significantly correlated with *recognition*. This means that most faculty do not rely on *recognition* in their assessments of their

own competence. However, Model 2 indicates that there is a higher order *Science Identity* construct and it is composed of *performance* primarily, *competence*, and *recognition* (though less important). Further, *Science Identity* is not significantly related to experiences or discrimination in the workplace for All Faculty. Because the original theoretical model was developed on WOC, the results in the next section differ with that sample.

WOC Analysis

Model 1-Three factor Correlated Model. The three-factor model was investigated in an effort to establish a good fitting model. The three-factor model had 42 distinct parameters with 78 degrees of freedom. The chi-square was $\chi^2 = 120.035$. The model was statistically significant ($P < .001$). Other fit indices, $CFI = .95$, $RMSEA = .048$, and $SRMR = .050$, indicated the model had a good fit for the WOC sample. Figure 4.3 and Table 4.4 present estimates of the correlation between each latent variable. It also shows that a significant and positive relationship exists between *competence* and *performance* ($\beta = .146^{**}$). Likewise, *performance* and *recognition* share a strong positive and significant relationship ($\beta = .149^{***}$). Unlike the All Faculty Model 1, there is a significant (albeit weaker) relationship between *competence* and *recognition* ($\beta = .96^*$) among WOC faculty in STEM. Thus, Model 1 for WOC conforms to the general theory of correlated constructs in the *Science Identity* Model in the literature, but the findings indicate that *recognition* is more strongly correlated with *performance* than *competence*. It is likely that *competence* has a weaker association with *recognition* because WOC have already developed the competence necessary for their career stage, or that WOC

have devised ways that protect their sense of self as part of survival in STEM that is discussed further in the qualitative findings

Figure 4.3- Three-Factor Model with Estimates for WOC

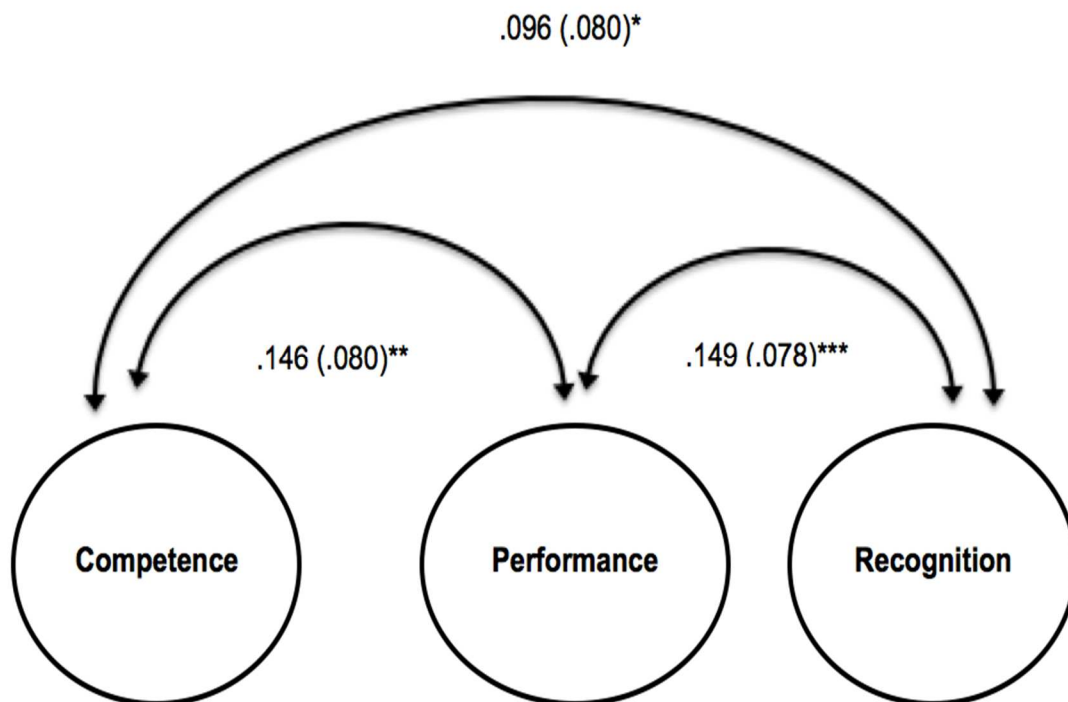


Table 4.4.

Parameter Estimates for Three Factor Correlated Model: WOC (n=272)

	b	β	Sig.	S.E.
<i>Performance</i>				
Competence (Covariance)	0.012	0.146	**	0.080
<i>Recognition</i>				
Competence (Covariance)	0.014	0.096	*	0.080
Performance (Covariance)	0.010	0.149	***	0.078

Note: $\chi^2=120.035$; $df=78$; $CFI=.95$; $RMSEA=.048$; $SRMR=.050$

* $p<.05$ ** $p<.01$ *** $p<.001$

Model 2- WOC Full Structural Model. The full structural model was examined in an effort to ascertain whether it provided a better fit than the three-factor model for the

WOC sample (see Figure 4.4). The structural model had 59 free parameters with 74 degrees of freedom. The chi-square was $\chi^2 = 116.399$, and the degrees of freedom ratio χ^2/df was 1.57. The model was statistically significant ($P < .001$). Other fit indices, $CFI = .95$, $RMSEA = .039$, and $SRMR = .044$, indicated the model had a good fit for the WOC sample. Figure 4.4 presents estimates of the correlations between each first-order construct in relation to the Science Identity theory. The data clearly show that WOC are significantly more likely to experience discrimination as a source of stress compared to the All Faculty, and more importantly, it is shown to significantly affect forms of professional identity in science. See Table 4.5 for estimates and corresponding standard errors. As expected, discrimination has a negative and significant relationship with *Science Identity*. The results suggest the *performance* ($\beta = .691^{***}$) served as the strongest indicator of *Science Identity*, followed by *competence* ($\beta = .273^{**}$) and *recognition* ($\beta = .153^*$).

Figure 4.4- Structural Model with Estimates for WOC

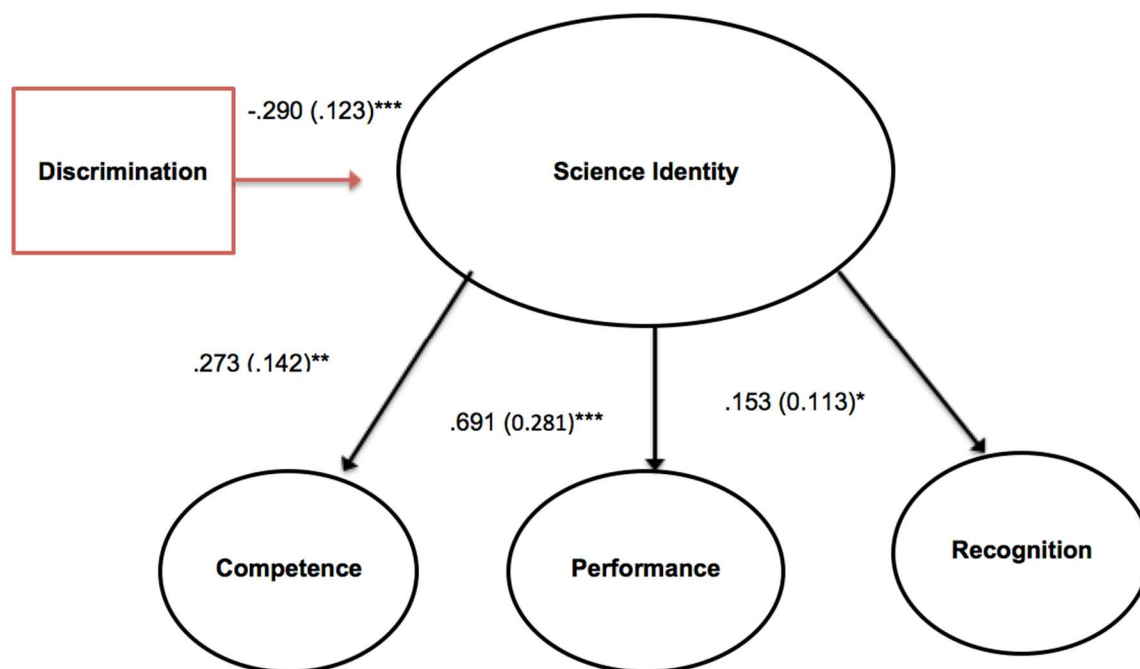


Table 4.5

*Parameter Estimates for Full Structural Model with Discrimination: WOC
(n=272)*

	b	β	Sig.	S.E.
<i>Science Identity</i>				
<i>Competence</i>	1.000	0.273	**	0.142
<i>Performance</i>	0.391	0.691	***	0.281
<i>Recognition</i>	0.449	0.153	*	0.113
<i>Discrimination</i>	-0.040	-0.290	***	0.123

Note: $\chi^2=116.399$ df=74; CFI=.95; RMSEA=.039

SRMR=.044

*p<.05 **p<.01 ***p<.001

Although the higher order factor Science Identify Model appears to be a better fitting model based on RMSEA and SRMR, I cannot compare the chi-square static because I estimated more degrees of freedom with the full structural model than with the Three-Factor correlational model. Instead, I used alternate comparison statistics in the model summary that ends this section of model analyses.

WOC Voices. As an example of the quantitative findings, participants shared in their interviews how discrimination operates in ways that impact their science identity with consequences for their profession. Pamela discussed the outcomes of the systemic discrimination that women faced within her discipline:

“A few months back, maybe in the summer, I put together a document that showed the percentage of women weighted to the percentage of their applications that they put in as PI's [for grants]. It's lower [than for men]. So this is an obstacle and it's an annoying obstacle.”

Although women apply for grants as principal investigators within STEM, particularly the physical sciences, they are still severely underrepresented in terms of being the recipients of research grants. Indeed, having restricted access to resources (such as grants) impacts WOC's science identity, especially performance and likely affects their evaluation during their tenure and promotion review process. ‘

Furthermore, WOC's science identity is shaped by disrespect from students that presumes incompetence and also manifests as a lack of support from leadership. Tia recounted her experiences with her department chair.

... There was a group of students who were disgruntled about the grade they earned in one of my courses. So they went to [another] faculty member, instead of contacting me. This man had the nerve to tell these students that he would “talk to me about it.” He is not my senior. So I went to the department chair, who also happens to be a White man, and of course nothing happened. Would you believe that he told me that perhaps I was being “too sensitive?” Needless to say, I know being a WOC in this department means fighting an uphill battle with people who fail to recognize their actions or inaction that supports this toxic culture.

Tia's experience with her department chair is not an isolated incident. The results from this study indicate the ways that other faculty and leadership attempt to silence WOC voices by invalidating their concerns. Tia's story also serves as reminder how WOC continually are engaged in a battle to fight oppressive forces, as evidenced by her colleague who tried inserting himself in an attempt to “show” students that he has some degree of power over her.

Valerie mentioned specifically how interactions with the campus community and field have shaped her science identity:

I used to believe that anyone can do everything, anything that he or she wants to. However, my experiences at this institution have led me to believe otherwise. It's hard. I do feel that there are these labels that people are putting on me as a Latina because society does it. When people see me in the lab they think I'm a student, they usually ask for the PI's information. You should see the look on their face when I tell them, "I am the PI." It totally dismantles their idea of what a scientist looks like. But it goes deeper than that. Somewhere they've developed a mindset that WOC are second-rate scientists. This plays out not only in my daily interactions with colleagues, but in the field.

White Men and White Women Analysis

It is important to note that the three factor models and full structural model is a good fit for *only* WOC and the entire faculty sample. This may well be because WOC are included in the All Faculty sample. In contrast, the fit indices for the three-factor correlational model showed a poor fit for White women ($\chi^2=145.312$; $df=78$; $CFI=.87$; $REMSEA=.062$ $SRMR=.076$) and White men faculty ($\chi^2=125.907$; $df=78$; $CFI=.89$; $REMSEA=.058$ $SRMR=.069$). Similarly, the fit indices for the hypothesized *Science Identity* Model revealed a poor fit for White women ($\chi^2=139.373$; $df=74$; $CFI=.81$; $REMSEA=.078$ $SRMR=.083$) and White men faculty ($\chi^2=120.081$; $df=74$ $CFI=.84$; $REMSEA=.66$ $SRMR=.70$). This indicates that the hypothesized *Science Identity* model better fits the data on WOC.

Hypothesized Model Summary

Fit indices suggested that both the hypothesized and measurement models offered a good overall fit to the data, yet model comparisons suggested that the measurement model fit the sample data significantly better than the hypothesized model. The aforementioned findings were not surprising, because the measurement model serves as an upper bound limit for the fit of the hypothesized model. However, the hypothesized model was the most theoretically sound and parsimonious model, given that the fit indices showed a good fitting model and the model accounted for the data with the latent construct of *Science Identity*.

I used the Akaike Information Criteria (AIC) and the Bayesian Information Criteria (BIC) provided by MPlus to compare which model provided the best fit for the data. Lower values suggest a better fit, whereas, higher values indicate a poorer fit (Muthén & Muthén, 2014). Thus, I concluded that the hypothesized model of *Science Identity* (Model 2) was the most appropriate model for the All Faculty (AIC: 24,597.11; BIC= 25,174.35) and WOC samples (AIC=8,066.54; BIC= 8,279.28). This was a contrast to Model 1, where the AIC values for All Faculty was 25,034.44 and BIC values were 25,311.36. For the WOC sample, the Model 1 values included: AIC=8,530.17 and BIC= 8,742.48. Both Models 1 and 2 yielded the good fits, with RMSEAs of less than .05 and CFI indices greater than .95. When I compared Model 2 with Model 1, I observe a slight difference in fit between them. All first-order estimates positively ranged from .18 to .59 for All Faculty. Estimates for the WOC sample ranged from .15 to .69. All of the first-order loadings were significant at $p < .05$ for both groups. This evidence suggests that a higher order latent variable model, reflecting *Science Identity*, is a plausible one for

WOC as it also fits the theory.

Disrupting the “Objectivity within STEM” Myth: An Alternate Model

Given the results from the both hypothesized higher order *Science Identity* Model and the initial correlated Three-Factor model, which suggested a poor fit for White women and men, I opted to develop an alternate model to test across the three STEM faculty samples. This model was simpler and included only 10 indicators and provided a good fit for the White men and White women samples. Given that the alternate model fit all three faculty samples (i.e. WOC, White men and White women) I was able to examine how the theoretical dimensions of Science Identity were interrelated concepts moderated by race and gender. Table 4.6 lists the measures and their corresponding indicators that were used for the analysis. It was important that the model was grounded in theory and provided an appropriate fit for each faculty sample, given that the overarching research questions that guided this study called for an examination of science identity for WOC in comparison to their white peers. Thus, the alternate model was still informed by Carlone and Johnson’s (2007) Science Identity model. In short, this section is called Disrupting the Objectivity within STEM because it begins to highlight the impact of discriminatory experiences for WOC and White Women, but the absence of such a relationship for White Men.

