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The Triumvirate Woman:

Reconceptualizing Academic Career Messages for African American Women in Engineering

by:

Latrice Diane Bonner

A dissertation submitted to the Faculty of Claremont Graduate University and San Diego State University in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Education

2019

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Approval of the Dissertation Committee

This dissertation has been duly read, reviewed, and critiqued by the Committee listed below, which hereby approves the manuscript of Latrice Diane Bonner as fulfilling the scope and quality requirements for meriting the degree of

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AS STRONG AS THREE POWERFUL MEN!

Abstract

The Triumvirate Woman: Reconceptualizing Academic Career Messages for African American Women in Engineering

by

Latrice Diane Bonner

Claremont Graduate University & San Diego State University: 2019

The purpose of this study was to understand the importance of access, equity, inclusion, and diversity in engineering by intentionally focusing on academic career messages for African American women who are tenured and tenure-track in engineering through the lens of Critical Race Theory, Black feminist thought, and intersectionality. This study illuminates within-group differences at the intersection of race, gender, field, and rank, while incorporating a conceptual framework that examines both the macro and micro perception of higher education. There was also a need to transform simultaneous forms of oppression into sources of empowerment. Therefore, this study utilized empirical research to validate the demand to create a new construct, Triumvirate Woman, to encompasses race, gender, and engineering. Findings indicate as of fall 2017, there were 33 (0.12%) African American women full professors, 50 (0.18%) associate professors, and 59 (0.22%) assistant professors tenured and tenure-track faculty in engineering. Although these women represented 0.52% of the faculty, this study determined that they understood the breadth and depth of the historic and current faculty demographics. The academic career messages they experience are both positive and negative; however, they are persistent, resilient, feel a sense of belonging and mattering, and they are here to stay.

*Key Words***:** African American women, engineering, engineering education, faculty, tenured and tenure-track, Critical Race Theory, critical race methodology, Black feminist thought, intersectionality, gender, race, diversity, inclusion, access, equity, higher education, faculty demographics, STEM, pipeline leakage, and Triumvirate Woman.

DEDICATION

I would like to dedicate my dissertation to the generations of ancestors who have prayed, fasted, and planted seeds of prosperity in my life. It is because of you all that I am here today! I am eternally grateful for the grace and mercy that has been bestowed upon my life. I would also like to dedicate my dissertation to every person who has encouraged, supported, mentored, advocated, embraced, and loved me for me. Thank you for allowing me to be the best version of myself so that I can be the change I seek in the world.

#BlackGirlMagic #BlackGirlsRock #BlackLivesMatter #BlackMindsMatter

#TonyCarr

R.I.H. To Big Momma, Grandpa, Momma Angie, Brothers Tony & Michael

"You write in order to change the world, knowing perfectly well that you probably can't, but also knowing that literature is indispensable to the world... The world changes according to the way people see it, and if you alter, even but a millimeter, the way people look at reality, then you can change it."

— James Baldwin

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I would like to thank GOD for everything! The amount of love, grace, and mercy that GOD has bestowed upon my life is unmeasurable! I would like to thank my grandparents Dorothy "Big Momma," Janice "Granny," Virgil "Big Daddy," Willie "Grandpa," and James "Grandpa" for their love and commitment to our family. You all have prayed for me, encouraged all of my dreams and loved me endlessly! My Dad, James and Mother, Angie for loving me unconditionally and always supporting me. Thank you all for teaching me the importance of hard work, dedication, and sacrifice. My committee members, Dr. Fred Bonner II, Dr. David Drew, Dr. Marva Cappello, Dr. Linda Perkins, and Dr. J. Luke Wood, thank you for mentoring and teaching me the how, what, when, where, and why in education to ensure that I learned how to be a researcher, educator and a scholar in this field. I sincerely appreciate all of you for affording me the opportunity to learn from you over the years. Thank you to my sisters, brothers, line sisters, nieces, nephews, and godchildren for your continuous support and love. I would like to thank my amazing sponsored children Fozia and Fekadu, their families, along with the country of Ethiopia for their love and support. I would like to thank Zeta Phi Beta Sorority, Inc. for opening my network and my family to a whole world of Sorors and Frat around the world who have mentored, guided, supported and motivated me to be a Finer Woman! Special thanks to Paul, Jewels, Lance, Dominique B., Carolyn H. (TSU JHJ), Daniel H., Taunya F., Auntie Val S., Lambda Zeta, Texas Southern University, and the countless others who have supported, mentored and encouraged me along the way. It definitely takes a village and I am honored to have you all in my life. Thank you all for everything and I love you! "Children have never been very good at listening to their elders, but they have never failed to imitate them."

— James Baldwin

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Chapter 1: Introduction

Introduction

The American Society for Engineering Education (ASEE) published the 2017 edition of *Profiles of Engineering and Engineering Colleges*, which stated "…338 U.S. four-year degree-granting engineering schools surveyed by ASEE reported an aggregate total of 27,178 tenured and tenure-track faculty members as of the fall of 2017" (Bonner, 2019, p. 15) in engineering across the United States of America. More specifically, when you examine the data and disaggregate by race or ethnicity and gender, there were 33 (0.12%) African American women full professors, 50 (0.18%) African American women associate professors, and 59 (0.22%) African American women assistant professors tenured and tenure-track faculty in engineering (Bonner, 2019). Indeed, African American women represent 0.52% of all tenured and tenure-track faculty in engineering across the US as of fall 2017.

A new era has emerged with a zeitgeist that illuminates the importance of African Americans and underrepresented minorities (URMs) around the world. Revolutionary social justice advocates are organizing and uniting millions of people from around the globe through trending hashtags such as #BlackLivesMatter, #BlackGirlMagic, #BlackGirlsRock, and countless others in support of an egalitarian society. In fact, during a recent podcast hosted by Shaun King, a world-renowned social justice activist and founder of the new *North Star*, he mentioned that it is hard to know a movement in history when you are in it (Lavin, 2019). Still, we are making history, and change is inevitable.

Background and Problem Statement

Innovation in domestic engineering advancements is essential for the US to remain competitive in the global community. It is imperative that in the US, we foster the environments

necessary for access, equity, diverisity, and inclusive representation for African American women in engineering academic career fields. On the one hand, the US is known for our leadership, technological advancements, innovation, and ability to produce the next generation of leaders to meet the needs of the global economy. On the other hand, for faculty in higher education, there is a significant loss of human capital from a diverse talent pool of African American women.

Recruiting and retaining African American women and other URM groups in engineering academic career fields can contribute to the progression of the US to meet the human capital demands in the global economy on the same level as other countries in regards to quantity and quality of skilled engineers (Ong, Wright, Espinosa, & Orfield, 2011). In either case, African American women faculty members in engineering endure multiple forms of oppression simultaneously, as they traverse through their academic career trajectories (Malcom, Brown, & Hall, 1976). Historical data confirms the disproportionate rate at which African American women are not recruited, not being appointed to tenure-track positions, and not receiving a promotion to full professor across engineering fields in higher education (ASEE, 2018).

Faculty in higher education are essential as they are the gatekeepers to educational mobility. More specifically, engineering faculty exude vast amounts of influence over the quantity and quality of engineering students that will matriculate through higher education (Leggon & Barabino, 2015). Likewise, faculty members in engineering determine who they will advise, who they will work with on special projects, and who they will mentor (Leggon & Barabino, 2015). This is why it is imperative that we examine the degree at which African American women are represented in engineering tenured and tenure-track positions, as they are

vital to the success of African American students seeking educational attainment in engineering (Malcom-Piqueux & Malcom, 2015).

Purpose of the Study

The purpose of this study was to understand and emphasize the importance of access, equity, inclusion, and diversity in engineering by intentionally focusing on academic career messages for African American women through the lens of Critical Race Theory (CRT), Black feminist thought (BFT), and intersectionality. More specifically, it would be a disservice for this study to aggregate all African Americans or all women into one group to make generalized statements. This means that it minimizes their uniqueness and stifles the narratives of the individual within the margins. Therefore, honing in on African American women who are tenured and tenure-track in engineering allows me to illuminate within-group differences at the intersection of race, gender, field, and rank.