Table 4.6
Variables Used in Alternate Model

Exogenous Variable	Variable
Competence	Source of Stress: Subtle discrimination (e.g., prejudice, racism, sexism)
<i>Indicate the importance to you personally of each of the following:</i>	
	Objective: Becoming an authority in my field
	Objective: Making a theoretical contribution to science
	Mentoring the next generation of scholars
Performance	
<i>How many of the following have you published?</i>	
	Articles in academic or professional journals
	Chapters in edited volumes
	How many of your professional writings have been published or accepted for publication in the last two years?
Recognition	
<i>Indicate the extent to which you agree or disagree with each of the following:</i>	
	My research is valued by faculty in my department
	My teaching is valued by faculty in my department
	Faculty of color are treated fairly here

Note: n=816 STEM faculty across 78 institutions.

Measurement Models

My next analyses focused on the relationships between three latent variables:

competence, *performance*, and *recognition* with fewer indicators. During the confirmatory factor analysis phase, I found that the residuals, though associated with each indicator variable were initially constrained to zero, a review of the modification indices for the baseline models for *competence* and *performance* revealed some evidence of model misfit. Indeed for both latent constructs, there was some overlap of item content within the subscales. I decided therefore to re-specify the models for these two factors allowing the residuals of some items to correlate (per the suggestion of the

modification indices) to account for the item overlap. Residuals of indicator items were allowed to correlate one-at-a-time. This was done in an iterative process until optimum model fit was reached for both latent constructs. Table 4.7 lists the factor loading for each indicator and respective significance values for the new Three-Factor correlated model.

Table 4.7.

Factor Items and Loadings for Correlated Model

Item	Standardized Factor Loading	R ²	P-Value
<i>Competence</i>			
Objective: Becoming an authority in my field	0.61	0.37	***
Objective: Making a theoretical contribution to science	0.76	0.636	***
Mentoring the next generation of scholars	0.58	0.226	***
<i>Performance</i>			
Articles in academic or professional journals	0.80	0.64	***
Chapters in edited volumes	0.58	0.33	***
How many of your professional writings have been published or accepted for publication in the last two years?	0.83	0.68	***
<i>Recognition</i>			
My research is valued by faculty in my department	0.66	0.32	***
My teaching is valued by faculty in my department	0.84	0.70	***
Faculty of color are treated fairly here	0.73	0.19	***

Note: n= 816 STEM faculty across 78 institutions.

Overall, confirmatory factor analysis showed that the hypothesized measurement models fit the data well. In terms of the *competence* factor model, the Satorra-Bentler chi-square statistic was 3.488 ($df= 3$, $N = 816$, $p = 0.000$), and the fit indices were CFI = 1.00, RMSEA = 0.00, and SRMR=.00. The *performance* factor model had a Satorra-

Bentler chi-square statistic of 7.835 ($df=3$, $N=816$, $p=0.000$), and the fit indices were CFI = 1.00, RMSEA = 0.00, and SRMR=.000. The *recognition* factor model had a Satorra-Bentler chi-square statistic of 3.061 ($df=3$, $N=816$, $p=0.000$), and the fit indices were CFI = 1.00, RMSEA = 0.00, and SRMR=.000. Since the measurement models for *competence*, *performance* and *recognition* were each comprised of only three indicators, the full structural model was just-identified and could not be tested, because they would always perfectly reproduce the data (Mulaik, 2009, p. 144).

Three-Factor Structural Model Estimation with Discrimination, All Faculty

First, I tested a three- factor model using the three modified theoretical constructs with the strongest loading measures (i.e. *competence*, *performance*, and *recognition* (see figure 4.5 and Table 4.8). Given only 13 participants (.015%) had missing data on the faculty surveys, I decided to keep these participants in the sample and used Full Information Maximum Likelihood (FIML) as the primary imputation technique. I analyzed the data using maximum likelihood estimation in MPlus. Hu and Bentler (1999) suggests evaluating more than one fit index to assess model fit. Acceptable Type II and Type I error rates reflected cut-off values close to .95 for the comparative fit index (CFI), .08 for the standardized root mean square residual (SRMR), and .06 for the root mean square error of approximation (RMSEA) (Hu & Bentler, 1999). A CFI greater than or equal to .95 in combination with an SRMR less than .08 signifies acceptable fit (Hu & Bentler, 1999). Given these criteria, the model fit for the modified three-factor model was excellent, $X^2=32.618$; CFI= .99; RMSEA= .026; SRMR= .021.

An investigation of the variables' indicators revealed that all factor loadings were above .50 and statistically significant at $P < .001$. The factor *competence* was set with

three indicators, “becoming an authority in my field”, “making a theoretical contribution to science”, and “mentoring the next generation of scholars. All three indicators had strong loadings at .60, .76, and .58, respectively. The factor *performance* also was set with three indicators, “articles in academic or professional journals”, “Chapters in edited volumes”, and “writing published or accepted for publication in the last two years.” All three indicators had strong loadings at .80, .58, and .83, respectively. Lastly, the factor *recognition* was set with three indicators, “my research is valued by faculty in my department”, “my teaching is valued by faculty in my department”, and “Faculty of color are treated fairly here. All three indicators had strong loadings at .66, .84, and .73, respectively. All loadings repeated statistical significance at $P < .001$.

The factor correlation and covariance table shows a significant positive correlation between *competence* and *performance* ($\beta = .386^{***}$). The factor *performance* was also significantly correlated with *recognition* ($\beta = .397^{***}$). However, *recognition* and *competence* had a non-significant correlation ($\beta = .070$), indicating that *recognition* in the department had no bearing on self-assessments of competence. Stress from discrimination had a significant negative affect on *performance* only ($-.079^*$) but no significant affect on the other two latent factors. (See Table 4.8).

Figure 4.5. Three Factor Structural Model with Discrimination (All Faculty)

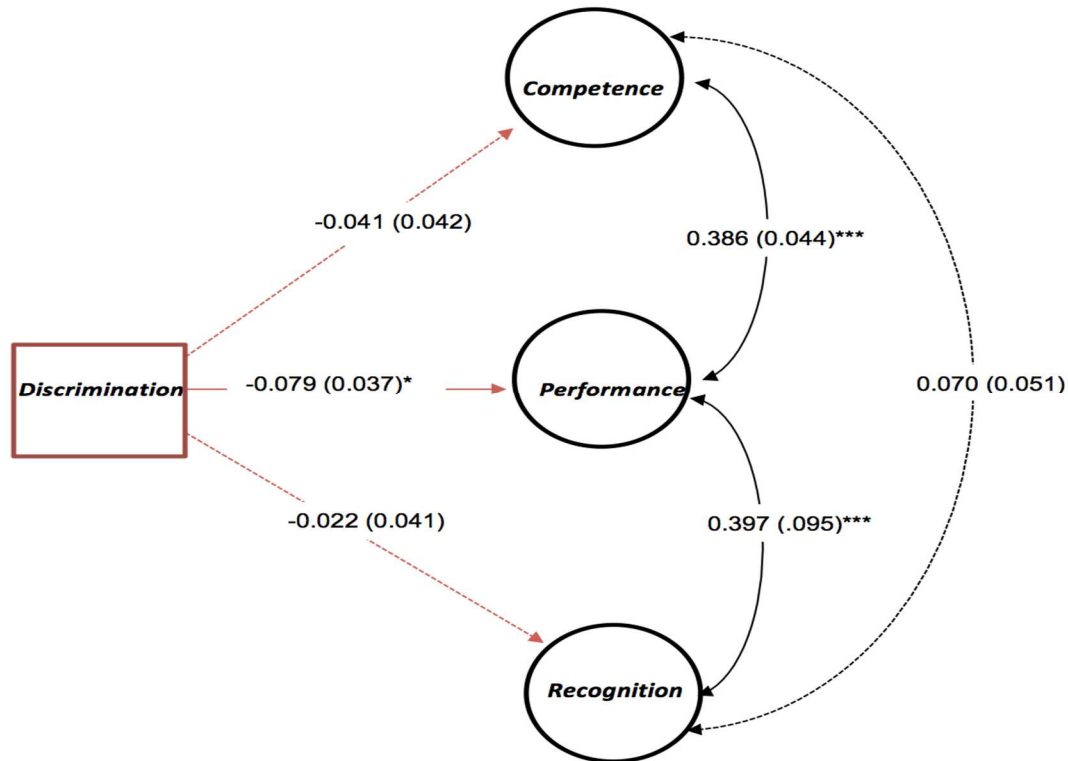


Table 4.8.

Modified Three Factor Structural Model: Parameter Estimates with Discrimination: All Faculty (n=816)

	b	β	Sig.	S.E.
<i>Competence</i>				
Discrimination	-0.028	-0.041	n.s.	0.042
<i>Performance</i>				
Competence (covariance)	0.304	0.386	***	0.044
Discrimination	-0.141	-0.079	*	0.037
<i>Recognition</i>				
Competence (covariance)	0.020	0.070	n.s.	0.051
Performance (covariance)	0.289	0.397	***	0.095
Discrimination	-0.014	-0.022	n.s.	0.041

$\chi^2=32.618$ df=21; CFI=.99; RMSEA=.026 SRMR=.021

*p<.05 **p<.01 ***p<.001

Table 4.8 shows the results of the final SEM model, including unstandardized regression coefficients, standardized regression coefficients, standard errors, and significance levels for the direct effects of the final model. Figure 4.7 diagrams the

causal paths in the final model, using solid lines to represent significant effects and dotted lines to represent non-significant paths. The Satorra-Bentler chi-square statistic for the final model were 32.618 ($df = 21$, $N = 816$, $p < 0.000$), and the fit indices were: CFI = 0.99, RMSEA = 0.026, and SRMR=0.21. Although the chi-square statistic was significant, as mentioned before, it is highly dependent on sample size and degrees of freedom in the model; therefore, I did not rely upon it as an indicator of model fit (Bentler, 2006). The other indices suggest that the model appropriately represents the relationships among the latent and exogenous variable of discrimination.

Modified Three Factor Structural Model Disaggregated by Race and Gender

I will first discuss the results as they pertain to stress from discrimination as a predictor of each construct, and then discuss the relationships among three latent factors of *competence*, *performance* and *recognition* which were proposed in Carlone and Johnson's (2007) model of Science Identity for WOC. Figures 4.6-4.8 shows the structural model of the three latent factors with discrimination as a predictor for each faculty group (i.e. WOC, White Men and White women). See Tables 4.9-4.11 for both standardized and unstandardized estimates, significance levels and standard errors

WOC in STEM. Figure 4.6 shows the results for WOC in STEM. Unlike the higher order factor model for WOC, this model showed no direct association between *competence* and *recognition*. It may well be for WOC and other faculty that, at this stage in their career, they feel highly competent regarding their own professional accomplishments and it is not dependent on the kinds of informal recognition they receive in their department. In contrast to the All Faculty Three Factor Structural Model, as well as the same models estimated for White Men and Women, this WOC model

shows how stress from discrimination has a significant negative effect on *recognition* (.254^{***}) and on *performance* (.19^{***}). Although there were no significant direct effects of discrimination on *competence*, the results suggest an indirect relationship with *competence* because of strong correlation with *performance* (.423^{**}).

Figure 4.6. Three Factor Model with Discrimination for WOC STEM Faculty

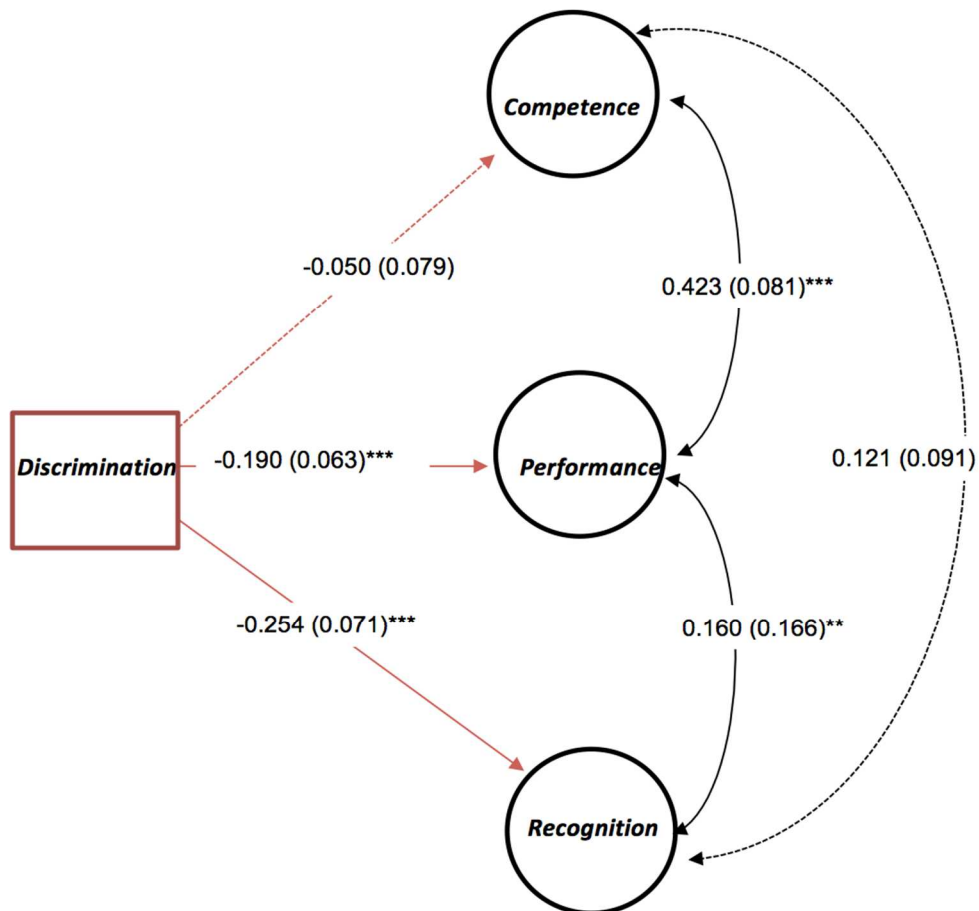


Table 4.9.

Modified Model: Parameter Estimates with Discrimination: WOC (n=272)

	b	β	Sig.	S.E.
<i>Competence</i>				
Discrimination	-0.029	-0.050	n.s.	0.079
<i>Performance</i>				
Competence (covariance)	0.288	0.423	***	0.081
Discrimination	-0.326	-0.190	***	0.063
<i>Recognition</i>				
Competence (covariance)	0.031	0.121	n.s	0.091
Performance (covariance)	0.111	0.160	**	0.166
Discrimination	-0.143	-0.254	***	0.071

Note: $\chi^2=24.246$ df=21; CFI=.99; RMSEA=.024 SRMR=.032

*p<.05 **p<.01 ***p<.001.

White Men in STEM. In contrast to the WOC model, Figure 4.7 shows that stress from discrimination has no significant direct effect on *competence*, *performance* or *recognition* for White Men in STEM. As found in previous models, *competence* is not significantly related to *recognition* but is strongly associated with *performance* (.414***). It is possible that in the absence of discrimination, White men's *competence* is greatly measured by their *performance* as faculty in STEM, especially when they are not confronted by misconceptions of being presumed incompetent like WOC. Likewise, their *performance* is likely to be perceived as an indication of their competency related to the field. The results also show that *performance* is significantly correlated with *recognition* (.121***). It makes sense that the level of *performance* is also strongly correlated to the amount of *recognition* that they receive. Furthermore, the *recognition* that White men in STEM receive is likely to result in access to resources (e.g. grants or promotion) that will support high levels of *performance*.

Figure 4.7. Three Factor Model with Discrimination for White Men STEM Faculty

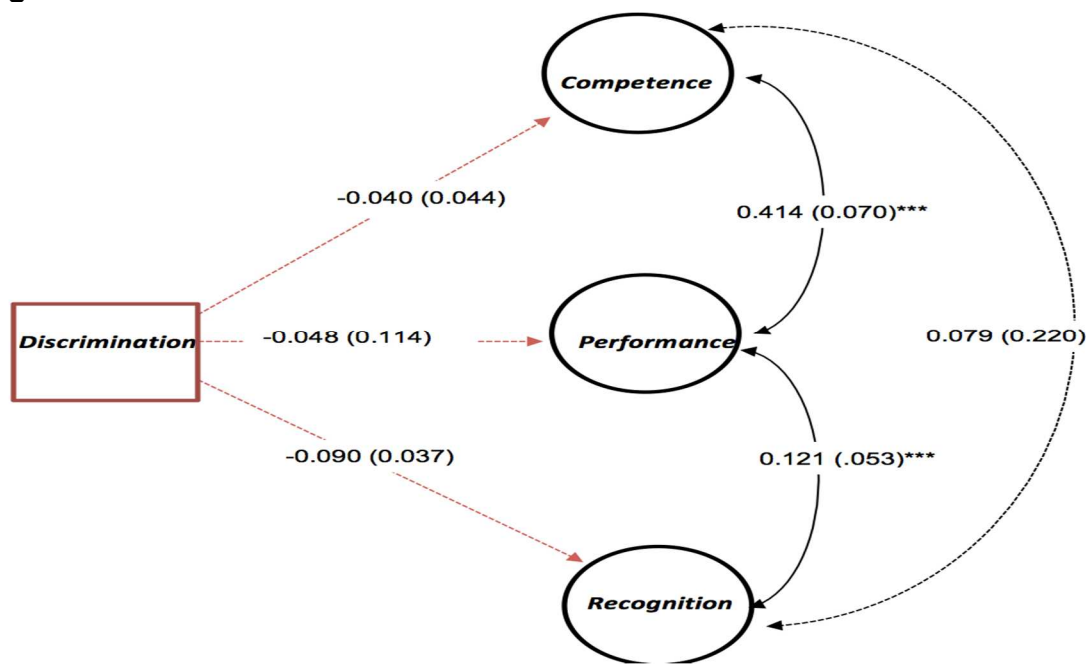


Table 4.10.

Modified Model: Parameter Estimates with Discrimination: White Men(n=272)

	b	β	Sig.	S.E.
<i>Competence</i>				
Discrimination	-0.025	-0.040	n.s.	0.044
<i>Performance</i>				
Competence (covariance)	0.281	0.414	***	0.070
Discrimination	-0.085	-0.048	n.s.	0.114
<i>Recognition</i>				
Competence (covariance)	0.014	0.079	n.s.	0.220
Performance (covariance)	0.546	0.121	***	0.053
Discrimination	-0.041	-0.090	n.s.	0.037

Note: $\chi^2=31.090$; $df=21$; CFI=.98; RMSEA=.042; SRMR=.042* $p<.05$ ** $p<.01$ *** $p<.001$

White Women in STEM. Figure 4.8 shows the results for White Women in STEM. Similar to the model for WOC, this model indicated no direct association between *competence* and *recognition*. The White women model shows how stress from discrimination has a negative effect on *recognition* (.023*) and on *performance* (.074**) in contrast to White men. However, these effects are less pronounced for White women compared with WOC. It may well be that White women, although they encounter sexism, are not confronted with discrimination due to both their gender and racial identity. While there were no significant direct effects of stress from discrimination on *competence*, the results suggest an indirect relationship with *competence* because of its strong correlation with *performance* (.352**).

Figure 4.8. Three Factor Model with Discrimination for White Women STEM Faculty

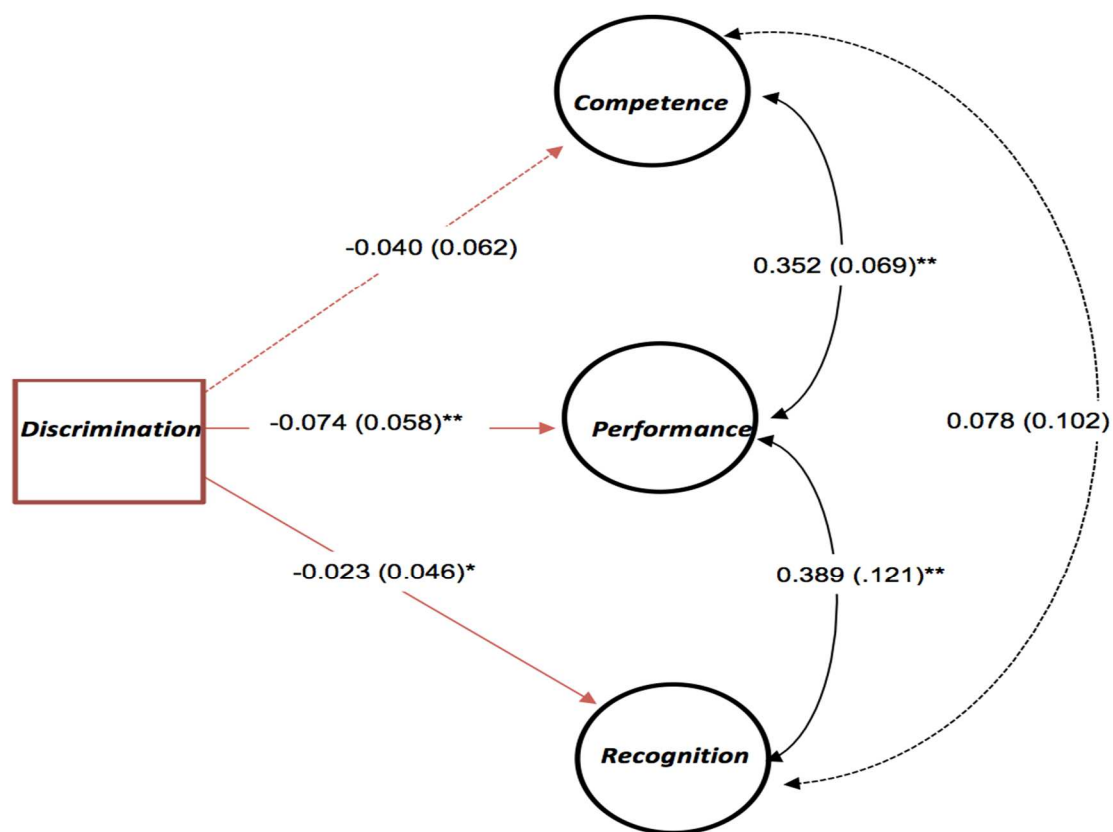


Table 4.11.

Modified Model: Parameter Estimates with Discrimination (White Women)

	b	β	Sig.	S.E.
<i>Competence</i>				
Discrimination	-0.026	-0.040	n.s.	0.062
<i>Performance</i>				
Competence (covariance)	0.323	0.352	**	0.069
Discrimination	-0.157	-0.074	**	0.058
<i>Recognition</i>				
Competence (covariance)	0.021	0.078	n.s.	0.102
Performance (covariance)	0.266	0.389	**	0.121
Discrimination	-0.020	-0.023	*	0.046

Note: $\chi^2=27.803$; $df=21$; $CFI=.97$; $RMSEA=.028$; $SRMR=.033$

* $p<.05$ ** $p<.01$ *** $p<.001$

Tests of the equality of regression coefficients. To summarize the differences between WOC, White Men and Women, using the same Three Factor Structural model, I conducted tests of the equality of regression coefficients. Paternoster and colleagues (1998) describe the appropriate equations to test for the equality of regression coefficients. A Z-test was only performed if beta coefficients for a given variable were significant for all groups. This test across groups helps confirm if the differences in regression coefficients were, indeed, significant. See Tables 4.12 for z-scores from the equality of regression coefficient test for each variable. Tests indicate that WOC were significantly more affected by perceptions discrimination on *recognition* in the department than White Women; but similar to White Women, in discrimination's significant effects on *performance* (publication productivity). Tests also reveal White men were significantly different in the correlation between *performance* and *recognition* in the department compared to WOC and White women. However, the relationship between *recognition* and *performance* affect WOC and White women similarly. In terms of the relationship between *performance* and *recognition*, the positive relationship was more pronounced for White men ($b = .55$) compared to White women ($b = .26$). Furthermore, the relationship between *recognition* and discrimination appeared to be more pronounced for WOX ($b = -.14$) compared to White women ($b = -.02$).

Table
4.12.
Comparing Significant Coefficients from the WOC Three-Factor Model to the Coefficients from the White Men and Women Three-Factor Model

Variables	WOC (n=272)			White Women (n=272)			White Men (n=272)			Z-Score	Meaning
	b		S.E.	b		S.E.	b		S.E.		
Competence											
Discrimination	-0.03		0.08	-0.03		0.06	-0.03		0.04	//	
Performance											
Competence	0.29	***	0.08	0.32	**	0.07	0.28	***	0.07	n.s	Similar Effect for WOC, White Women and White Men
Discrimination	-0.33	***	0.06	-0.16	**	0.06	-0.09		0.11	n.s	Similar Effect for WOC and White Women
Recognition											
Competence	0.03		0.09	0.02		0.10	0.01		0.22	//	
Performance	0.11	**	0.17	0.27	**	0.12	0.55	***	0.05	WM compared to WOC** WM compared to WW*	Affect more pronounced for WM; Similar Effect for WOC and WW
Discrimination	-0.14	***	0.07	-0.02	*	0.05	-0.04		0.04	WOC Compared to WW**	Affect more pronounced for WOC

Notes. ***p<.001, **p<.01, *p.05. Z scores that fall outside the range of -1.96 and +1.96, indicate a p-value of less than .05, and demonstrate that the beta coefficients between WOC, White men, and White women STEM faculty are statistically different. See article by Paternoster and colleagues (1998) for equation to test for the equality of regression coefficients. A Z-test was only performed if beta coefficients for a given variable were significant for all groups.; otherwise is indicated by a "/" symbol.

Using Qualitative Results to Explain Quantitative Findings

The following sections combine results obtained from interviews from WOC in STEM to help explain and provide stories related to the quantitative findings. First, I give examples regarding each of the theoretical constructs that reflect how WOC spoke about their experiences.

Competence. With respect to the first-order latent factor measuring *competence*, findings revealed that discrimination did not influence faculty's *competence*. In other words, the more stress that faculty experience from

discrimination that they encounter within their work environment, does not impact their level of competence (internal assessment of goals as measured by how much they value “becoming an authority in the field”, for example). This suggests that WOC are questioned about their competence but are reasonably confident about their own assessments. This finding was also revealed within the qualitative WOC faculty data, wherein they discussed encountering racial and gendered interactions in their academic programs. As the only Black women in her Engineering program, Irene discussed how she had to manage presumptions about her ability to succeed from her own graduate advisor:

He bluntly told me, ‘I want to warn you that you’ll not be my first female student but have not seen even one female student who actually finished the PhD. I advised all three, and each one got pregnant and left the program.

This is only one out of countless examples of WOC who are subjected to various forms of challenges to their abilities from others in their field of study. Irene, in particular, discussed how she was intentional to seek out mentors and other forms of support as a means to cope with hostile environments. Nearly all of the participants reported that their current navigation strategies had origins within their academic training programs.

Moreover, participants spoke about the internal motivation that drives WOC faculty in STEM to remain resilient through the face of adversity. Mary (physical sciences) offered insight about how she did not allow for negative experiences that she encountered with her peers and students to disrupt her *competence* as a scientist:

“It was very clear that I wouldn’t let my colleagues’ perceptions diminish my legitimacy as a scientist -- I didn’t want to give it up. So I decided to show them

that I could be the best, regardless of what they threw at me. So I used that every time that some colleague, or some student, or whoever said, 'Come on. You can not do it.' I said [to myself] 'I would show him.'

The challenge of "proving" others wrong was cited as a mechanism WOC faculty in STEM as coping strategies. These narratives also illustrate the confidence WOC have in their competence and their identities, even in times where they are forced to defend their place in STEM. That is, although they experience stress from discrimination, high achieving WOC in STEM at this career stage remain confident in their competence.

Performance. The quantitative analysis showed that *competence* has a positive relationship with *performance* for WOC ($\beta = 0.423$, $p < 0.001$), White men ($\beta = 0.414$, $p < 0.001$) and White Women ($\beta = 0.352$, $p < 0.01$). This finding makes sense, given that the Science Identity theory acknowledges that an individual must first have strong competencies within their fields in order to effectively perform. SEM analysis also revealed that the discrimination exogenous variable had a significant negative relationship with the latent factor of *performance* for women. Experiencing more stress from discrimination (e.g., prejudice, racism, sexism) had a negative relationship with *performance* for both WOC ($\beta = -0.190$, $p < 0.001$) and White women ($\beta = -0.074$, $p < 0.01$). Also, it makes sense that faculty who experience stress from discrimination would affect the productivity levels more than professors who experience less or no bias based on race, gender or other social identity. This issue seemed to intensify upon making the decision to have a family. Vanessa recounted her experience telling her department head that she was expecting her first child, which required bed rest:

He was annoyed with me, for some reason, when he learned of my pregnancy.

He said that I behave as if being pregnant is a sickness, and that I am not putting all my effort [in the work]. Although I still was very productive, but he actually told me that I cannot use my pregnancy as an excuse.