In regards to aggregate and disaggregated data, some studies do not emphasize the need for specific differences within groups. However, this study specifically emphasizes intersectionality and how it correlates to African American women in engineering. Intentionally focusing on African American women allows for me to understand the narratives of this specific group of women without lumping them into a category of all women who do not always share the same struggles, although they may be similar. The Harvard Educational Review (2011) reported findings on research conducted on URM women and recommended that future research disaggregate the data to differentiate between the experiences of women of color (WoC), which further illuminates the importance of race and gender and how this intersection manifests.

While the concern for examining the breadth and depth of race and gender is central to the focus of this study, there is also a need to transform these simultaneous forms of oppression

for African American women in engineering into a source of empowerment. Therefore, this study utilizes empirical research to validate the demand to create a new construct that encompasses a salient third oppression. Indeed, African American women in engineering are faced with three forms of oppression: race, gender, and their field of choice—engineering. While this third oppression was initially introduced in reference to "science," the term has evolved into what is now known as STEM (Malcom et al., 1976).

Significance of the Study

This study explores the experiences of tenured and tenure-track African American women in the field of engineering. Furthermore, this study has helped me understand the current challenges and duties on the path towards appointments and tenure for African American women who are engineers in academia. Also, I utilized the literature available to illuminate the theories and research that solidify the three forms of oppression—race, gender, and engineering—collectively as a robust force explaining the *Triumvirate Woman*. Since the release of the monumental 1975 seminal report, *The Double Bind: The Price of Being a Minority Woman in Science,* scholars have argued that African American and other URM women in engineering are faced with three forms of oppression that they endure simultaneously; which is why they are worthy of a name to identify the tenacity, grit, and resiliency they encompass within themselves. Therefore, since triumvirate means the strength of three powerful men, an African American woman in engineering who endures these simultaneous forms of oppression as they negotiate through academic career trajectories is a *Triumvirate Woman*—as strong as three powerful men. The Triumvirate Woman was incorporated into this study to create a construct that is viewed through an antideficit lens by taking forms of oppression then making them a source to empower and celebrate their narratives.

In addition, while conducting the initial research into African American women in engineering academic career fields, another salient theme emerged and unveiled the existence of a publication gap. Indeed, this prominent theme was highlighted on an international level during a more recent symposium on URM women in STEM where Ong (2010) discussed the status of those within the field by stating:

> We have found many, many dissertations. When I asked my researcher to find out how many had been published, what they had published, the answer came back as zero. There's not a knowledge gap. It's a serious gap in publishing, in being able to get the word out. (p. 13)

More specifically, the acknowledgment of the publication gap was followed by a piece by Malcom and Malcom (2011) that reported the following:

> In order to understand the true nature of the obstacles faced by minority women in STEM, we need data disaggregated by race and by sex as well as by field and institution type. But their small numbers are driving statistical agencies to suppress the very information we need to inform our programs, policies, and practices as well as to inform efforts to improve the conditions for URM males in STEM fields. (p. 169)

Therefore, researching and publishing the disaggregated data on the actual number of African American women in engineering for the fall of 2017 will provide the audience with the knowledge and the data needed to validate the demand for essential programs, policies, and practices that can be used to meet the needs of African American women in academic career fields.

Research Questions

The following research questions were utilized to better understand the academic career messages for African American women in engineering:

1. How many African American women are tenured and tenure-track by rank in academic engineering careers in the US as of fall 2017?
2. How do the historical data on engineering faculty demographics from 2001-2017 impact academic career messages and persistence for African American women?
3. How do the 2001-2017 faculty demographics attribute to a sense of belonging and mattering for African American women in engineering academic career fields?

Organization of the Dissertation

This dissertation is organized in the following manner: Chapter 1—introduction, theoretical framework, limitations, positionality, and a list of abbreviations and acronyms; Chapter 2—literature review and conceptual framework; Chapter 3—overview of the methodology, participants, data collection, instrumentation, data analysis, protection of human rights; Chapter 4—findings, counter-story themes, research questions, conclusion; Chapter 5—summary, findings, discussion, implications, recommendations, limitations, and conclusion.

Theoretical Framework

Identifying a framework to illuminate the importance of race and gender was of the utmost importance for this study; however, this study is framed by three interrelated theories. The following theories were utilized to guide the research questions for this study: Critical Race Theory (CRT), Black feminist thought (BFT), and intersectionality. This section is organized into three parts, whereas to briefly discuss each theoretical framework individually to provide an overview of the significance and how it applies to this study.

Critical Race Theory (CRT)

CRT emerged from a subdivision of Critical Legal Studies (CLS), as a race-based epistemology that centers race and racism in the everyday lives of People of Color (PoC) (Taylor, Gillborn, & Ladson-Billings, 2016). Although CRT is historically rooted in CLS, as an educational discourse, this race-based epistemology has evolved into a powerful lens to support educational researchers with a deeper understanding of how systemic forms of oppression are experienced by PoC (Taylor et al., 2016). Likewise, CRT allows scholars to discern the critical elements of racial identities, racism, and other forms of oppression that impede on the lived experiences of PoC by virtue of other subordinated identities such as gender, class, religion, dis/ability, sexual orientation, sexism, homophobia, and ableism (Bartlett & Brayboy, 2005; Brayboy, 2005; Kumasi, 2011; Lynn & Adams, 2002; McCoy & Rodricks, 2015; Taylor et al., 2016; Yosso, Ceja, & Solórzano, 2000). Critical race theorists unequivocally recognize that racism is not just an individual act, but part of the broader, systemic framework within "…structural conventions and customs that uphold and sustain oppressive group relationships, status, income, and educational attainment" (Taylor, Gillborn, & Ladson-Billings, 2009, p. 4). Moreover, critical race scholars are more surprised by racism's absence than its presence, which makes it a priority to routinely expose, disrupt and eliminate racism within the educational system (McCoy & Rodricks, 2015; Parker & Lynn, 2002).

Black Feminist Thought (BFT)

Black feminist epistemologies have an extensive history of social justice activism work towards the eradication of multiple forms of oppression and the liberation of African American women and other historically marginalized groups (Collins, 2009). Although African American women contributed to the creation of scholarship and advancements by sharing their lived

experiences during the feminist movements, *hooks* (1984) argued that they still were not acknowledged as academic intellectuals in theorizing feminist theory. Scholars such as *hooks* were instrumental in creating empirical research by and for advancements in Black feminism; however, this study draws from the concepts tangential to those produced by Patricia Hill Collins. In 1986, Collins identified the impact of the work that many African American women created to solidify their standpoint as a means of resistance through, music, essays, playwrights, and "…the blues roots of Black literature," (2009, p. 123) which were not classified as academic or intellectual scholarship; and so, Collins labeled it Black feminist thought.

Intersectionality

Intersectionality is a multifaceted, interdisciplinary concept that is used by practitioners, scholars, activists, teachers, parents, students, and a myriad of other categories of individuals and organizations seeking to understand the many axes of human experiences and the dynamics of the world we live in (Collins & Bilge, 2016). At its core, using intersectionality as an analytical tool provides the foundation to work at the junction of major social axes in society, such as race/ethnicity, gender, sexual orientation, dis/ability, and age to create a point that allows multiple components to be examined in conjunction with each other simultaneously to address various positions (Collins & Bilge, 2016). However, since intersectionality transcends across disciplines, epistemologies, and social constructs, there are countless ways in which it can be analyzed and applied. Ultimately, intersectionality was simultaneously included in this study as it is embedded in both CRT and BFT. Thus, the three theoretical frameworks complement each other to allow me to understand the academic career messages received by African American women in engineering.

Limitations

The primary limitation of this study is the number of African American women who meet the criteria for this study, and the inability to capture data on those who are no longer in the field for various reasons. As previously mentioned, another limitation to any study on African American women in STEM, precisely in engineering, is the amount of published empirical research. Ong et al. (2011) found that between 1970 and 2008, there were 116 empirical studies published on WoC in STEM. Therefore, for this study, I conducted an independent analysis of the empirical research published between 2009 and 2018 on graduate, postdoctoral, and career trajectories within STEM specifically for African American women and found somewhat similar results. Therefore, the reference to WoC, PoC, URM women, and STEM was utilized throughout the study in lieu of engineering and African American women specifically.

Positionality of the Author

As an African American woman continuing to matriculate through a doctoral program, my personal and professional experiences ignite my interest and propel me to continue to pursue my educational endeavors. My intention when I began my undergraduate degree was to pursue a Bachelor of Arts degree in Mathematics with a minor in Business Administration. However, during the first few weeks of my freshman classes in STEM, I immediately changed my major to business only. Not only did my professors encourage most of the women to drop the course, but they also insisted that we would be better suited for bookkeeping or other forms of clerical work. The overall climate within the STEM department was "chilly," and it was not a conducive environment for me to maintain my studies and achieve my goal of earning my degree at the university.

List of Abbreviations and Acronyms

- AAUP: American Association of University Professors
- AAUW: American Association of University Women
- BCE: Before Common Era
- BFT: Black Feminist Thought
- CBPR: Community-Based Participatory Research
- CLS: Critical Legal Studies
- CRF: Critical Race Feminism
- CRT: Critical Race Theory
- CRM: Critical Race Methodology
- EU: European Union
- HBCU: Historically Black Colleges and Universities
- I-O Psychology: Industrial and Organizational Psychology
- JBHE: The Journal of Blacks in Higher Education
- NCES: National Center for Education Statistics
- NSBE: National Society of Black Engineers
- NSF: National Science Foundation
- PoC: People of Color
- PWI: Predominantly White Institution
- STEM: Science, Technology, Engineering, and Mathematics
- TAPP: Tenure and Promotion Process
- TCUs: Tribal Colleges and Universities

- URM: Underrepresented Minority
- WoC: Women of Color

Chapter 2: Literature Review

Introduction

Illuminating the importance of access, equity, and inclusion for African American women in engineering is a multifaceted area of research that should be addressed through the lens of intersectionality while incorporating an interdisciplinary perspective to include multiple fields and discourses to provide a macro and micro view of the literature available. Through the lens of CRT, BFT, and intersectionality, I investigated the literature on African American women in engineering career trajectories and other pertinent empirical research applicable to this study. More specifically, this literature review explored six areas of research: U.S. history; the history of faculty in higher education in the US; the engineering community; academic career trajectories in engineering; critiques of gender inequalities; and the Triumvirate Woman. Then, I provided a summary of the literature covered in this chapter by honing in on the themes that emerged through this review of the literature to reinforce their connection to academic career messages for African American women in engineering. Lastly, this chapter covered the conceptual framework created to guide this study.

U.S. History

The Civil Rights Act of 1964, which prohibited discrimination and segregation against any person based on race, color, religion, sex, or national origin, was a historic landmark in the Civil Rights Movement and the U.S. labor laws. However, racism, sexism and discrimination continue to morph in American society through the perpetuation of systematic oppression in spite of this doctrine (Arrighi, 2007; Castenell & Pinar, 1993; Neisser, 1986; Putnam, 2015; Stephan & Banks, 1999; Sue et al., 2007; Yosso, 2005). Scholars have documented this history through empirical research that has attributed to the history of inequality and oppression in

America on the basis of race/ethnicity, gender, sexual orientation, religion, class, and dis/ability that influence the lives and culture of African Americans and other URM groups (Bartlett & Brayboy, 2005; Bonilla-Silva, 2003; Brayboy, 2005; Feagin, 2006; Jones, Lee, Gaskin, & Neblett, 2014; Kumasi, 2011; Loewen, 1995; Lynn & Adams, 2002; McCabe, 2009; McCoy & Rodricks, 2015; Solórzano & Yosso, 2001; Zinn, 2005).

Racial Dominance

On both mainstream and social media, overt acts of racism and discrimination are frequent in many ways and distinctively apparent in arenas across American society. Furthermore, most White men and women are unaware of the advantages they enjoy in society and how their attitudes and actions unintentionally discriminate against PoC, which is referred to as "White privilege" (President's Initiative on Race, 1998). In addition, Wilson (2009) argued that:

> At its core, racism is an ideology of racial domination with two key features: (1) beliefs that one race is either biologically or culturally inferior to another and (2) the use of such beliefs to rationalize or prescribe the way that the 'inferior' race should be treated in this society, as well as to explain its social position as a group and its collective accomplishments. (p. 15)

This deficit ideology is portrayed throughout academia by Delpit and Dowdy (2002) as:

> African [Americans] were said by some historians to have had no history, by linguistics to have had inferior language, by political scientists to have had poor self-government, by psychologists to have had low intelligence, by biologists to have had inferior genes, and by theologians to have had no soul –among other things. (p. 90)

Notwithstanding, the notion of White privilege is explored by the prominent philosopher, Peggy McIntosh, who recalls her own experiences, and how White privilege has played a role in her life. McIntosh (1988) states:

> I was taught to see racism only in individual acts of meanness, not in invisible systems conferring dominance on my group… As a white person, I realized I had been taught about racism as something which puts others at a disadvantage, but had been taught not to see one of its corollary aspects, white privilege, which puts me at an advantage. I think whites are carefully taught not to recognize white privilege, as males are taught not to recognize male privilege…I have come to see white privilege as an invisible package of unearned assets that I can count on cashing in each day, but about which I was "meant" to remain oblivious. White privilege is like an invisible weightless knapsack of special provisions, maps, passports, codebooks, visas, clothes, tools, and blank checks. Describing white privilege makes one newly accountable. (p. 239)

Those unfamiliar with this school of thought may be inclined to deny the idea of White privilege or the "invisible knapsack," although McIntosh (1988) argues the presence in American society.

The 1998 Advisory Board to the President's Initiative on Race observed the fact that the US still struggles with the impact of its past policies, practices, and attitudes based on racial difference. This report states that "…race and ethnicity still have profound implications on the extent to which a person is fully included in American society and provided the equal opportunity, and equal protection promised to all Americans" (President's Initiative on Race (US), 1998, p. 2). On the one hand, the history of inequities in America is seen as a controversial topic that elicits many to rebuff its existence in our past and present, by demanding that we "Make America Great Again." On the other hand, for the lives of those that acknowledge its

presence, there are underacknowledged roots that manifest in the form of racism, sexism, and discrimination, among a myriad of other things (Harper, 2012; Museus, Ledesma, & Parker, 2015). Museus et al. (2015) argued that there are numerous buildings, statues, and streets that honor this legacy by ensuring that the remnants of the past are preserved. This is validated by the substantial number of videos and photos on international media outlets and various forms of social media from the protests opposing the removal of such types of oppression.

History of Faculty in Higher Education

Faculty Racial Composition

According to both Schuster and Finkelstein (2011), the first institution for higher education in the US, Harvard College established in 1636, was staffed with young male tutors around twenty years of age to teach other males as they prepared for careers in ministry. Schuster and Finkelstein (2011) continued by arguing that Harvard set a precedent for a blueprint to use in establishing and maintaining an institution that was followed by the subsequent schools. Schuster and Finkelstein were attesting that institutions of higher education were designed to educate White men by White men and eventually, White women. This is validated by Karabel (2005) when he confirmed that in fact, higher education was designed for the White majority, as there were even policies and practices to keep the Jewish community from attending these Ivy League institutions.

Historically Black Colleges and Universities (HBCUs) and Tribal Colleges and Universities (TCUs) were established to create separate but equal institutions for higher education. Indeed, Museus et al. (2015) concurred by arguing that during this time, racism manifested in higher education, and during the 19th century, "…racism informed seemingly objective and progressive higher education policy… and the establishment of these campuses

reflects White's historical unwillingness to accommodate students of color within their own higher education…" (p. 50).

The historical context of racial inequalities in higher education is comprised of literature with common themes that illuminate the challenges for PoC such as microaggressions, bicultural stressors, invisibility, marginalization, tokenism, stereotype threat, and racial battle fatigue (Arrighi, 2007; Bartlett & Brayboy, 2005; Sue, 2003, 2010; Sue, Capodilupo, Nadal, & Torino, 2008; Wilson, 2009). Many perceive these interactions as forms of unconscious biases from people that are generally well-meaning and not racist individuals. According to Grant, Brown, and Brown (2016), CRT takes these lived experiences and counter-stories into account by asserting that the concept of "race" has been under-theorized in education, thus silencing the implicit and explicit patterns of racism that many PoC experience on a daily basis (p. 19).

Washington and Harvey (1989) stated that "the statistics on the presence of African-American and Hispanic faculty illustrate the important role that colleges and universities have played in maintaining racial segregation in the United States" (p. 4). This statement was made about the culture of higher education before the integration of Affirmative Action; however, institutional barriers still exist in higher education for both students, faculty, and administrators. More specifically, this is evident in the data from Table 1, with the percentage of women faculty in engineering from 2001 to 2017.