Vanessa made it clear that she was not using her pregnancy as an excuse. In fact, she was able to get a lot of writing done during that period. However, it was the department head's bias that led him to think that she was not being productive. Others mentioned that they were required to manage sexual harassment in their field. As Natalie mentioned:

There were several cases of sexual harassment in our field that became public.

Since I was sexually harassed many times in my path, this is something that was very disturbing.

Although experiencing sexual harassment is enough to impact WOC's performance. WOC resist these overt forms of discrimination by also being a support to others who may experience similar experiences. Many of the participants discussed the importance of being there for their students, especially females, when instances of sexual harassment come to light. The results showed that WOC engaged in advocacy to ensure that issues of discrimination and harassment are addressed. Often this was addressed on top of their formal responsibilities. Echoing other studies (Dade, Tartakov, Hargrave, & Leigh, 2015; Dancy & Jean-Marie, 2014; Lloyd-Jones, 2014), the model shows that the degree of stress that is imposed on faculty, particularly from underrepresented groups (e.g. WOC and White women), can negatively impact scholarly productivity. Indeed, time and energy exerted towards combating bias likely

affect the time and energy available to perform their research, writing and other duties.

As Vanessa (biological sciences) notes:

You need to understand that, although teaching is important, this campus prioritizes my published research above all else. I wouldn't say that it is an unreasonable expectation. But when my teaching load becomes heavier, then I'm also -- I'm here for my research. It suddenly becomes a lot. Then when things like cases of racism or sexual harassment come, it makes it difficult to put the time and energy into my research—although I find the motivation from somewhere to do it. Also, I feel that it's important that I be there for the students during these times, especially for students of color. So I feel this is something that I know a lot of women of color feel, that they're the sink of diversity, in a way.

Indeed, WOC are capable of managing their multiple responsibilities as faculty in STEM. However, their efforts to produce research is impacted by racism and/or sexism. This requires WOC to exert time and energy finding ways to cope with hostile work environments, which would otherwise be invested in their work. Vanessa's quote also highlights the tenacity WOC exude as they press forward through adversity to ensure that their work is completed. Furthermore, in this passage Vanessa metaphorically referred to WOC as the "sink of diversity" because of the gender and racial diversity that they add to their departments and campus. Unfortunately, this requires them not only to navigate racism and sexism but also they feel compelled to serve in other capacities such as support to students, particularly students of color.

Recognition. Interestingly, the results indicated that the relationship between *competence* and *recognition* was non-significant for all three groups. It is possible the

faculty have reached a stage in their career where they have developed enough agency not to rely on external recognition in their department to impact perceptions of their own *competence*. However, the analysis indicated that *performance* has a positive relationship with *recognition* for WOC ($\beta = 0.160$, $p < 0.01$), White men ($\beta = 0.121$, $p < 0.001$) and White Women ($\beta = 0.389$, $p < 0.01$), with the effect more pronounced for White men (see Table 4.14). This finding is expected given that *recognition* (e.g. tenure, awards, funding) is typically tied to specific levels of *performance* that is based on publication. With respect to *recognition*, the discrimination is a negative and significant predictor for both WOC ($\beta = -0.254$, $p < 0.001$) and White women ($\beta = -0.023$, $p < 0.05$), with the effect more pronounced for WOC (see table 4.14) . This finding suggests that subtle discrimination is more likely to negatively impact the frequency with which they receive *recognition* in the department. If they think that faculty of color are treated unfairly in their department (one of the items in the *recognition* measure), the cause is likely to be some form of discrimination. In layman's terms, perceptions of *recognition* that a faculty member receives in a department is most likely influenced by perceived levels of stress from discrimination in their work environment. This relationship may be more indicative of the departmental and institutional climates that perpetuate norms, which further marginalize individuals through acts of bias. Cordelia recounted her experience with a colleague whose bias impacted awarding grants to principal investigators:

Every single female's proposal [was rejected] because his reply for everything was, "Who does she think she is? She probably cannot do it." That was for all the women. So I saw the statistics, I marked it, and then of course I couldn't shut

up. So I said something. So he said, "I'm not a chauvinist. I just think that their proposals weren't good." Anyway, not a single female from that panel [review] got in. When I submitted stuff, I got that one review that thought that I'm a man. He liked [the proposal]. He said, "Oh." So I have a funny name, so maybe he didn't know [that I was a woman].

It is well documented within the literature that faculty who experience discrimination are less likely to have access to opportunities to be recognized for their work due to deep-seated bias, and are placed in a situation wherein they must defend their legitimacy as a scholar within their respective fields.

Higher-Order Modified Structural Model: All Faculty

Using the modifications in first order latent factors, I tested a second-order model to determine whether the *Science Identity* as a second order latent variable was an acceptable fit to the data. A second-order factor is one that has a direct impact on the first-order factors. The existence of a second-order factor indicates that the three first-order factors all share one common characteristic: the second-order factor as a cohesive concept (Kline, 2011). The second-order model yielded an unacceptable fit to the data, $\chi^2 = 62.159$; CFI= .86; RMSEA =.092; SRMR .077. Each of the three first-order factors loaded onto the higher order factor (i.e. *Science Identity*) at *significant level* $p < .001$ (see Figure 1 for second-order factor loadings). This finding indicates that the three factors *do not* represent one umbrella factor for *Science Identity* for all STEM faculty.

Findings from the three-factor model indicated nonequivalence to the unmodified second-order model. The three-factor model's chi-square ($\chi^2 = 32.618$) signified a slightly better fit in comparison to the second order model ($\chi^2 = 62.159$). This constituted a difference of 29.541 chi-square and four degrees of freedom between these two models. These two models were statistically different. Further examination suggested the three-factor model had a better fit with CFI=.99, RMSEA= .026 and SRMR = .021, compared to the second-order *Science Identity* model, CFI=.86, RMSEA=.092, SRMR=.077.

Given that the second-order model was an unacceptable fit for the data, the three-factor models for WOC, White women and White men were appropriate to develop further tests of differences (described in the previous Table 4.12). This allowed

me to observe how the relationship between discrimination and the three theoretical constructs for each sample. The indices indicated an exceptional model fit for WOC sample ($X^2 = 24.246$; $df=21$ CFI= .99; RMSEA .024; SRMR .032). In terms for White women the fit indices reveals an excellent fit ($X^2 = 27.803$; $df=21$ CFI= .97; RMSEA .028; SRMR .033). Finally, the model provided a better than good fit for the White men sample ($X^2 = 31.090$;; $df=21$ CFI= .98; RMSEA .042; SRMR .042).

Construct validity. To establish the construct validity of the theoretical constructs, I assessed correlations between the three theoretical constructs. The constructs were significantly and positively correlated with all similar constructs. Correlations ranged from .12 to .42 for WOC, .08 to .39 for White women and .07 to .41 for White men. These values suggested that the *competence* were related to but distinct from *performance* and *recognition*. The constructs also demonstrated discriminant validity.

My analysis focused on the relationships between a set of three latent variables: *competence*, *performance*, and *recognition*, in relation to scientific identity for WOC. During the confirmatory factor analysis phase, I found that, although the residuals associated with each indicator variable were initially constrained to zero, a review of the modification indices for the baseline models for *competence* and *performance* revealed some evidence of model misfit. For both latent constructs, there was some overlap of item content within the subscales. I decided therefore to re-specify the models for these two factors, thus allowing the residuals of some items to correlate (per the suggestion of the modification indices) with the item overlap. Residuals of indicator items were allowed to correlate one at a time, with the model re-ran after each modification. This

was done in an iterative process until wellness of model fit was reached for both latent constructs.

Furthermore, the second-order factor analysis was tested, based on the original theory and modified three-factor model. It was important to assess if there was degradation in fit due to specification process by examining the chi-square differences between the first-order and second-order factor model (Brown, 2006). The nested chi-square of second-order factor model $\chi^2=62.159$ was different to first-order factor model $\chi^2= 32.618$. The difference (29.541) was relatively small with 3 degree of freedom, which signified that there was no degradation of the model fit.

The findings were unsatisfactory due in part to the Heywood effect. The Heywood case refers to parameter estimates that yield values which exceed the normal range such as negative variances (Brown, 2006). In a Heywood situation, the model is not considered identifiable, and the results are not discernible (Jöreskog & Sörbom, 1984). Consequently, the solution cannot be interpreted. The Heywood issue in the scientific identity model for WOC was observed by the error variance of latent variable *competence*, which had an estimate of -.015. This produced a standardized regression value greater than 1 in this second-order factor model. Given this value, the second-order factor model was a misfit due to the Heywood effect. Thus, the second-order factor model is not a valid statistical model.

Qualitative Findings: Identity and Experiences in STEM

Two themes emerged from the data which answered the study's second research "How does racial and gender identity shape WOC experiences as faculty in STEM?" Although the participants shared rich narratives that were unique to their personal

journey of being a STEM academic, two major themes were woven throughout their stories. The themes include *reconfiguring salience of identity* and *barriers to recognition: navigating unsupportive structures*. The following sections discuss the aforementioned themes in greater detail.

Reconfiguring the Salience of Identity

Evaluating identity topics through an epistemological lens allows scholars to acknowledge that each individual comes from various backgrounds, notwithstanding their socioeconomic status (Abes et. al., 2007). Although the participants may share similar struggles as they navigate through the academy, they come from diverse developmental identities (i.e. religious, ethnic, citizenship status, sexual orientation) that may diverge in salience from one individual to the other. Indeed, one of the most interesting findings that emerged came from responses of faculty who decided not to participate within this study. Whereas individuals were invited to participate in this study based on the premise that they had phenotypic characteristics of a woman of color, many rejected the invitation with the reason that they do not identify as being a woman of color. Out of the invitations that I sent, 57 individuals did not respond to the invite and 21 expressed interest in participating but disqualified themselves by saying they did not fall under the category of being a person of color. This finding emphasizes the notion that identity is both socially and personally constructed. It is important not to ascribe identities or labels rooted in perceptions of the person's physical appearance. Given that I engaged in racial identification (how others identify an individual) by using the photo's posted on the department website, it is possible there was a discrepancy between these individuals' racial and gender identity, and my perception that they fit the

description of being a WOC. Thus, even though many women may look like WOC, they either do not identify and feel that they have more privileges than WOC, or did not want to partake in the study to have their stories revealed.

Equally as important was the theme of reconfiguring the salience of one's identity. In some cases, the participants described their identity as not being dominated by gender or racial boundaries until they entered the professoriate. It was their experiences within the academy that influenced them to recognize the importance of their racial and/or gender identities. Camilla speaks openly about when she became aware of her racial identity:

For myself as a student, I would say my color and my race wasn't something I ever really considered. Now that I'm in this position, I am more and more aware of my race. That has its own psychological aspects; when you're already in an isolating position, it can be even more isolating.

As Camilla mentioned the act of being placed in a isolating setting, where there is little to zero racial and/or racial diversity within STEM disciplines, likely propels these identities to become more salient than before. Thus, it is possible that certain work environments—especially those that lack diversity—facilitate a deepened awareness of their multiple identities. Furthermore, this emerging salience of identity is also stimulated by an informal responsibility for supporting female students and other students of color. This idea of advocacy will be discussed later; however, it is critical to understand the perceptions of identity and the process of how the participants prioritized certain aspects of their multifaceted identities.

Barriers to Recognition: Navigating Unsupportive Structures

As previously mentioned, the underrepresentation of WOC within the leadership ranks has major implications in terms of the current conditions they face within academy, particularly within STEM disciplines. Scholars argue that leadership in STEM, which has traditionally been dominated by white men, impacts various facets of faculty experiences, including teaching loads, service commitments (i.e. working on initiatives), professional development and networking opportunities, and more importantly the tenure and promotion process (MacLachlan, 2006). Tensions between faculty and leadership can intensify when coupled with power dynamics that are based on race and/or gender difference, as is often experienced by WOC in STEM fields where department chairs and other administrators are most frequently White and male (Carlone and Johnson, 2007; Ko et al., 2014; MacLachlan, 2006). Natalie notes how talented WOC are leaving the academic ranks because of the pressures and stress caused by the hardships to which they are subjected, and the implications for the field:

People are leaving. People are leaving after spending five years, ten years, twenty years, doing [academic work] ...*Women of Color*. And it's a huge issue. It means that you don't get them [advancing] in the senior ranks. You don't then have that kind of pipeline of role models. You don't get them in administration 'cause of the bullshit. And they deal with the exact same things. So things like this study can really make a difference.

Thus, it is not surprising to find that many participants disclosed strained relationships with departmental and campus leadership. Issues that served as common occurrences for the participants included: sexual harassment, racial and gender discrimination,

silencing of WOC STEM faculty, and intentional sabotage. Tia illustrates the environment filled with disparate treatment for WOC through which she must maneuver:

And here [at my current institution], I've dealt with the worst racism that I've ever come across in my department and the worst sexism that I've seen, far worse than other places. But I think if it was not for those experiences when I was at university and in graduate school and as a post-doc, I might not have gotten through it.

Tia goes on to discuss how such systemic inequalities impact the careers of women in her department:

What's striking is that there are issues that pertain to sexism that have been expressed in my department that are heightened extraordinarily with respect to my own case. I think that represents the issue of race in general. And probably also age plays into it. But the dominant thing by far in my case relates to race and gender. The ways that it's played out for all women in my department is that every single woman faculty member has had a problematic promotional process for every major promotion, for tenure or going to full [professor]; where people have challenged [each case] despite the fact that internal – the department -- despite whatever external evaluations are, and despite the fact that the evaluations of the females are on par or better than the males.

Other participants mentioned how they faced retaliation for challenging inequalities.

Although they were qualified to receive promotion, senior faculty and leadership ensured that the process was all but seamless. Some thought this was a tactic to stop the STEM academic pipeline for women. However, the women's commitment to their

disciplines and advocacy influenced their decision to stay. Mary discussed her experiences with retaliation:

I had three outside offers when I came up for tenure, two as full professor and a dual-career situation, and the department completely tried to sabotage my retention and the hiring of my spouse. So, at the end of the day, everything's documented and been reported by umpteen people. So, at the end of the day, we see that these types of things go through for people when they're kind of the 'chosen ones' or when they're white and male, when they're people who don't whine 'cause it's political. They don't challenge the status quo. The thing is people see me, and they think I should be quiet – in a small, dark way, that's the role that people who are small and dark and female have had [to play] in this country. That's the stereotypical role throughout its history. And it's remarkable how much that stigma still is in people's freakin' minds.

Some participants discussed that men were not the only perpetrators of hostile environments. Stories of women in leadership position who failed to adequately address issues of discrimination and harassment emerged from the data. Specifically, Tia detailed her experience with senior female faculty and her resistance to the idea that a colleague would engage in any type of inappropriate behavior:

There were a few senior women who were extremely against, not only, doing anything with that [information] but simply did not believe the evidence. They would not accept the fact that [a male colleague] could have been a sexual harasser, would not accept the fact that they have any responsibility to their

younger generation, to their younger colleagues, or students, and post-docs.