Table 1

Percentage of Women Faculty in Engineering Across the US, 2001-2017

Year	Race			
	Asian	**White**	**Hispanic**	**African American**
2001	17.0%	8.9%	3.0%	2.1%
2002	17.8%	9.2%	3.0%	2.0%
2003	19.2%	9.9%	3.1%	2.2%
2004	20.2%	10.4%	3.2%	2.3%
2005	20.9%	10.6%	3.2%	2.4%
2006	22.0%	11.3%	3.3%	2.4%
2007	22.6%	11.8%	3.4%	2.5%
2008	22.7%	12.3%	3.5%	2.5%
2008	22.7%	12.3%	3.5%	2.5%
2009	23.3%	12.7%	3.5%	2.5%
2010	23.9%	13.2%	3.6%	2.5%
2011	24.1%	13.8%	3.7%	2.5%
2012	24.6%	14.0%	3.9%	2.7%
2013	25.2%	14.5%	3.6%	2.6%
2014	25.6%	15.2%	3.9%	2.5%
2015	26.9%	15.7%	3.9%	2.5%
2016	27.6%	16.3%	3.7%	2.3%
2017	26.0%	17.0%	5.1%	3.1%

Note. 2008-2017: Includes faculty data from schools in Puerto Rico; 2001-2008: Includes faculty data from University of Puerto Rico, Mayaguez, and Polytechnic Univ. of Puerto Rico. Source of data collected by ASEE (2018).

Gender Inequalities

Collins (2000, 2009) argued that from the beginning, African American women were excluded from P-20 education, therefore denying them the credentials needed to become literate, which subsequently excluded them from positions held by academia. Collins (2000, 2009) continued by acknowledging that although there is a long history of African American women historians and scholars, they were not appointed to positions of power and leadership within

publishing affiliations, professional associations, or institutions of higher education. Collins' theory that African American women have been intentionally oppressed is shared by other scholars such as Higginbotham (1989) and Morton (1991) when they argued that "Black women's exclusion from positions of power within mainstream institutions has led to the elevation of elite White male ideas and interest and the corresponding suppression of Black women's ideas and interest in traditional scholarship" (p. 7). More specifically, according to Carrell (1968), evidence shows that during the second half of the eighteenth century, there were nineteen U.S. degree-granting institutions with around 210 White men professors. However, as of fall 2017 in engineering alone, there are 27,178 tenured and tenure-track faculty and only 142 African American women. This means that African American women in engineering have not surpassed the initial count of White male faculty since the inception of U.S. higher education almost 400 years ago.

There is an extensive history of discrimination against African American women in higher education that illuminates the oppression based on race and gender. One article, in particular, was published under *News and Views* (1995), which is a division of *The Journal of Blacks in Higher Education* (JBHE), without providing specific information on the contributing members. This article sheds light on the disproportionate rate at which African American women are not achieving high-level appointed academic appointments as opposed to African American men. The report illustrates this disparity by highlighting Harvard and how the institution repudiated African American women into tenure appointments for practically two-and-a-half centuries. The research department within JBHE sought to unveil the specific appointments by analyzing The Harvard University Affirmative Action Plan of 1995, where the university lists the number of tenured faculty appointments by race and gender.

The research department within JBHE concluded that Harvard misrepresented their figures by listing Professor Evelyn Brooks Higginbotham twice, as she held "…appointments at both Harvard Divinity School and the Harvard College's department of Afro-American studies" (News and Views, 1995, p. 1). Moreover, the article sheds light on the quantitative data for the number of African American women who earned graduate degrees and how they are represented across America's institutions of higher education.

Another article highlights the protest of the trailblazer, Derrick Bell, who was the first African American professor at Harvard Law School, who took a stand against racial injustice and overt discrimination against African American women at Harvard. The article sheds light on the fact that Bell took unpaid leave and a six-figure salary cut to protest Harvard, and he refused to return to work until an African American woman at the law school was appointed to a tenured position. Butterfield (1990) further explained the dilemma where Bell implores to the Harvard community that change is imperative in what is perceived as an egalitarian environment that supports diversity. Bell states that "…I cannot continue to urge students to take risks for what they believe if I do not practice my own precepts" (Butterfield, 1990, p. 1).

Furthermore, Butterfield (1990) provided supportive quotes from other professors and students at Harvard. Prior to this protest, a large amount of the students staged a sit-in that lasted two nights in the office of the dean at the time, Robert C. Clark, to bring to the forefront their condemnation of the small number of women and minorities on the faculty of the law department (Butterfield, 1990). The article concludes by providing quotes and explanations of the policies for hiring tenured faculty that were supplied by the associate dean of the law school. In addition, the associate dean stated that Bell's protest was "counterproductive," as they would not be changing the way they select or appoint tenured faculty.

Engineering Community

The US is now facing a "quiet crisis," a phrase coined by Shirley Ann Jackson in the 1990's where she described it as a gradual crippling of the US's, and potentially global communities, ability to promote the development of a talent pool of engineers qualified to sustain the global demand for human and economic needs (Slaughter, Tao, & Pearson, Jr., 2015, p. xii). In *Changing the Face of Engineering: The African American Experience*, Jackson argued that the US must double down on initiative for historically URM groups and ensure that within these groups, there is specific focus on meeting the needs of those who have been "…overlooked, specifically discouraged or simply not encourage to peruse STEM fields, and who remain underrepresented" (Slaughter et al., 2015, p. xiii). Another prominent scholar, John Brooks Slaughter, further expands upon this situation by referring to it as the "new" American dilemma, whereas the US should respond swiftly and forcefully to migrate the potential deficit in the talent pool (Slaughter et al., 2015). According to both Jackson and Slaughter, the "quiet crisis" is the "new" American dilemma that could paralyze the US and the global economy if we do not utilize our untapped human capital.

Over the past four decades, several scholars such as Malcom, Ong, Brown, Hall, Hill, Gregory, Wright, Espinosa, Orfield, Jackson, Slaughter, Yi, and Gault have worked to provide empirical research to ignite change for minority women in STEM. As previously mentioned, the monumental 1975 seminal report *The Double Bind: The Price of Being a Minority Woman in Science* documents the first conference in American history specifically for minority women to address biases, oppression, and social injustices related to race/ethnicity and gender—the double bind (Malcom et al., 1976). This is crucial because since then, this report has contributed to the production of countless studies, new empirical research, policies, practices, and laws in America.

Initiatives

The National Science Foundation (NSF) has a long history of funding programs and initiatives to meet the needs of minorities in STEM, which is why they have a fund of over $925 million dedicated to diversity programs that span across K-20, postdoctoral and into faculty initiatives (Mervis, 2018). This means that it is vital that we examine the breadth and depth of access, equity, inclusion, and diversity to ensure that African American women are not excluded from programs intended to serve URM women. The concept of being overlooked within initiatives designed for URM women in engineering must be examined to ensure the effectiveness and efficiency of the resources allocated. Moreover, after completing a forty-year empirical analysis of all the literature available on URM women in STEM, Ong et al. (2011) argued that many of the existing initiatives created to serve URM women were not adequately serving URM women, but they did benefit White women. The initiatives were designed to aid URM women in advancements in STEM fields; however, they have not effectively served all URM women. The data provided on the percentage of URM women and White women who are faculty in engineering from 2001-2017 in Table 1, shows the impact of initiatives over a 16-year period. The growth rate for Asian women increased by 9%, White women increased by 8.1%, Hispanic women increased by 2%, and African American women increased by 1%.

Diversity

Fostering diverse environments within institutions and fields such as engineering is essential; therefore, efforts have been made to ensure that the needs of all those involved are met. However, Puritty et al. (2017) argued that diversity alone is no longer enough and is not acceptable solely for addressing the discrimination, microaggressions, and structural and systemic bias that URM groups experience within higher education. In particular, STEM

communities can attribute to URMs' feeling of being unwelcome, unheard, and unvalued (Puritty et al., 2017). Despite these arguments, Puritty et al. (2017) asserted that there is hope and room for growth as a society, academic community, and individuals by incorporating the concept of "inclusion" as a dichotomy where one should not be considered without the other. Puritty et al. (2017) urged institutions to understand that in order to be diverse and inclusive to meet the needs of URMs, it is imperative that they welcome differences in cultures, instill utility in individual identity, embolden the correlation of work and cultural identity, and foster communities within the institution that embody equitable access for all to feel welcomed and valued (Puritty et al., 2017).

Access, Equity, Diversity, and Inclusion

The demand for institutions to focus on access, equity, inclusion, and diversity is vital to the overall success of students, faculty, and the institution. Fostering environments that have a diverse population and inclusiveness could generate a variety of different outcomes. For instance, Ross and Godwin (2015) sought to unveil the breadth and depth of the stories of African American women in engineering through the theoretical framework of social identity and intersectionality theory. Moreover, this research used phenomenology to provide a deep understanding of the multiple identities and forms of oppression that African American women experience simultaneously while extending beyond the method and coupling hermeneutics to give meaning to the everyday life practices that would emerge from the qualitative analysis. The preliminary results were obtained from a snowball sample of two women who work as government contractors in engineering.

Ross and Godwin (2015) unveiled emergent themes from the data that were very similar and then conflicting from the two women interviewed. Some of the themes covered areas such as

experiences related to microaggressions, different ends of power dynamics, gender stereotypes related to cultural identities within engineering, and undergoing the decision to take an active role in the historical view of women as it relates to familial responsibility. Ross and Godwin (2015) concluded that although there is still much to learn from more qualitative data participants, by intentionally honing in on the importance of intersectionality as it relates to Black women through a phenomenological lens, they will be able to provide "…more insight into solutions for solving the diversity problem in engineering" (Ross & Godwin, 2015, p. 1).

On the one hand, the article was designed to share "Stories of Black Women in Engineering Industry—Why They Leave," whereby virtue it is implied that engineering is "diverse" because we are hearing the stories of two women who are engineers, working in the field of engineering. This means that diversity alone is not the solution. On the other hand, one woman was quoted saying the following:

> If I had more of a supportive leadership team. If I felt as if people were actually rooting for my success, then yes, I think I would feel more comfortable [staying in the workforce] and the pull [to leave work and be a stay-at-home-mom] would not be so strong." (Ross & Godwin, 2015, p. 4)

In other words, the participant in this study said (a) if I had more of a supportive leadership team—access to better leadership; (b) if I felt as if people were actually rooting for my success—equity in wanting her to be as successful as others within the organization, and not being the only African American woman; and (c) I would feel more comfortable—inclusion in the organization. Thereby, fostering engineering communities that have access, equity, inclusion, and diversity are critical to a flourishing academic community.

Academic Career Trajectories in Engineering

Creating an environment for academic career trajectories for African American women in engineering with access, equity, inclusion, and diversity is vital for the recruitment and retention of those within the field or interested in this career path. Meyers and Ríos (2012) argued that there are numerous scholars who have worked towards eliminating the plethora of inequalities that African American women and other URMs face in getting their work published, receiving recognition for their contributions, earning tenure-track appointments, being tenured and promoted, earning the same salaries, and receiving research leaves and other resources as their male colleagues, on a relatively level playing field (p. 3). Moreover, African American women in engineering are unequivocally faced with multiple forms of oppression on the grounds of race, gender, and engineering in academic career fields (Malcom et al., 1976). Fostering an environment within engineering that provides access, equity, inclusion, and diversity will allow for more recognition, innovation, and collaboration for African American women and academia overall. Now more than ever, it is crucial to illuminate the importance of African American women in engineering to ensure that they can teach, guide, and mentor the next generation.

Tenured and Tenure-Track Appointments

Faculty members are the gatekeepers to advancement in higher education; therefore, increasing the number of African American women in faculty positions begins by appointments in tenure-track positions within engineering. Since the 1900s, tenure-track positions have existed in the US, and "it has evolved into a system of policies designed to provide academic freedom, provide faculty job security, and create an elite cadre of professionals in the academy" (Cooper, 2016, p. 7). Moreover, the American Association of University Professors (AAUP) implemented the *1940 Statement of Principles on Academic Freedom and Tenure* to regularize tenure decision

making and ensure guidelines are in place for the decision-making process (Schuster & Finkelstein, 2011).

This study examined tenured and tenure-track within the following three categories: (a) tenure-track assistant professor; (b) tenured associate professor; and (c) tenured full professor. Achieving the academic status of a tenured professor in any field of higher education is considered a prestigious position and is associated with a level of achievement, recognition, and freedom for those who hold the position. Cahn (2011) argued that a "…tenured professor is one that holds a lifetime appointment that guarantees the right of professionally qualified people to discover, teach, and publish the truth as they see it within their fields of competence" (p. 1). Moreover, Cahn (2011) continued by stating that "…tenure provides a level of freedom for the appointee to embark on research without anyone dictating if the subject is controversial or taboo; it also provides a level of power and authority within the institution" (p. 1).

Tenure and Promotion Process

The tenure and promotion process (TAPP) is typically conceptualized in a linear series of orderly steps, but it will vary by institution. Cooper (2006) described the process in five main stages: (a) you receive the guidelines for tenure and promotion during a new faculty orientation where new faculty are asked to create a plan for research, teaching, and service agendas; (b) a department-level annual review to evaluate the success and achievement of the goals made; (c) mini-tenure or third-year review where the school or college dean may become involved to review and make comments on areas for improvement; (d) fourth-fifth year dedicated to research, teaching, and service, while adding to the literature base; and (e) fifth-sixth-year review where a tenure dossier must be prepared and submitted to the department, institution (advisory board or committee for faculty), and the upper administration level (provost, president, or both).

It is during this time the institution decides if the faculty member will receive tenure or tenure and promotion.

However, Cooper (2006) suggested that the TAPP is not the same for all faculty members; there are unwritten rules that many do not know exist and that they are playing a game where they do not recognize the formal and informal rules. Indeed, although there are only three sections required for promotion and tenure—research, teaching, and service—Cooper (2006) argued that there is a fourth component to TAPP, which is collegiality. This fourth component offers insight into the unwritten rules of TAPP, as well as access to individuals you need to know. In spite of all the knowledge that you may acquire, it is not always about "what" you know, but "who" you know. Baker (2010) argued that the social component of collegiality illuminates the size, quality, and diversity of your personal and business networks; therefore, extending the network of people who you *don't* know and creating indirect relationships with the people you *should* know.

F. Bonner (2004) referred to these unwritten rules and networks as being "On the Track but Out of the Loop." Furthermore, F. Bonner (2004) argued that:

> No faculty member can be successful without establishing professional networks—that is, being included in the higher-education loop. Unfortunately for many African-American faculty members, gaining access to the loop is difficult, if not impossible. New professors typically get into the loop through their advisors, mentors and more-established colleagues. But many African American faculty members have no one to help them make connections. Many of us have felt excluded from networks since graduate school, when professors chose nonminority students to write papers or make presentations with them, ignoring minority students with equally high grades. (p. 1-2)

Indeed, for African American women in engineering, this means that they must be selected for inclusion by one or more of the faculty members in the department to learn the ways of the institution so that they can gain access to the fourth component of the TAPP.

Mentoring

Understanding the benefits of effective mentoring for African American women in tenure-track positions in engineering is essential to their retention and a successful TAPP. In a recent study, Crawford (2014, 2015) conducted a qualitative analysis to examine the unique needs of WoC and the benefits they receive from effective mentoring. Crawford (2014, 2015) collected qualitative data from two focus groups using the constant-comparative method, in which several themes emerged from the ethnographer's field notes, journals, and group transcripts. Crawford (2014, 2015) reported multiple barriers based on race/ethnicity and gender, such as isolation within the university, tokenism, stereotyping, the centrality of power by the dominant culture, lack of entry into formal and informal networks, racism, and sexism. Crawford (2014, 2015) suggested that these barriers can be mitigated through effective mentoring because oftentimes, WoC are silenced, while their voices and experiences as female faculty members go unseen or unheard by the institution. When African American women in engineering have access to effective mentoring like their colleagues, they too will have the ability to advance in the TAPP. Indeed, Cooper (2006) reported that for African American women to break these barriers, they must have an effective mentor to guide their career development to ensure they meet the goals set for service, teaching, and research.