They resent the fact that we even brought this [sexual harassment issue] up.

Although several women within this study shared stories of retaliation threats similar to Mary's, they were determined not to let these racialized and gendered experiences deter them from their passion in STEM. In many cases, these experiences strengthened their convictions to succeed as exemplary models of scholars within their respective fields. These strategies align with what Carlone and Johnson (2007) referred to as "redefining meaningful others." The authors contend that WOC may find success in seeking out other sources of *recognition* (i.e. family, peers outside the STEM department) when distinguished members within their departments or disciplines are unsupportive. Hence, I observed some participants placing more value on the feedback they received from their support systems rather than colleagues who exhibited sexism or racism.

Equipped with the Tactical Tool Belt: Navigation Strategies

Three themes emerged from the qualitative data which answered the study's third research question: "What strategies do WOC use to successfully navigate the academy? These themes highlight WOC's resiliency and agency in the face of adversity. The themes specifically the themes *Leveraging trusted supports systems*, *Reaffirming enthusiasm for the discipline*, and *Expanding competence: Drivers of advocacy* best capture how the participants were able to develop effective strategies throughout their careers as faculty within STEM spaces. Although many of the participants described ways they navigated the academy, by tapping into specific support networks and other self-supporting tactics, their narratives also highlighted

hostile STEM departments. While most of the women in my study expressed feelings of isolation, they possessed a strong sense of resiliency that allowed them to uncover various strategies to mitigate the effects of working in unsupportive environments. The following sections details the themes that emerged from this finding in greater detail.

Leveraging Trusted Support Systems

A number of the women in this study acknowledged that there is power in numbers, and tapped into savvy strategies such as collaborating with supportive colleagues once they recognized that they were navigating hostile working conditions. Participants recounted that these support systems were instrumental in helping them navigate the academy. Vanessa reported how valuable it was to collaborate with colleagues who either shared similar struggles as a WOC in academia, or finding allies who may not have shared a similar racial or gender background but mitigated the challenges she faced:

But the senior white male allies that I found are typically people who are not powerful or respected in the same way as the senior white male bullies...racists and sexists are. That's been great because then I've been able to draw on that demographic and have a token senior white male to go talk to – to go talk to an administrator and report – talk to a university [representative] about crap that's happened. Like [depending on an ally], and here's somebody who can validate this so that way you don't have to just go on my word.

Although the idea of WOC needing to have their experiences validated by a person from the dominant culture is problematic, Vanessa's experiences with White male allies emphasizes how she strategically leverages partnerships in order to navigate

departmental politics. Furthermore, support systems are often meaningful for WOC in their pursuit of acquiring resources. A majority of the women within this study shared experiences with successfully securing grants. Judith disclosed her personal experiences trying to receive grants as a faculty member:

I find it a lot more difficult to get my papers published than when I was a trainee. It would seem like if I had my advisor's name on it, it would just go through without a problem. Now I'm getting a lot more rejections or having to go through three or four revisions. That's definitely been an obstacle, which has been the same for grants as well. I've served on review panels, and I've actually seen firsthand where, because somebody has a big name in the field, they give the grant to that person, even though the grant was poorly put together. However, in the last six months or so, I've reached out to some friends from grad school to start up a monthly Skype meeting to discuss grant proposals.

Judith's narrative also highlights the ways WOC seek support outside of their STEM communities. Other participants expressed a sincere gratitude to their partners and family. Irene mentioned that her partner since college had been her number one supporter, which got her through a lot of difficult times. She went on to say that, as she moved up through her career, she became more and more isolated and realized the need for external support.

Irene went on to share that she has a child who requires additional medical attention. Her partner has been key in supporting her and providing the best care for their child while she pursues her career. In a context in which WOC STEM faculty experience feelings of isolation and confront racialized and/or gendered events, I found

that the intentional construction of familial relationship and peer networks reduced the effects of isolation, and often provided the participants with capital to overcome circumstances that would have otherwise distracted them from producing excellent work.

STEM disciplines are often homogenous environments that lack the diverse perspectives that come from STEM academics with multiple underrepresented intersectional identities (i.e. Female, racial/ethnic minority, and scientist) (Ong, 2005). Some participants in this study sought out other opportunities to engage with groups that were inclusive of their multiple social identities. Such groups provided the participants with a safe haven to express their authentic self and allowed them to reveal the racial or gendered aspects of their experiences. For example, professional associations and support groups (both formal and informal), particularly those that adopted a mission of serving minorities or women in STEM, were designated safe spaces where individuals could collaborate on scholarship and engage in conversations about systematic inequalities plaguing their disciplines. For Valerie, her professional association was a space where both her identities as a STEM academic and WOC were legitimized. Annual conferences were events for her to stay abreast on the current trends within her field, and expand her network of like-minded colleagues throughout the nation:

I converse with other scholars and students alike about issues pertaining to our field, and in the same breath discuss the current scandals that are impacting our discipline. The best part is that these conversations are commonplace, like they are sort of expected, given our experiences with discrimination. It is also nice to

know that we don't have to look over our shoulder, nor am I required to negotiate my race with my field.

The quote illustrates ways WOC found external connections when they were unable to identify colleagues who shared their racial and gender identities within their department. Valerie, for example, joined an ethnic specific professional association in an attempt to find more opportunities to socialize and expand her network to include more professionals who share her identities. The women in this study reported that these outside activities equipped them with the tools to withstand chilly working conditions by minimizing perceptions of isolation and linking them to those with similar experiences. In the subsequent subsection, I will discuss other strategies WOC employ that fuel their motivation to remain within the academy.

Reaffirming Enthusiasm for the Discipline

Despite the challenges WOC face within their work environment, their enthusiasm for their respective disciplines provided them with the motivation to continue their careers in the professoriate. A number of participants within the study vividly described their enthusiasm for STEM and how reflecting about their passion has prompted them to withstand the obstacles that they encountered. Pamela expressed the excitement for science and described why remaining in the field is worth the trials and tribulations she faces:

From the age of five, I knew I wanted to be in this field. Perhaps it was because I was an inquisitive little girl. But when I was exposed to it, I just knew that I was in love. Although I have gone through a lot, I am still as excited about my work as I was when I was a little girl. Maybe I was naïve to the misogyny that runs rampant

here, but how was I supposed to know this when I was younger? All I know is that I want to share my excitement with other young women, so we can increase the diversity in the field. I am hopeful that many of the barriers that I have faced during my journey will be nearly non-existent by the time the next generation—like my daughter—enters the field.

Camilla provided an equally powerful interpretation of how she perceived STEM and described the ways her enthusiasm for the field and engaging within the knowledge construction process has helped her cope with the nuances found within her department:

When I talk to my closest family and friends about my experiences within the field, they always tell me that a person with less determination would not have made it as far as I have. My response to them is simple: A person with the same level of passion that I have for my scholarship, students, and the discipline would never consider quitting as a viable option. I hope that doesn't sound overly dramatic, but this is the only way I can decipher in words why I am still standing after the bullshit that I have been through.

Similarly, Cordelia reported that STEM can be intellectually, physically, and emotionally taxing as a woman of color, but it was the career that resonated with her passion. She goes on to explain how she worked tirelessly to get to her position and how her enthusiasm was renewed during her lowest points:

I cannot see myself doing anything else than what I'm doing right now. The road for me has been paved with less than perfect experiences, but it is all part of the process, I feel. There have been times that I have wanted to throw in the towel

both physically and mentally, but then I remember why I am here. I genuinely enjoy the art of my discipline, even though there's a need for improvement. When I get to the point where I think I want to take a break or quit, I immediately am reminded of the hard hours I have put into both my academic career and my professional career. Besides, I still get excited about the newest studies and my contribution to the field.

Cordelia, along with other participants, articulated the role of their enthusiasm as key sources of motivation, and at times, outweighing the obstacles ingrained within their departmental climates. Indeed, many women within this study discussed their passion and interest for their field as being momentous, in that they intentionally used their positions to expose their excitement to upcoming future female scientists and engineers within the K-12 and post-secondary pipeline.

Expanding Competence: Drivers of Advocacy

A majority of the participants in the study described engaging in advocacy. Engaging in advocacy is not only used as a method to help support the STEM aspirations of underrepresented groups, but it also is valuable for WOC. For example, Natalie expressed her commitment to promote people of color within STEM:

If we have more faculty of color, particularly WOC in STEM, then there's not just a couple of us to do all this. But there's not a push to say 'we need to hire faculty of color in STEM. We need to hire WOC.' There's nothing like that. We never have that directive or that kind of push. The second thing you asked about was with respect to challenges relating to balancing family. It's really intense.

Financially, it's really intense supporting an extended family. It's emotionally intense. And it's not something that our dean gets or our chairs get.

It is evident that advocacy influenced these participants to persevere in their fields. The participants also used advocacy as a form of agency in their efforts to change departmental and institutional cultures. Additionally, advocacy was a method WOC in STEM used to give back to their communities. Participants in my study displayed a deeply rooted commitment in increasing diversity in STEM.

Women in this study also reported engaging in outreach efforts, such as mentoring and recruitment activities. They are typically sought out by members of the STEM community to become role models and mentors, or to participate in programs/initiatives that facilitate opportunities to students and colleagues alike. Irene encouraged high school girls to explore non-traditional careers and get hands-on physics experience. Irene shared her informal duties of motivating students, particularly women, to consider engineering as a career:

I have a lot of students come up to me for mentoring things or serve on panels like the Society of Women Engineers. There is a lot of outreach related things that I end up doing. Then the college tends to contact me about all of these things as well.

Activities involving advocacy were often prompted by racialized or gendered experiences. Vanessa discussed feeling a sense of responsibility to provide mentoring for the girls or minorities, who will come after her: "Now that I'm a mentor where I have this role of educating the next generation, and you look around and there's no one coming up behind you that looks like you, it's a little concerning."

Tia discussed how her advocacy also extended to other faculty members who might not have felt empowered to openly question current structures or voice their concerns:

What I did when I came here was, I spent a lot of time sticking up for the issues that I thought were important: advocating for people in less powerful positions, the students and post-docs; things that I thought were unequal. And the people who were the most supportive in all that were not the senior people, by and large. But they were actually the other junior faculty people who were hired at the same time I was—who get it. They're used to being in a more diverse higher education environment. And they're used to hearing discussions about how we need to make it far more diverse. And they're not challenged by that. So there's that. They're also used to hearing women speak their mind and not thinking that that's any different from hearing a man speak their mind, or hearing a person of color speak their mind.

Advocacy was an intrinsic reward in itself for the WOC in this study, whether observing students progressing through the STEM pipeline or being perceived by the aspiring students as a legitimate STEM authority. Mary recalled the level of transparency provided to students with respect to the current state of the academy:

I talk with students and post-docs about real aspects of academic life, both good and bad, particularly ones from diverse backgrounds and actually people across the board, in part, so that they know this crap is out there. But they've actually turned out to be some of my best friends. And they're the next generation. That's what we're doing this all for, 'cause otherwise, I would've quit this job a long time ago for all the bullshit—yeah, so that they don't have to deal with that as

much.

The theme of advocacy manifested in different ways for the women of this study, through mentoring and providing a voice for those who have been traditionally silenced. The scope of engagement and the value added for both the participants and others highlights advocacy's role in serving as a source of motivation, inspiration and empowerment on both ends of the giver and receiver, given that advocacy was not typically valued during the promotion or tenure process (Baez, 2000). Indeed, the time and energy exerted by the women's engagement was an outward demonstration of their commitment to addressing the inequalities within STEM disciplines.

CHAPTER 5: DISCUSSION AND CONCLUSION

Although the recruitment and retention of WOC in the academy has garnered national interest, colleges and universities have yet to achieve their goal of attaining full representation of WOC faculty in the STEM disciplines (National Academies of Sciences, Engineering & Medicine, 2013). This is due in part to institutions' arcane normative practices (e.g. processes for promotion, hiring, etc.) that can perpetuate racism and sexism, and thus requiring WOC to manage their responsibilities as STEM faculty in addition to navigating a hostile work environment. The first step to supporting WOC faculty in STEM includes understanding how race and gender influences their engagement in research, teaching, relationships with colleagues, and the campus community. To develop a more robust understanding of the interplay of WOC's identity and their experience as STEM faculty, it is important to unpack the multiple contexts and identities that affect their lived experiences.

This study investigated how one's identity shapes experiences within the academy and how specifically WOC navigate their own identities with the expectations that come with not only being a faculty member but also the expectations associated with their underrepresented group status. It is important to note that focus of this study is not necessarily the issue of underrepresentation of WOC in STEM; rather it is centered on the consequences of their underrepresentation. Certainly, the underrepresentation of WOC in STEM is a societal problem and these dynamics play out in their personal professional lives. The other part of that problem is because of their underrepresentation they are subjected to more stereotyping, and often lower expectations. The literature documents this as a major issue encountered by

underrepresented groups in general, and WOC in particular (Ong et al., 2010). Certainly this issue may be mitigated by increasing the representation of WOC faculty in STEM. However, this may not totally rectify the issues that WOC face as they navigate the academy.

This chapter reviews the major findings yielded from this study and provides theoretical implications and contributions for science identity development, and higher education with recommendations for future research. Additionally, this chapter offers an interpretation of the study results as they relate to institutions of higher education, recommending practices and policies to improve the STEM workplace in which WOC faculty work. Colleges and universities, especially predominantly white institutions (PWIs) that seek to recruit and retain WOC must address how their organizational discourses influence the navigation of WOC faculty in STEM. More specifically, institutions need to assess the ways that race and gender impact WOC perceptions and experiences as STEM faculty in departments that are traditionally dominated by white males. These gendered and racialized experiences often have an adverse impact on WOC STEM faculty as they negotiate their multiple roles, while answering calls for greater service responsibility related to diversity in the STEM disciplines. This chapter is organized in the following sections: Summary of the study, significance of the study; discussion of major findings; implications for practice and policy; suggestions for future research, and concluding statement.

Summary of the Study

Although existing scholarship has examined the mechanisms that promote the success for WOC in STEM by looking at completion of undergraduate and graduate

programs, few have investigated their career experiences as STEM academics through the use of a mixed method research design. Thus, the purpose of this study was to examine how the intersection and roles of race and gender identities shaped science identity (Carlone & Johnson, 2007), and specifically how WOC navigated the STEM academic workplace by addressing three overarching research questions. First, I examined how the theoretical constructs of the *Scientific Identity* model (i.e. *competence*, *performance* and *recognition*) are interrelated and moderated by race and gender. Specifically, I sought to investigate which aspects of the theoretical model are unique to WOC by contrasting the model with White women and men.