Publishing

Institutions each weigh service, teaching, and research differently; however, in engineering, conducting studies and publishing research is an essential element required as a faculty member. This means that faculty members have an obligation to contribute significant work in their field by contributing to the advancement of scholarship through publishing their research and findings. A number of scholars have reported findings from multiple studies that African American faculty are not supported or not invited to work with most of their colleagues, because they view the research of African American faculty as race-based minority concerns that are not pertinent to the general population, not specific to the field, or their episiotomy is unscholarly (Cooper, 2006; Fields, 1996; Johnsrud & Des Jarlais, 1994; Locke, 1997; Moses, 1997). In other words, with so little literature available to establish a foundation for "acceptable" scholarly research, African American women in engineering are faced with the challenge of choosing to either write about gender and race issues that may not advance their career in isolation, or research areas of study that are deemed acceptable for publication by their field that may not address their specific research interest.

The hierarchical structure for tiers of acceptable journals that are recognized as significant contributions to the field is also limited. It is rare that these top-tier journals consistently publish work associated with themes such as structural-related gender biases or literature centered on race-based epistemologies, especially in engineering. Indeed, this is further validated by the words of Moses (1997), where she argued, "I have survived because I do two sets of research: one on Black women's issues and one that is mainstreamed within my profession. It is the only way I will have legitimacy when tenure comes" (p. 32). Although this

may seem trivial to some, it is crucial in terms of the academic career advancement for African American women in engineering.

Critiques of Gender Inequality in STEM

Several psychologists in industrial and organizational (I-O) psychology have created a series of publications researching gender inequalities in STEM and why they persist. The focal article "From 'Her' Problem to 'Our' Problem" was published in the *Journal of Industrial and Organizational Psychology,* and other I-O psychologists provided four commentaries. This section will provide critiques to the focal article and three of the commentaries. The focal article was authored by Miner et al. (2018), where they argued that using a social-structural lens to explain gender inequalities in STEM is more advantageous and provides a clearer picture of the causes and solutions to best achieve equality, as opposed to an individual lens because it shifts the problem from "her" problem as an individual, to "our" problem as a society.

"From 'Her' Problem to 'Our' Problem"

Miner et al. (2018) argued that the shift from "her" problem to "our" problem as a society can be achieved by comparing the difference between outcomes from a social-structural lens to an individual-level lens, which the authors believe will ultimately account for variations in the gender inequalities in STEM. Moreover, Miner et al. (2018) provided context throughout the argument to better understand both ends of the spectrum and explain why I-O psychologists have a responsibility to provide a complete picture from a social-structural lens. Thereby, Miner et al. (2018) suggested that if an analysis of gender inequalities in STEM were examined from an individual lens, it would not be an erroneous conclusion, but comparatively fragmental and equivocal to the basal origins of the matter or phenomenon within the organization.

To substantiate this theory, Miner et al. (2018) created three individual-level myths analogous to gender inequalities in STEM that were presented and supplemented with supporting statement(s) that either (a) stereotyped women, or (b) provided explanations of the arguments. Miner et al. (2018) then offered an analysis from both a social-structural and an individual lens, that followed with an I-O psychologist's implication to explain the cause and a social-structural solution. Miner et al. (2018) concluded that, instead of looking at the problems of the individual women, we should examine the social-structural problems, which will require the work of all members of society. This means that the correlation between the three myths, arguments, and I-O psychologist's implications indicate that Miner et al. (2018) believe a social-structural lens is a foremost explanation for gender inequalities in STEM.

"Intersectionality Insufficient"

Brown and Liu (2018) provided commentary on the focal article and argue that there is an insufficient amount of research devoted to exploring intersectionality as it relates to WoC in STEM by failing to identify within gender inequalities. In an attempt to rectify the missing piece in the focal article, Brown and Liu (2018) emphasized the importance of intersectionality within STEM and provided practical implications and interventions for WoC. By coupling social constructionism and intersectional identities, Brown and Liu (2018) were able to set the foundation for the stereotypes that were researched and identified within STEM. Moreover, Brown and Liu (2018) reported the interplay between the social exchange, social dominance, and intersectionality was utilized to determine emerging themes that continue to keep WoC in isolated spaces. Furthermore, Brown and Liu (2018) confirmed that positive social value and in-group advantages were also salient themes that created barriers to entry and advancement, in addition to increasing racial inequalities within STEM. Brown and Liu (2018) illuminated the

importance of intersectionality and provided different methods for I-O psychologists to offer their knowledge and expertise for more in-depth conversations in regards to WoC in STEM.

"Spotlight on WoC in STEM"

Flores (2018) provided commentaries on the focal article and argued that it is of the essence to expand the research in the focal article by intentionally focusing on WoC in STEM. In addition, Flores (2018) implored to disaggregate the data created in the focal article and include race into the conversation from a social-structural and intersectional perspective. Flores (2018) used the following themes to disaggregate the data and address the intersectional aspect of race and gender in STEM—recognizing the difference: the numbers; transforming silence into language: an intersectional perspective; the house of differences: social-structural issues for WoC in STEM; the tightrope: monitoring behavior to avoid prescribed stereotypes; double consciousness: W.E.B. DuBois's (1961) concept; microaggressions: communication of hostile or derogatory slights or insults; diversity climate: perceptions of prejudiced individuals and bias in organizational policies; and facing anger constructively: future recommendations.

Flores (2018) used these eight themes to synthesize future recommendations which indicate the vital necessity to take an interdisciplinary approach by seeking references in other disciplines such as womanism, African American studies, anthropology, etc., to collaborate with the intersectional perspective; acknowledge other aspects of identity by continuing to disaggregate the data to class, dis/ability, sexual orientation etc.; and to include WoC in the research and theory building through community-based participatory research (CBPR) (Flores, 2018).

Gender Disparity and a New Theoretical Framework

Sachdev (2018) provided commentary on the larger focal article by arguing that gender disparities in STEM should not be viewed from an individual-level lens, but from a societal-structural lens to provide a thorough examination of the phenomenon, challenges, and explanations for experiences. Sachdev's (2018) commentary seeks to provide a better understanding of gender disparity across cultures, countries, and industries in STEM by integrating concepts through a cross-cultural examination of global social-contextual factors. Furthermore, Sachdev (2018) concurred with the findings in the focal article and expanded upon the claims by outlining a program of research to develop a theoretical framework that would account for cross-cultural perspectives to explain gender inequality in STEM. In addition, Sachdev (2018) then examined the influence and beliefs of cultures and how they view STEM. Sachdev (2018) concluded by providing practical implications from an I-O psychologist's perspective, by recommending that the conversation must start with understanding the cultural norms of different societies to offer culturally relevant initiatives.

The Triumvirate Woman

The concept of the Triumvirate Woman reconceptualizes what the stereotype of an engineer should look like and accepts images of African American women as engineers, which they have earned through their prowess as academic professionals. Malcom et al. (1976) have argued that African American women and other URM women, in what is now known as STEM, are faced with three forms of oppression that they endure simultaneously. They deserve to have a name that empowers and celebrates their ability to traverse through the TAPP. Solórzano and Yosso (2002) argued that "…when the ideology of racism is examined and racist injuries are named, victims of racism can find their voice. Furthermore, those injured by racism and other

forms of oppression discover they are not alone in their marginality" (p. 27). Thus, for this study, I sought to capture the three forms of oppression—race, gender, and engineering—and use them as a source of power to celebrate the work of the African American women who have matriculated through higher education and embarked on academic careers in engineering. The concept of the Triumvirate Woman can transcend across generations, epistemologies, and it is by definition transdisciplinary as it relates to both race, gender, engineering, and forms of oppression.

Outsider Within Engineering

This study drew upon the work of Collins' (1986) BFT as she argued that "Black women have long occupied marginal positions in academic settings…This 'outsider within' status has provided a special standpoint on self, family, and society for Afro-American women" (p. S14). This means that African American women in engineering academic career fields are positioned within the margins of multiple intersections, which can create a standpoint with endless possibilities. Therefore, the concept of the Triumvirate Woman acknowledges this standpoint by empowering those currently in the field, and others who may be seeking an academic career in engineering, to know that they are not alone in their marginality. Moreover, Collins (1986) argued, "… for many Afro-American female intellectuals 'marginality' has been an excitement to creativity" (p. S15).

History of Triumvirate

The word triumvirate is defined as "a group of three men holding power…[or] a group of three powerful or notable people or things" (Oxford Dictionaries, 2019). There are two significant alliances identified as triumvirates: (a) The First Triumvirate: Gnaeus Pompeius Magnus (Pompey), Marcus Lucinius Crassus, and Gaius Julius Caesar; and (b) The Second

Triumvirate: Octavian, Lepidus, and Mark Antony (Wasson, 2016 a,b). Wasson (2016a) argued that the First Triumvirate was created in 60 BCE and changed the entire political regime in ancient Rome, as they were the most powerful force in the Roman Republic. Indeed, Wasson (2016a) reported that the men were powerful and wealthy individuals; but together, Pompeius, Caesar, and Crassus realized that their mutual alliance was essential to achieve lofty political goals and personal agendas. This alliance remained intact until the death of Caesar in 53 BCE at the Battle of Carrhae (Wasson, 2016a).

As a result, Wasson (2016b) argued that The Second Triumvirate was then formed out of an association of convenience first to rectify the assassination of Caesar and then stabilize the Roman Republic. In other words, a Triumvirate was associated with three forms of power that came together to create an alliance to achieve goals. Hence, the association with utilizing the word triumvirate to empower African American women in engineering to use the three forms of oppression as a source of power. In addition, this should also motivate academia and other agencies to foster a community that allows access, equity, inclusion, and diversity to encourage African American women to pursue career fields in engineering.

Top-Down Approach

Providing women in STEM with equal representation on all levels of academia, public private, and government agencies should be a collective effort as a global community to enrich the research and repertoire of STEM. An example of this process is illuminated by Nelson and Brammer (2008), where they argued that the European Union (EU) has fostered a system to implement initiatives, programs, and laws into legislation to ensure that gender inequalities are addressed from the top down. Nelson and Brammer (2008) reported that almost 20 years ago, the E.U. Parliament passed “Women and science: Mobilizing women to enrich European research”

into legislation to initiate a concatenation of initiatives and programs that specifically focused on increasing the representation for women in STEM. Nelson and Brammer (2008) continued by emphasizing that while the EU reports that women's representation has increased across various sectors and initiatives, E.U.'s Fifth Framework Programme set a goal to ensure women represent an average of at least 40 percent of their participation in advisory groups, the Marie Curie scholarship committee, and assessment/monitoring panels throughout the organization (p. 1159).

This top-down approach for implementing changes from the highest level of government sets the tone for all subsequent public and private organizations or institutions to increase access, equity, inclusion, and diversity for women in STEM. Nelson and Brammer (2008) insisted that this exhibits a framework that could be modified and replicated in the US to broaden the career and academic trajectories for women in STEM from the top government and political officials, to the provost and department deans. Furthermore, Nelson and Brammer (2008) observed a level of transparency displayed in the E.U. reports on their demographics, which is provided with a level of cogency that should ignite change in U.S. reporting standards, thereby increasing the amount of comparable data to research and use to produce new policies and practices.

Discussion

This literature review provided information on several areas that influence academic career messages for African American women in engineering. More specifically, 16 themes that emerged from the literature were identified, which were: (a) legal landscape for PoC, (b) history of exclusion, (c) hiring practices, (d) diversity, (e) recruitment and retention, (f) isms—racism, sexism, etc., (g) isolation and marginalization, (h) tokenism, (i) pipeline issues, (j) TAPP, (k) faculty research, (l) faculty teaching, (m) faculty service, (n) standards for yearly faculty evaluations, (o) work expectations, and (p) mentorship. Through the lens of CRT, BFT, and

intersectionality, I was able to hone in on each of the themes as several of them resurfaced multiple times throughout the literature. These themes were utilized to understand how African American women experience academic career trajectories and to guide the research for this study.

Furthermore, this literature review has covered six areas of research: U.S. history, the history of faculty in higher education in the US, the engineering community, academic career trajectories in engineering, critiques of gender inequalities, and the Triumvirate Woman. Then, I provided a summary of the literature covered in this chapter by honing in on the themes that emerged through this review of the literature. Each section provided insights into the literature that pertains to African American women in academic careers in engineering. As a result of this study, a new construct was introduced by myself, the Triumvirate Woman, which provides African American women with a term that empowers and celebrates their position in engineering environments as a form of reinforcement for their poise, tenacity, and resiliency.

Theoretical Framework

Critical Race Theory

Taylor (2009) cited multiple scholars, Matsuda, Lawrence III, Delgado, and Crenshaw (1993), by arguing that "CRT cannot be understood as an abstract set of ideas or doctrines" (p. 4). In fact, one of the essential components utilized by critical race theorists is the understanding that racism is not a random, isolated act in education. When examining theory and practice within the field, critical race theorists unveil that racism within education seems natural, that it is often unrecognizable or invisible to most individuals due to the severity in which it is engrained in American society (McCoy & Rodricks, 2015; Taylor, 1998, 2009). Furthermore, CRT assimilates scholar-activist traditions found in ethnic and women's studies by pulling from the

basis of multiple critical theories, including Marxist and feminist theories, which allows CRT to transcend through epistemological and disciplinary boundaries, cementing itself as an interdisciplinary theory (Lynn & Adams, 2002; McCoy & Rodricks, 2015; Yosso, Parker, Solórzano, & Lynn, 2004).

There are five central elements to CRT, and each part provides insight for critical race theorist to understand the dynamics of race and racism in education. This provides strategies towards dismantling racism and other forms of subordination based on class, gender, and sexual orientation (Solórzano & Yosso, 2002). The five central elements to CRT include: (a) counter-storytelling as a use of experiential knowledge; (b) interest convergence; (c) permanence of racism; (d) critique of liberalism as dominant ideology; and (e) Whiteness as property (Bell, 2009; Taylor, 2009; Solórzano & Yosso, 2002). Many of the central themes in CRT are mirrored in CRM; therefore, this portion of the study will briefly mention three of the elements of CRT: counter-storytelling, interest convergence and permanence of racism.

Counter-storytelling

CRT is by definition a multifaceted theoretical framework because of its historical foundation; it also encompasses an additional element, which is the ability to emphasize the importance of illuminating the lived experiences and counter-stories of PoC. Counter-storytelling and narratives are essential to the breadth and depth of CRT. This is because they serve as pedagogical tools that can be used to guide and inform researchers to gain a deeper understanding of the lived experiences of PoC through deliberate and mindful listening techniques (Gillborn, Ladson-Billings, & Taylor, 2016, p. 8). This creates counter-stories that can be used to accurately portray the lived experiences of African American women in

engineering, which can impact change and inform further research in the field for Triumvirate Women.

Interest Convergence

Taylor (2009) cited the theory of interest convergence by Bell (1980) which asserts, "…the interest of Blacks in gaining racial equality have been accommodated only when they have converged with the interest of powerful Whites" (p. 5).

Permanence of Racism

Mills (1997) argued that "racism is a global White supremacy and is itself a political system, a particular power structure of formal and informal rule, privilege, socioeconomic advantages, and wealth and power opportunities" (as cited in Taylor, 2009, p. 4). Toni Morrison (1992) emphasized this by utilizing the following argument "…the difference between looking at the fish and castles and bubbles in a fishbowl versus seeing the bowl itself, the structure that transparently (and invisibly) permits the ordered life it contains to exist in the larger world" (as cited in Taylor, 2009, p. 4).

Black Feminist Thought

Collins (1986) informed sociologists of the substance within transdisciplinary African American female intellectuals, by honing in on the emerging research, creativity, and "…sociological significance of the Black feminist thought stimulated by Black women's outsider within status" (p. S15). This revelation was also instrumental because Collins (1986) argued that it is important for Black women to be the authors of their own story by insisting that within BFT, a primary "role for Black female intellectuals is to produce facts and theories about the Black female experience that will clarify a Black woman's standpoint for Black women" (p. S16). Moreover, Collins (1986) outlined three key elements that characterized BFT: (a) the meaning of

self-definition and self-valuation; (b) the interlocking nature of oppression; and (c) the importance of Black women's culture.

Since then, BFT has evolved into a multifaceted, transdisciplinary, educational epistemology, and Collins (2000, 2009) has expanded to include the seven core themes: (a) work, family, and Black women's oppression; (b) mammies, matriarchs, and other controlling images; (c) the power of self-definition; (d) the sexual politics of Black womanhood; (e) Black women's love relationships; (f) Black women and motherhood; and (g) rethinking Black women's activism.