After addressing the relationship between these constructs, this study identified how WOC's racial and gender identity shaped their experiences as faculty in STEM. In addition to addressing how the theoretical constructs applied to WOC faculty in the STEM disciplines, this study also explored the effective strategies they utilized to successfully navigate the academy. In general, this study contributes to existing literature on WOC faculty by offering new insights on how the intersection of their identities influences their perceptions of their workplace and their performance as STEM academics.

This study was guided by a mixed methods design, which was consistent with the pragmatic paradigm that emphasized practicality and utilized a methodology that was appropriate to answer the research questions of interest. The mixed methods design allowed for the generalizability of faculty survey data and depth provided by qualitative results for WOC, which led to a comprehensive analysis of a complex phenomenon. For the purposes of this study, I used a convergent mixed methods

design that integrated tests of theory using structural equation modeling (SEM) of a national dataset based on Science Identity theory; and conducted in-depth narratives of 10 tenured WOC faculty in STEM. The data from STEM faculty who participated in the 2007-2008 and 2010-2011 HERI Faculty surveys were analyzed to test *Science Identity* models across race and gender groups—WOC, White women and men. The qualitative phase of this study included a pattern-matching analysis of 60 to 90 minute semi-structured interviews of WOC STEM faculty, all of whom were employed at two large research universities. Aside from deepening our understanding of how and why certain theoretical constructs related to scientific identity shape the experiences of WOC faculty, data from the qualitative analysis were utilized to triangulate and counter quantitative findings.

Although the women's stories were unique to their lived realities, several themes were interwoven with respect to resiliency in the face of discrimination. These themes included: Reconfiguring salience of identity; barriers to recognition: navigating unsupportive structures; and equipped with the tactical tool belt: navigation strategies. Results from this study suggest that WOC travel a unique path within the STEM academic pipeline as a result of encountering gendered and racialized experiences found within their work environment.

This study highlights how WOC faculty in STEM remained resilient as they encountered the challenges they engaged in research, teaching, and service, and the ways in which they had to negotiate their identities for success and collegiality. These experiences were not only mentally taxing for WOC faculty in STEM, but they had a financial impact, ultimately with reports of promotion difficulties for themselves and other

women in their discipline. This gender and race tax impacts higher education and the STEM disciplines in terms of the loss of talent to advance the field, and shapes the discourse of how colleges and universities can change policies and practices to ensure the success of WOC in STEM.

Additionally, this study revealed the strategies WOC STEM faculty utilized to resist racism and sexism, which were embedded within the climates of their respective STEM departments and disciplines. In general, these strategies were described as identifying issues pertaining to gender and race in their interactions with colleagues, staff, and departmental norms that perpetuated sexual harassment and racial bias. As apparent in the participants' narratives, WOC faculty in STEM initially normalized their gendered and racialized experiences, thus rationalizing that their experiences were commonplace for all faculty. However, once the participants were aware their experiences were unique, they began the process of resisting the racial and gender discourses found within the context of their workplace. As WOC become more aware of overt sexism and racism, they often became advocates for other faculty and students who are hesitant to speak out against such experiences. This study significantly contributes to both theories of STEM identity development and intersections of identity, as well as practices within higher education and STEM disciplines.

Discussion of Major Findings

This study identified major themes that captured how identity shaped the navigation of WOC faculty within the STEM disciplines. These themes included: 1) the ways that WOC made meaning of the salience of their identity, 2) the barriers to performance and how WOC STEM faculty navigated unsupportive structures, 3) the

ways that WOC faculty strategically used the recognition they received and leveraged their trusted support systems, 4) how WOC faculty in STEM use their love for their respective disciplines to reaffirm enthusiasm for their work despite the racism and sexism they encountered, and 5) expanding their *competence* by acting as drivers of advocacy for underrepresented groups within the STEM fields. Of these five themes, three major findings emerged when combined with model tests of the theory of Science Identity, offering answers to the research questions that guided the study.

Science Identity at the Intersection of Race and Gender

The first research question guiding this study was: *Given identified theoretical dimensions of Science Identity (competence, performance and recognition), how are these interrelated concepts moderated by race and gender? Which aspects are central to WOC?* The quantitative analysis shows that *Science Identity* is primarily based on a strong relationship between *performance* and *recognition* at this career stage for all STEM faculty. All groups experienced *competence* (expressed as professional goals) as distinct from the other dimensions of *Science Identity*. This is in contrast to the *Science Identity* Model that was developed on undergraduate and graduate students (Carlone & Johnson, 2007). Most striking was that *performance* and *recognition* are more linked among White Men's experience (and less strong but significantly linked for women in STEM), and discrimination has no impact on any aspect of White men's *Science Identity*. Since White men do not often experience discrimination and tend to dominate STEM departments and disciplines, this is not surprising. In contrast, the findings revealed the ways in which WOC faculty experienced stress from racism and sexism within the STEM disciplines, which was associated with significantly lower *performance*

(productivity in writing) and *recognition* in the department (perceptions of the valuing of their contributions). Results from the quantitative phase revealed that the negative relationship between discrimination and *recognition* in the department is more pronounced for WOC than their colleagues that identify as White women. Furthermore, WOC express feelings of ostracism, disrespect, and harassment by individuals on campus based on their identities. Because of the intersection of their gender and racial identities, they were stereotypically perceived as incompetent and had their legitimacy as a scholar challenged. Thus, their ideas were invalidated, and their experiences as women of color were intentionally disregarded. These negative interactions and experiences in the academy echo existing literature research that suggest WOC faculty are unjustly presumed incompetent (Muhs, et al, 2012); are criticized about their pedagogy and practices; their voices censored or silenced by colleagues or senior leadership (Chupina, 2012;); and oftentimes are recipients of microaggressions and other unacceptable behaviors by students, colleagues, staff and senior leadership (Ford, 2011; Hendrix, 2007). Many of the participants in this study experienced challenges as they tried to pinpoint the aspects of their identity that served as a basis for race, gender, or combination of the two. In other words, the participants found it difficult to parcel out the multiple components that made up their identity. Certainly, the intersection of their gender and racial identities uniquely shaped their professional experiences, compared to their non-WOC colleagues (Jean-Marie, et al., 2014; Marbley, & et al., 2011; Turner, et al., 2011).

The findings also illustrate the ways that WOC experiences as STEM academics influenced the salience of their identity. Given the hostile work environments in which

WOC work, they felt as though the academic culture did not align with their own values, and thus perceived that they bore the burden of being the sole champions of diversity. This often led to them feeling like “outsiders,” as they perceived that they were unsupported and isolated within their institutions. Indeed, this finding confirms existing literature that argues that the “outsider within” syndrome was a common experience among WOC scholars in the academy (Turner & et al., 2011). Additionally, they were overwhelmed with an inequitable division of labor that was service heavy. Some participants mentioned the mental and emotional impact that working in such a context has on their identity.

Fortunately, the cognitive, mental and physical effects of discrimination have been documented. These challenges have been identified and defined as racial battle fatigue syndrome (Smith, Yosso, & Solórzano, 2011), referring to the physical and emotional breakdown which persons of color experience when they are subjected to racism and discrimination. The literature suggests that racial battle fatigue syndrome can be observed in colleges and universities, particularly PWIs. The findings from this study showed that racial battle fatigue has also impacted WOC faculty as they performed their duties within the STEM disciplines. In fact, higher reported levels of stress from discrimination, bias and harassment are associated with lower levels of productivity among WOC and White women.

Navigation of STEM Through the Lens of WOC Faculty

The second research question this study sought to answer was: *How does racial and gender identity shape WOC experiences as faculty in STEM?* The results indicated that WOC faculty in STEM encountered different forms of racism and sexism, all of

which created challenges as they performed their work-related responsibilities. As the WOC faculty navigated their institutions and respective STEM disciplines, it was necessary that they provided support, resources, and mentors as they contributed to the technical and academic excellence within their fields. Participants within this study experienced racist, sexist, and ethnocentric comments that were either directed toward them or expressed about other WOC. The narratives from the participants confirmed findings from existing research (Marbley, et al., 2011; Muhs, et al., 2012; Jean-Marie, et al., 2014), in which other WOC reported that they, too, had faced racist and sexist discourses from colleagues and senior leadership within their institutions.

Specifically, the WOC faculty within this study shared that they had to legitimize their role as a STEM academic because colleagues, leadership, and even students challenged their competence and tried to invalidate their contributions and ideas. It was these experiences to which the literature points as commonplace within four-year PWIs, particularly ones that are research intensive (Mertz, 2011; Muhs et al., 2012; Turner, & et al., 2011). As indicated by the literature, the mission and values at research-intensive institution shapes the criteria for tenure and promotion (Marbley et al.; 2011; Muhs et al., 2012) but these gendered and racialized experiences are not reported or acknowledged in the review process, except in appeals for promotion decisions.

This study also illustrated the way WOC STEM faculty encountered organizational barriers, which oftentimes impacted their success and highlighted the dissonance between institutional desire for equity and greater representation of underserved populations compared to actual institutional policies and practices. The findings from this study indicated how participants' experience extreme

underrepresentation within institutions of higher education, particularly in the STEM disciplines. Additionally, findings from this study reveal that, despite institutional policies and regulations in place at institutions, and despite the fact that the STEM disciplines prides itself in its objectivity, non-WOC faculty within the STEM disciplines displayed a good amount of subjectivity when it came to evaluating grants and dealing with issues of bias or sexual harassment. This was particularly evident among White men who brought their own bias into the process for key decisions of professional consequence. Scholars contend that senior leadership typically does not acknowledge or understand the challenges WOC faculty in STEM experience once they are recruited into institutions of higher education (Bass & Faircloth, 2011; Bilimoria & Busch, 2010; Turner, et al., 2011). Although many colleges and universities provide resources such as workshops on diversity in the workplace, the WOC within this study stressed that said workshops were not sufficient to address the perpetual systematic marginalization that was embedded within their institutions. The narratives of this study's participants provided justification for the need of senior leadership to address the subjective aspects of the STEM disciplines that are often grounded in organizational norms that continue to perpetuate racism and sexism. Lastly, the results yielded from this study suggested that if colleges and universities fail to address how environmental factors shape the science identities of WOC, the STEM disciplines will continue to have inhospitable workplaces and produce faculty who are part of the institutionalized system of white privilege, racism, and sexism.

Another contribution to the understanding of science identity offered from this study is the idea that WOC faculty in STEM bear the burden of engaging others in

discourse about race and gender. In this study, WOC reported that their tokenized status led them to become hyper vigilant because they perceived that their interactions had the potential to be evaluated within the tenure and promotion process. Thus, through their experience, many participants became more aware of their feelings and interactions with others early in their career, mentioning that they were hesitant to advance larger discussions about diversity, race, and gender in various aspect of their work, such as conversations in the classrooms, with colleagues, and in departmental meetings. WOC faculty in STEM, particularly assistant professors, were concerned that their unique perspectives and their interactions on campus might adversely impact their tenure and review process. One participant mentioned, “You are always on. In a way, as a WOC, I am placed on display to have everything about me critiqued. However, it was when I earned tenure that I started speaking out.”

Indeed, censoring aspects of their identity and silencing their voice can take an emotional and intellectual toll, as WOC negotiate when and where it is safe to be their authentic self, especially in spaces where they are tokenized. As individuals from populations encounter social stigma or stereotypes, tokenization is likely to have a cognitive and emotional impact that requires additional time and energy to react and recuperate (Steele, 1997). Future conceptual research could be extended to racial and gender tokenization within organizational settings.

Strategically Overcoming the STEM Labyrinth

The third research question guiding this study was: *What strategies do WOC use to successfully navigate the academy?* The participants within this study discussed the ways in which they leveraged their trusted networks to support their work. The WOC in

this study worked closely with colleagues that had similar experiences with racism and sexism in the academy. They also collaborated with other faculty who as allies and stood in solidarity with barriers that they faced within the workplace. The findings from this study also suggest that support systems outside the workplace are important for WOC faculty in STEM. Participants cited their family and closest friends resources that helped to ease the negative effects of working in an unsupportive work environment. Similarly, the participants discussed being active in specific professional groups that are inclusive of their multiple social identities. Such groups offer WOC the opportunity to be their authentic self and a safe space to engage in discussions about the racial or gendered aspects of their experiences.

Although the WOC who participated in this study experienced challenges within the STEM academic workplace, their passion and the intrinsic rewards they received through their roles as professors and mentors added to their resiliency and served as strong driving forces that add purpose to their navigation of the academy. Furthermore, their enthusiasm for the discipline and passion for research has inspired them to remain committed STEM work in institutions. Additionally, WOC faculty feel compelled to give back to communities of color, not just because these communities reflect their identity, but also to set an example for their students. In general, the participants were driven by their natural instincts to serve as change agents for their students, respective institutions, and communities.

Significance of Study

This study contributes to research on WOC in STEM in several important ways. First, it expands the literature with mixed methods research that produces generalizable

findings across faculty groups as well as contextually-based narratives that yields important new findings as a result. Second, it contributes to the development of the theory of Science Identity at a much later career stage and for WOC in academia. This adds context to a theory and is vital to understanding the intersection of race and gender. Third, it provides evidence of strategies, strength, and the fierce resilience of WOC in STEM, despite discrimination and the consequences of severe underrepresentation in a White male-dominated field. These contributions are detailed in the sections that follow.

Expanding WOC Literature With Mixed Methods Research

The literature is extremely limited with respect to the topic of WOC in STEM and this study added both generalizability and depth of findings in research. Only less than a handful of studies focus on WOC's navigation as faculty in STEM (Jean-Marie & Lloyd-Jones, 2011; Johnson, 2011; Ong et al., 2010), and they fail to examine the nuance in how identity and environmental factors shape their experiences within the academy. Not only are WOC few in number, they are highly visible as targets of discrimination. The stress from discrimination that WOC face makes it difficult for research on this topic to be produced because revealing the sexist and racist norms of their departments and disciplines makes them all the more vulnerable. It is important to note that I conducted a total of 14 interviews. However, four participants subsequently requested that their narratives be excluded from the study. This is indicative of the level of vulnerability that WOC feel when they decide to share their stories. Certainly the threat of retaliation or punishment for raising issues is a reality for WOC, especially for those in assistant faculty positions or in line for promotion. Moreover, existing research on WOC faculty in

STEM lacks in-depth analysis (Ong et al., 2010). This study employed a mixed method convergent design, as quantitative data do not provide sufficient contextual information about identity experiences, and qualitative data alone are typically not sufficient for producing generalizable findings. Together they helped to fill the gaps in research (Creswell & Plano Clark, 2011) on WOC in STEM.

Theoretical Contributions

Expanding the Model of Science Identity

Several studies have used Carlone and Johnson's (2007) Science Identity model as a guiding framework when examining the experiences of WOC within STEM (Espinosa, 2011; Johnson, 2011; Johnson, Brown, Carlone, & Cuevas, 2011; Wong, 2015) However, this study expands the model by empirically testing the theoretical constructs of *Science Identity*, and understanding the components that are central for WOC who are faculty in STEM. Given that the original model was developed using undergraduate and early career WOC in industry, this study took a unique approach to exploring science identity for WOC faculty within the STEM academic disciplines. Through this approach, this study begins to show academic departments, institutions, and professional normative practices that contribute to WOC experiences as science faculty. Most importantly, it shows in this environment and career stage that *competence* is relatively independent from *recognition* but strongly linked with *performance* for all faculty. As we would expect, *recognition* is strongly associated with *performance* for all groups in academia, but it is more strongly associated with White men, than women faculty in STEM. Moreover, *competence* and *performance* are strongly associated across all groups (equal strength). This suggests elements of the

Science Identity theory that are applicable to White women and men, and that the theory strongly supports WOC experiences (using extended models shown in Chapter 4).

Context and Science Identity as Critical to the Intersections of Identity

This study also extended the conceptual model of Science Identity by providing evidence of the ways that context (i.e. experiences with discrimination) shapes and influences the science identity for WOC. The original model only suggests *recognition* as an external factor critical to identity; and while this is true, it says little about the conditions that shape *recognition* in these contexts. Contextual interactions are usually informed by dominant discourses of whiteness and masculinity while faculty may perpetuate systemic processes that exclude WOC while claiming the system is objective and inclusive.

The original model postulates that race and gender impact science identity but is not specific in how this may occur. As mentioned in chapter 2, given their tokenism and underrepresentation, WOC are required to negotiate the identities in their daily work and interactions as faculty. This study showed that conditions within the STEM academic workplace influence the ways to which WOC negotiate their identity as a response to racialized and gendered interactions with colleagues and senior leadership. These experiences are typically normalized within colleges and universities, as well as STEM disciplines, which operate under the guise objectivity of intellectual production and work in research intensive institutions. However, working in unsupportive work environments not only impact the productivity of WOC and White women, but they also disadvantage institutions of higher education. The time and energy that WOC faculty spend to

maneuver hostile departmental climates detracts from efforts that would otherwise be used to carry out their duties in advancing research, teaching and service. By exploring stress from discrimination and its effects on *Science Identity*, this study showed how WOC are uniquely affected compared to White women and men. It advances research that focuses on the intersection of identity by suggesting an element of the context that reinforces how race and gender identity shapes professional identity in science.

Although there are campus initiatives that aim to diversify STEM talent, particularly for WOC interested in becoming faculty, institutions are failing to prepare the STEM departments for the change in demographics. This study shows that regardless of the support that they receive up until being appointed to a faculty position is important but not enough to abate the discrimination that they experience as faculty. The story of Dr. Tamika Cross, who was not viewed as a qualified physician even when someone was faced with a major health risk (in chapter 1), along with the narratives shared by the participants in this study illustrate daily personal and professional instances of overcoming assumptions about their identity. This is the same group that much investment has been placed on in order for them to enter and succeed within the STEM pathway; only for them to be subjected to racialized and gendered experiences as STEM faculty. Hence, this study shows that identity matters. The findings from this study indicate the ways WOC faculty in STEM manage and navigate racism and sexism on a daily basis, confronting dominant white male norms. Because WOC are not part of the dominant group, they are required to confront racism and sexism every day.

WOC Resilience, Strength and Advocacy

Most importantly, this study is concerned with exploring the ways that allow WOC faculty become whole people in expressing their science and multiple social identities in underrepresented contexts, particular within STEM. In supportive environments where WOC can express themselves, they will be free to act on their full identity rather than the segmented parts that the academy will accept. The consequences of the underrepresentation of WOC faculty in STEM make it more difficult for them to navigate the academy. Another issue they face, as evidenced by this study, is that they are more likely to encounter barriers to *recognition* and promotion due to their identity as a WOC. However, their resiliency and their tenacity has allowed them to advance in the faculty ranks. Although there are individuals that attempt to argue science is gender and color blind and the only identity that matters is having a strong science identity, this highlights the importance and impact of other social identities, especially in resisting and becoming advocates for others.

The literature on WOC STEM faculty typically focuses on the effects of experiencing oppression within the workplace, (such as burnout), and the suppression of emotions (e.g. anger and bitterness) (Armstrong & Jovanovic, 2015; Hill, Corbett, & Rose, 2010). Although the literature examines the emotional stress WOC in STEM encounter, this current study contributes to the literature on WOC faculty in STEM by shifting from a deficit narrative to one that highlights their resilience in the face of adversity. Indeed, WOC develop the savvy to manage gendered and racialized interactions in order to navigate the academy until they are able to position themselves where they will be heard (most times, this occurs once they achieve tenure). Through

the examination of the workplace context, this study highlights the ways that WOC encounter discrimination as STEM academics, as senior faculty and leaders perpetuate the historical hierarchies that have advantaged White male faculty. Suffice it to say, WOC must contend with the STEM academic workplace that involves racism and sexism, but also feel an informal responsibility to be an agent of change so that the next generation of WOC scholars do not experience disruptions caused by similar negative experiences. This finding aligns with Mirachandani's (2003) work, which examined the work-related experiences pertaining to inequality in service and non-service occupations. Mirachandani (2003) suggested that the compensation focused mostly on the performance of formal duties, but failed to recognize the unpaid informal work in which WOC engage (e.g. mentoring students or contributing to the local community). These informal typical duties are beneficial for colleges and universities, as they add to their recruitment efforts of diversifying STEM and responding to the needs of an increasingly global and diverse society. However, these responsibilities are not typically given as much weight as research within the tenure and promotion processes.

This study found that WOC faculty in STEM were adept in managing their emotions, and channeling frustration and disappointment in more productive ways. Many of the participants reported using their frustrations as motivation to engage in acts of social justice, through their advocate of students and colleagues that shared similar experiences. Recommendations from the literature (Bass, & Faircloth, 2011; Leggon, 2011; Marbley et al., 2011) suggest the importance of WOC being able to perform their duties with their whole identity rather than segmented parts. In reality, performing one's full identity is easier conceptualized in theory rather than in practice. This will require the

acknowledgement and validation of WOC experiences with race and gender, and the emotions that are a product of these experiences (such as anger). WOC faculty in STEM oftentimes reframe their anger to translate a deeper commitment towards fighting the very injustice that they experienced so that others have a better future. In these situations, negotiating one's identity is centered on WOC being their most authentic self, but more importantly, it is about strategically resisting systemic racism and sexism. WOC faculty in STEM often resist the notion that science is truly objective, especially based on their experiences, thus this offers a degree of protective value for assessing their own competence and racial and gender identity.

In this study, WOC mentored students of color, spoke up for junior faculty, and challenged colleagues on racist/sexist behaviors. By not acknowledging and taking note of the informal duties of WOC in terms of the work of diversity, institutions are likely to engage in ineffective practices to promote diversity within the institutions. This may lead colleges and universities to make the mistake of investing resources in these ineffective practices, while diverting support from WOC whose work has been proven successful in terms of mentoring relationships of faculty and students from underrepresented groups. Findings from this study are also important, given that WOC STEM faculty perceive their service activities such as mentoring students as work that is not given much merit in terms of tenure and promotion. Nonetheless, these activities such as mentoring have more of an intrinsic value knowing that WOC faculty are impacting the lives of students who have similar identities. WOC reported that their roles as mentors gave them perspective and served as motivation for them to remain in academia, despite the challenges that they encountered within their workplace. Hence, WOC in STEM view

their service work as essential for advancing diversity within the field, but at the same time important for their own mental health and motivation, continue within the STEM disciplines.

Despite the fact that colleges and universities often undervalue service activities, this type of work has symbolic and practical value, and is typically expected as part of WOC faculty's contribution to the diversity mission of the institutions. Existing studies have suggested that WOC provide a significant amount of service in terms of mentoring and carrying out roles as diversity representatives for their academic units, for their colleges, and campuses committees, often at the expense of their own time to engage in research (Turner & Myers, 2000).

Strength and Identity Performance. The majority of participants discussed experiencing feelings of anger, something that perpetually lingered as they navigated the academy. They discussed the importance of having a personal office as a place where they could be their most authentic self. One participant described it as a space that they could shed their façade, or “mask,” that they use when interacting with students, colleagues, and staff. The symbolic act of putting on and taking off masks as a proxy for emotions led to WOC faculty becoming cautious of the possible interactions and observation rather than performing in their true identity. Thus, it is critical for research to address the context that shapes the ways that WOC faculty members perform (or chose to conceal) their identities across time and space. This type of research examines the nuance in the ways that environmental and systemic forces influence science identity. This will disrupt the traditional discourses surrounding objectivity in the STEM discipline as it relates to race and gender. Aspects of these

discourses are persistent, significantly shaping the workplace dynamics in which WOC faculty in STEM engage; however, this also suggests that WOC faculty also develop and utilize agency as they strategically act out parts of their identity as a means to navigate the academy. However, again, institutions have the responsibility of fostering environments that allow for faculty to work as their “whole self.” Despite college and universities’ inability to promote environments that are conducive to the success of its faculty, this study shows WOC faculty’s agency in developing safe spaces for themselves and others, and strategically using their identities to disrupt and resist racism, sexism and objectivity.

Mentorship as an Intrinsic Reward. WOC faculty in STEM reported expressed feelings of frustration, pain and isolation through their experience of negotiating their identity as they navigated through the academy. However, it is important to note that most of the participants mentioned satisfaction, joy and receiving intrinsic rewards, which often resulted from their responsibilities of mentoring and teaching, and were also pivotal in their own motivation to remain within the STEM disciplines. As one participant stated:

“Students of color have a very special place in my heart. Although I put in countless hours to make sure that they have everything to be the best they can be, it’s worth it. In fact, they are on the forefront of my mind when I face blatant patriarchy or racism from colleagues and administration alike. Then I think to myself: ‘If I’m not here, who is going to fight for these students? Who will step up and empower these students, and let them know that they are meant to be here?’ The answer to this question is quite frightening. I know it may seem self-

sacrificing, but I personally see it as investing into their future. Now, don't get me wrong—I am passionate about research, and I love writing, but mentoring makes it bittersweet.”

This quote eloquently captures the sentiments of the majority of the faculty included within this study. Thus, colleges and universities must strive to not only promote, but also acknowledge and adequately reward these types of mentoring relationships within the process of tenure and promotion. This type of informal work benefits all faculty in general, students (especially from underrepresented populations), and the institutional goals related to diversifying the STEM fields.

Implications for Practice and Policy

The findings yielded from this study should prompt institutions to consider the loss of productivity because of the substantial amount of time and effort that WOC devote to counteracting hostile working conditions—time which detracts work from within their respective fields. STEM departments should also be particularly interested in improving their success to advance innovation, collaboration, and productivity. Indeed, departments should pursue effective strategies that will foster an inclusive institutional climate that accommodates WOC's multiple social identities. Though many institutions already provide support programs for underrepresented groups (i.e. women and racial minorities), a majority of these programs typically fall short in their efforts to address the unique needs of faculty with intersecting identities. Additionally, by examining the narratives of WOC, department and institutional leaders can implement institutional initiatives aimed at supporting the success of WOC faculty.

Given the findings from this study, the tenure process should be examined through a

lens that acknowledges the subjectivity found within the STEM disciplines. Thus, it is important to assess how the informal responsibilities of WOC can be integrated within review of tenure and promotion. The majority of the participants within this study discussed how their identities influenced their efforts to triangulate their work responsibilities (both formal and informal) as faculty. As mentioned in the previous chapters, these efforts were at times frustrating and emotionally taxing. Based on the findings from this study, I have developed a set of recommendations for institutions, with respect to supporting the success of WOC STEM faculty.

Recommendation for Institutions and STEM Departments

The act of shifting a campus or departmental climate first begins with the leadership (Ko et al., 2014). Thus, institutions should implement mandatory cultural awareness trainings for both faculty and administrators to inform them of how to avoid engaging in discriminatory practices (both overt and covert), as well as how to work across differences (i.e. engaging with people with different perspectives). Second, if not already created, departments should develop a plan for increasing diversity, specifically the number of tenure track faculty who identify as WOC. This may require the creation of a steering committee that is responsible for diversity-related issues (i.e. practice and policy). Third, departments must direct their efforts in recruiting of WOC to both the faculty and leadership ranks.

As the participants mentioned in this study, the severe underrepresentation perpetuates the current conditions that they face since there are few people in leadership positions investing in affecting departmental and institutional change. WOC's presence in these positions will serve as an impetus to attract other women and

minorities to the professoriate. Departments may also find value in institutionalizing formal structures that facilitate mentoring among newer and senior faculty, as well as for leadership for leadership positions. These mentoring relationships have the potential to extend WOC's navigational and political capital required for advancing to the next phases of their career. Lastly, the findings from this study provide empirical evidence that suggest that institutions should rethink how service is valued (in most cases, it is not), and assign more value on these activities, given that WOC are more likely to undertake service-related responsibilities (i.e. mentoring, committee work, etc.) as a means to cultivate the talents of the next generation of scientists and engineers. For example, departments can create service awards that have value in review processes.

The findings from this study also indicated that WOC faculty in STEM perceive that their identity impacts their access to support and resources at the institutions and that they have diligently provided their time and contributions. Although many of the participants stated they did not rely on campus-wide *recognition* for their talents, they desired their colleagues to acknowledge and respect them as scholars. As shown in this study, WOC faculty members in STEM contribute to the success of STEM students, especially those from underrepresented populations. As previously mentioned, WOC report feelings of frustration, which stem from specific organizational obstacles that affected their engagement in teaching, research and service. Scholars have argued the significance of promoting the success of WOC faculty (Bass & Faircloth, 2011). Thus, it is important that WOC's narratives of marginalization are not thought of as isolated instances, or divergent cases, but seriously considered in order to generate solutions that will minimize the racism and sexism found within the STEM disciplines. Additionally,

the study's findings showed that WOC were inventive in terms of accessing support networks and resources through informal networks and allies, since their institutions failed to provide support. Indeed, WOC can benefit from institutional support and the receipt of culturally aware mentoring from individuals within their respective disciplines. What follows are a number of recommendations for academic leaders, administrators, and faculty alike in an effort to improve the STEM academic workplace for WOC faculty:

1. Review and revise hiring practices and the demographic composition of hiring committees to establish a more transparent, balanced, and equitable process that selects qualified candidates for a position.
2. Develop a recruitment plan with actionable items that will increase the representation of WOC and faculty with a reputable track record of improving the outcomes for students from underrepresented populations (e.g. mentoring, integrating a culturally responsive pedagogy, etc.).
3. Develop, execute and assess a diversity awareness program (outside the realm of a workshop) for senior leadership, faculty, and staff to address issues related to WOC, and practical recommendations to help attain the objectives of faculty diversity plans.
4. Implement and institutionalize both campus-wide and discipline-specific mentoring programs that offer support and guidance for WOC, with respect to navigating the tenure and promotion process, securing external funding, transitioning to senior leadership positions, and circumventing burnout.
5. Establish streamlined processes through which WOC faculty can express concerns, without the fear of retribution for their perspective, or being dismissed

or serving as a whistleblower. The person reviewing each case should be an impartial compliance officer to investigate and offer solutions, thus reducing bias.

6. Senior leadership and faculty must develop policies and practices that will protect WOC from any adverse action, such the threat of losing their job, if they come forward about their experiences with harassment on campus.

Suggestions for Future Research

This study examined how identity influences the experiences of WOC faculty in STEM, and future research can investigate and extend the findings in further detail. First, research should focus on how to evaluate *Science Identity* in relation to actual outcomes. Although the Carlone and Johnson's (2007) model provides a framework, future studies should further investigate how WOC employ their science identity within the workplace. This will require researchers to examine that ways that WOC act upon their science identity within their work and engagement with students, colleagues and the campus community. This may also call for an in-depth analysis of how WOC STEM faculty make meaning of the intersections of their multiple identities (e.g. gender, ethnic, socio-economic, sexual orientation, professional, etc.) in relation to how they do science and perform professional tasks.

Second, research focus should explore the indirect effects of *competence* via *performance* on *recognition* at the department level. Although there were no significant direct effects of discrimination on *competence*, the results suggest an indirect relationship with *competence* because of strong correlation with *performance*. WOC faculty in this study were fairly secure about their competence but other research has shown how it can take a toll and lead the women to question their work in STEM.

Third, future studies should incorporate a mixed methods design to investigate senior leadership's perspective on equity and access, given that there is a dissonance between institutional practices and the experiences of WOC faculty in STEM disciplines. Future research should also examine in further detail the mentoring experiences of WOC STEM faculty and how senior leadership structures such programs for success. Much of the literature on mentoring focuses on the experiences of WOC undergraduate STEM majors at colleges and universities. Subsequent studies should examine mentoring opportunities for WOC faculty at each academic rank, and the effect of mentoring programs for WOC.

Future research can further investigate inequitable workload expectations of WOC faculty, and how these formal and informal expectations vary across STEM disciplines. There is a possibility that the experiences and values placed on teaching, research, and service are different for a WOC in mathematics compared to a WOC in engineering. Further future research can explore how certain STEM contexts perpetuate inequalities as it relates to other aspects of one's identity such as race, gender, class, sexual orientation, citizenship status, and religion. Nonetheless, this study highlighted how WOC STEM faculty are typically tokenized across both racial and gender lines, since they contribute to diversity missions within institutions of higher education. Furthermore, they encounter resistance (both explicit and implicit), as they combat racial and gendered hierarchies within their respective disciplines.

Concluding Statement

As more WOC enter the STEM pipeline with aspirations to join the faculty ranks, it is important that the academy prepares itself to address their unique needs of

ensuring that they are supported as they engage in scientific and technological advancement. Thus, scholarship is necessary to provide institutions with the information to understand the types of conditions that promote WOC success, as well as build awareness about the barriers that influence WOC to exit from the academic pipeline. This study allows for the unique narratives of WOC STEM faculty to be heard, as the participants had the opportunity to reflect on their educational STEM pathways and how they have made meaning of their experiences within the academy. The findings from this study have the potential to highlight the importance of institutional investment in retaining WOC in STEM, and ways institutions can effectively support this population throughout the stages of their careers.

This study has contributed to the body of literature on WOC STEM faculty by examining the ways that identity and the workplace context impact their experiences within the academy. In general, the findings conclude that WOC are required to navigate racism, sexism, and organizational impediments. Despite the institutional regulations on sexual harassment that are supposed to promote and safeguard diversity, a contention exists between the value of objectivity in STEM—the need for non-WOC faculty to become more culturally aware—especially with respect to search and hiring committees, campus-wide and departmental decisions, and pedagogy. This suggests that it is not enough to simply increase the number of WOC STEM. It is critical that their experiences of working within a hostile workplace are shared and understood by their colleagues. WOC reported feelings of frustration, citing organizational barriers that made their efforts to advance the technical and academic excellence of their respective disciplines and improve student-learning outcomes. Experience with racism

and sexism within the academic workplace led to perceptions of isolation and vulnerability.

Certainly, the academy is doing an injustice to talented WOC. It is critical to consider how each field suffers from the lack of diversity in perspectives. A critical mass of individuals exists who think that science is objective, and the color or gender of the professional behind the microscope should not matter. However, in reality this is not true. WOC's presence in STEM is important for students of color to see faculty who look like them. Also their representation impacts the field in terms of the types of topics that are being studied and guiding research agendas that might not be of interest to White men but benefit society as a whole. This study denotes the ways that WOC are not like other scientists, but they are *still* scientists and play a pivotal role within the academic and scientific community.

Notwithstanding these challenges, WOC faculty in STEM are resilient in their ability to influence their work context through their pedagogy, advocacy for students and other underrepresented faculty, and reinventing within their respective disciplinary communities. Given this finding, it is apparent that WOC would benefit from receipt of necessary institutional support and resources to effectively perform their duties and help them cope with their negative experiences and feelings of marginalization. Thus, colleges and universities must challenge the STEM disciplines that claim to operate in objectivity in order to dismantle racist and sexist practices that create a hostile work context for WOC faculty. Moreover, the experiences shared by the participants within this study clarify dynamics that perpetuate the low representation of WOC academics within the STEM disciplines, which ultimately and adversely impacts students, and

colleges and universities that are underestimating or resisting the contributions of talented WOC in STEM.

Appendices

Appendix A: Protocol

As this is a semi-structured interview these are guiding questions; not all question may be asked, and question may not be asked in this exact order. Follow-up question may also emerge during the conversation

Thank you for agreeing to participate within this study and share your experiences with me. Please know that you participating is voluntary and you reserved to stop the interview or withdraw from the study at anytime.

1. For the record please state your name and role on this campus? How long have you been at the institution?
2. What were some factors that led you into the position that you are currently in as STEM faculty?
 - a. How would you describe your graduate school training?
 - b. What type of program did you participate in
 - c. What were your experiences in the program?
 - d. Describe your relationship with your advisor?
 - e. Where did you gather your support?
3. In what ways that you feel supported by colleagues in your department?
 - a. In your field?
 - b. What ways do you feel a lack of support by your colleagues?
4. From your vantage point, describe the climate within your field?
 - a. How have you found support within the field?
 - b. Who do you collaborate most with?
5. What are some of the obstacles that you face being a STEM faculty?
 - a. How would you describe the climate of the campus? Climate of the department? Is it a climate that supports diversity?
 - b. Managing Legitimacy?
 - c. Managing Class loads?
 - d. Service?
 - e. Producing scholarship?
 - f. Familial obligations?
6. In what ways do you try to overcome these obstacles?
 - a. Where do you get most of your support?
 - b. In what ways do you feel supported by your colleagues
 - c. In what ways do you feel supported by your institution?
 - d. Is there anything else you see key in reducing these obstacles?
7. Is there anything that you would like to add, that may not have been captured during the interview?

This concludes our interview. I would like to thank your for your participation and please feel free to contact me with any questions or comments.

Appendix B: Demographic Sheet Women of Color STEM Faculty Study

Demographic Sheet: Women of Color STEM Faculty Study

1. Please indicate your gender.

Female

Male

Other

☐☐☐ 2. Please specify your ethnicity. ☐

African American or Black

Asian/ Pacific Islander

Latino(a) or Hispanic

Middle Eastern

Native American or American Indian

White or Caucasian

Other:

☐☐☐ 3. What is your title? ☐

Instructor

Assistant Professor

Associate Professor

Full Professor

☐☐☐ 3. Please specify your academic discipline ☐☐☐☐ _____

4. Please select the statement that you agree with the most. ☐

_____ You have a genuine enthusiasm for practices, subject matter, or career possibilities related to your field. You have received recognition from prominent individuals within the science community such as faculty and other professionals in the field.

_____ You see the knowledge and skills within your field as deeply tied to their altruistic values. You have an interest in humanity, including both human behavior and human physiology; Your reasons for pursuing STEM, was more about using your discipline as a vehicle for altruistic ambitions. You see yourself using your expertise in direct service of humanity.

_____ You have a genuine enthusiasm for practices, subject matter, or career possibilities related to your field; however, you have felt overlooked, neglected, or discriminated against by meaningful others within science. You have felt that established members of their science departments recognized you not as a STEM person but, instead, as representatives of stigmatized groups.

Appendix C: Descriptive Statistics for All STEM Faculty

Appendix C .

Descriptive Statistics for all STEM faculty

	<i>All STEM Faculty (n=816)</i>				
	Mean	S.D.	Kurtosis	Min	Max
<i>Control Variables</i>					
Stress: Subtle discrimination (e.g., prejudice, racism, sexism)	1.42	0.47	-1.88	1.00	3.00
<i>Competence</i>					
Indicate the importance to you personally of each of the following:					
Objective: Becoming an authority in my field	2.86	0.93	-0.79	1.00	4.00
Objective: Making a theoretical contribution to science	2.49	0.96	-0.95	1.00	4.00
Mentoring the next generation of scholars	3.33	0.74	-0.22	1.00	4.00
<i>Performance</i>					
How many of the following have you published?					
Articles in academic or professional journals	3.37	1.83	-1.16	1.00	7.00
Chapters in edited volumes	1.54	0.88	4.62	1.00	7.00
How many of your professional writings have been published or accepted for publication in the last two years?	2.08	1.13	0.60	1.00	7.00
<i>Recognition</i>					
Indicate the extent to which you agree or disagree with each of the following:					
My research is valued by faculty in my department	2.91	0.89	-0.38	1.00	6.00
My teaching is valued by faculty in my department	3.38	0.70	1.18	1.00	7.00
Faculty of color are treated fairly here	3.35	0.73	0.78	1.00	7.00

Note: n=816 STEM faculty across 262 institutions.

Appendix D: Covariance Table: Hypothesized Model

Appendix D

Covariance Table of all the Variables in the SEM Model: All Faculty Sample (n=816)

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1 Received funding for your work from - State or federal government	0.21														
2 Articles in academic or professional journals	0.32	0.34													
3 Chapters in edited volumes	0.22	0.46	.77												
4 How many of your professional writings have been published or accepted for publication in the last two years?	0.38	0.66	0.48	0.86											
5 Objective: Becoming an authority in my field	0.14	0.11	0.18	0.22	0.72										
6 Influencing the political structure	0.07	0.04	0.13	0.06	0.27	0.93									
7 Objective: Making a theoretical contribution to science	0.15	0.21	0.21	0.28	0.46	0.22	0.64								
8 Keeping up to date with political affairs	0.03	0.04	0.06	0.02	0.17	0.66	0.22	0.79							
9 Becoming a community leader	0.00	0.08	0.06	0.03	0.32	0.47	0.27	0.35	0.55						
10 Mentoring the next generation of scholars	0.17	0.11	0.11	0.19	0.29	0.25	0.38	0.23	0.36	0.37					
11 Faculty here respect each other	0.00	0.03	0.04	0.03	0.04	0.07	0.02	0.04	0.01	0.03	.79				
12 My research is valued by faculty in my department	0.14	0.22	0.08	0.18	0.05	0.06	0.12	0.00	0.01	0.16	0.29	0.49			
13 My teaching is valued by faculty in my department	0.03	0.05	0.07	0.07	0.03	0.01	0.07	0.03	0.05	0.00	0.33	0.47	0.52		
14 Faculty of color are treated fairly here	0.13	0.16	0.09	0.15	0.02	0.40	0.07	0.04	0.04	0.05	0.29	0.24	0.36	0.73	
15 Stress: Subtle discrimination (e.g., prejudice, racism, sexism)	-0.08	-0.26	-0.28	-0.02	-0.03	-0.01	-0.05	-0.04	-0.05	0.00	-0.02	-0.01	-0.03	0.00	0.65

Note: n=816 STEM faculty across 262 institutions.

Appendix E: Covariance Table: Modified SEM Model

Appendix D

Covariance Table of all the Variables in the Modified SEM Models: : All Faculty Sample (n=816)

Variable	1	2	3	4	5	6	7	8	9	10
1 Articles in academic or professional journals	0.343									
2 Chapters in edited volumes	0.741	0.769								
3 How many of your professional writings have been published or accepted for publication in the last two years?	0.365	0.474	0.285							
4 Objective: Becoming an authority in my field	0.18	0.142	0.227	0.863						
5 Objective: Making a theoretical contribution to science	0.386	0.181	0.307	0.438	0.932					
6 Mentoring the next generation of scholars	0.161	0.079	0.163	0.202	0.274	0.552				
7 My research is valued by faculty in my department	0.35	0.06	0.181	0.04	0.104	0.104	0.786			
8 My teaching is valued by faculty in my department	0.059	0.042	0.057	0.02	0.048	0.001	0.293	0.494		
9 Faculty of color are treated fairly here	0.208	0.06	0.121	0.014	0.054	0.03	0.153	0.183	0.524	
10 Stress: Subtle discrimination (e.g., prejudice, racism, sexism)	-0.128	-0.056	-0.017	-0.026	-0.035	-0.001	-0.009	-0.017	-0.003	-0.658

Note: n=816 STEM faculty across 262 institutions.

Appendix F: Fit Indices from Alternative Models

Appendix F.
Fit Indices from Alternative
Models

Model	Women of Color (N=272)				White Men (n=272)				White Women (n=272)			
	χ^2	CFI	RMSEA	SRMR	χ^2	CFI	RMSEA	SRMR	χ^2	CFI	RMSEA	SRMR
Competence	3.49	1.00	0.00	0.00	3.49	1.00	0.00	0.00	3.49	1.00	0.00	0.00
Performance	7.84	1.00	0.00	0.00	7.84	1.00	0.00	0.00	7.84	1.00	0.00	0.00
Recognition	3.06	1.00	0.00	0.00	3.06	1.00	0.00	0.00	3.06	1.00	0.00	0.00
Three-Factor Model	24.25	0.99	0.02	0.03	31.09	0.98	0.04	0.04	27.80	0.97	0.03	0.03
Higher-Order Model	N/A				N/A				N/A			

Note: Models are listed from best fit to worse fit

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