The body of work shared by Collins guides this study by allowing the experiences of African American women to be centered at all times and stresses the importance of Black women having control of their narratives. Therefore, since a Black woman is conducting this research, for Black women, a unique lens is created to allow critical insights on the experiences of other Black women. This unique position is also expressed by Collins (2000, 2009), where she quotes Frances Ellen Watkins Harper's 1892 novel, *Iola Leroy*, and then references this to African American women:

> Miss Leroy, out of the race must come its own thinkers and writer. Authors belonging to the white race have written good books, for which I am deeply grateful, but it seems to be almost impossible for a white man to put himself completely in our place. No man can feel the iron which enters another man's soul (Carby 1987, 62). Only African-American women occupy this center and can "feel the iron" that enters Black women's souls, because while U.S. Black women's experiences resembles others, such experiences remain unique… It does mean that the primary responsibility for defining one's own

> reality lies with the people who live that reality, who actually have those experiences. (p. 39)

Therefore, BFT allows me to "feel the iron" and understand the breadth and depth of other African American women. In addition, BFT understands that Black women are not the only people able to participate in producing this work. Still, Black women are the ones able to define the reality and authentic experiences of Black women.

Intersectionality

Although undefined at the time, Collins and Bilge (2016) traced the work of intersectionality back to the early nineteenth century, where scholars such as Savitribai Phule (1831-1897) advocated for social equality at the margin of major axes for URM groups and religions. Since then, several entities, human rights activists, social justice movements, and grassroots organizations have utilized intersectionality as a multifarious heuristic device to cultivate change. In particular, African American women began to incorporate intersectionality in the 1960s to combat oppression as "…their needs simply fell through the cracks of anti-racist social movements, feminism. And unions organizing for workers' rights…[and] African-American women were simultaneously black *and* female *and* workers…" (Collins & Bilge, 2016, p. 3). Thus, intersectionality became pivotal for African American women as "her political activism encompassed intersecting categories of social division—she didn't just pick one" (Collins & Bilge, 2016, p.4).

There are six core ideas embedded in the framework of intersectionality: (a) social inequality; (b) domains of power; (c) relationality; (d) social context; (e) complexity; and (f) social justice. Since there are several themes that emerge within intersectionality and the context of this study, I utilized intersectionality as a heuristic device to better understand how African

American women in engineering traverse through these multiple intersections simultaneously, while being the only one or one of few compared to tens or dozens of individuals from a dominant group. Notwithstanding, intersectionality is also entwined in both CRT and BFT, which creates a natural transition between applying the concepts cogently. There are four distinguishing yet intertwined domains of power: (a) interpersonal, (b) disciplinary, (c) cultural, and (d) structural (Collins & Bilge, 2016). Racial dominance signifies advantages in quantity, thereby shaping everyday ordinary social interactions as the "other(s)," which is the interpersonal domain of power.

Conceptual Framework

Understanding the academic career messages for African American women in engineering is a multifaceted study; however, it is also a subset of an immense structural system within higher education. Thus, a conceptual framework was created to guide this study that examines both the macro- and micro-perception of higher education to create a full view of the system and the position of African American women in engineering. The conceptual framework drew from CRT, BFT, and intersectionality as a guide to better understand the structure and design of Figure 1.

Life Cycle of Academia

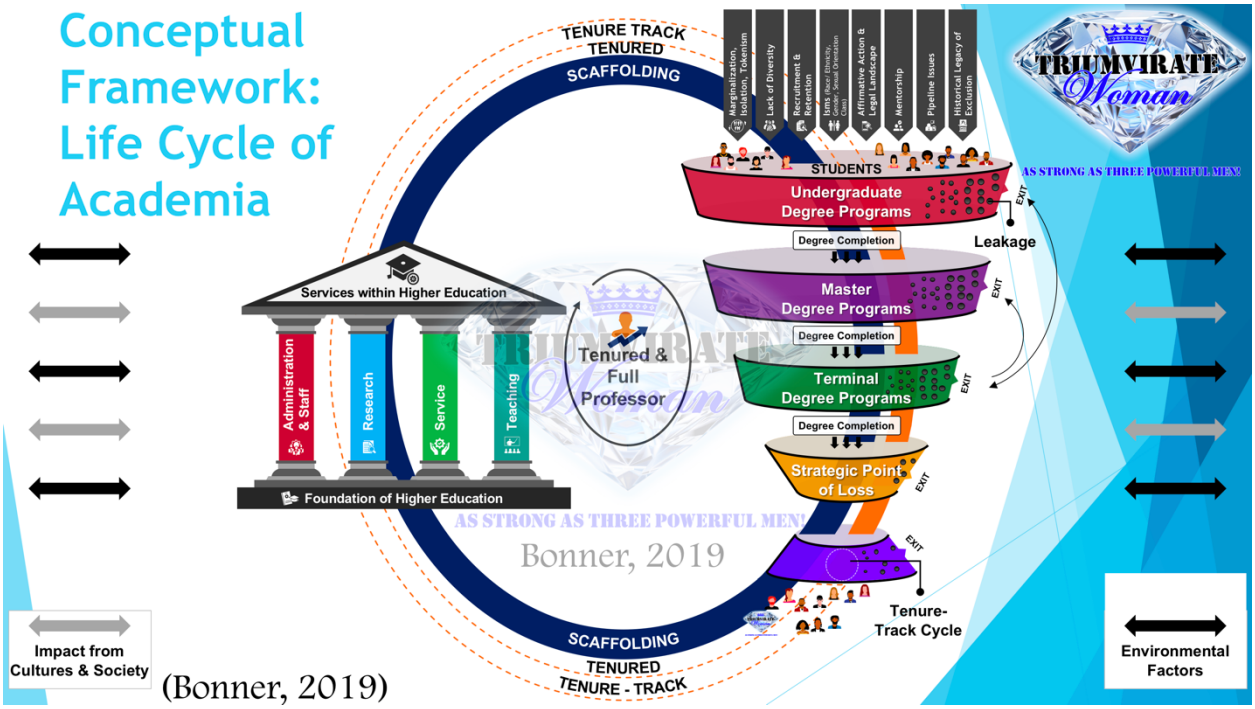
This framework is conceptualized as the Life Cycle of Academia. Although this study was not designed to deconstruct the totality of higher education, I will identify many of the critical components of this system and hone in those applicable to this study. I identified 16 themes that emerged from the literature review, which were: (a) legal landscape for PoC, (b) history of exclusion; (c) hiring practices, (d) diversity, (e) recruitment and retention, (f) isms—racism, sexism, etc., (g) isolation and marginalization, (h) tokenism, (i) pipeline issues, (j) TAPP;

(k) faculty research, (l) faculty teaching, (m) faculty service, (n) standards for yearly faculty evaluations, (o) work expectations, and (p) mentorship.

In addition, the conceptual framework considers (q) impact from society and cultures, (r) environmental factors that may also impede the Life Cycle of Academia, (s) tenure-track cycle, (t) scaffolding, (u) leakages, (v) exits, (w) strategic point of loss, (x) associate professors, and (y) full professors, as additional concepts that play a pivotal role in the life cycle of academia. This list of components is not designed to be exhaustive, but to provide cogency to the magnitude in which the Life Cycle of Academia is designed and the position of African American women in academic career fields in engineering. Thus, African American women in engineering are represented by the diamond in Figure 1.

Figure 1

Life Cycle of Academia



(Bonner, 2019)

There were several key elements that each of the theoretical frameworks encompassed, which were honed in on specifically when designing this conceptual framework. The key features from CRT are: (a) interest convergence, (b) permanence of racism, and (c) dominate ideology. The following key aspects from BFT are: (a) work, family, and Black women's oppression; (b) power of self-definition; and (c) rethinking Black women's activism. All six key elements from intersectionality were utilized: (a) social inequality, (b) domains of power, (c) relationality, (d) social context, (e) complexity, and (f) social justice. Although there are specific parts within the conceptual framework that utilized other themes, the key elements listed emerged multiple times throughout the understanding of the Life Cycle of Academia.

The core of higher education functions on a system of scaffolding, which Tourse, Hamilton-Mason, and Wewiorski (2018) argued that there is a:

> …multidimensional nature of oppression. It is the scaffolding anchored in that oppression that supports and maintains racial discrimination. Scaffolding is an unseen but integral aspect of racism that helps to prevent the collapse of this morphing entity. It involves thought processes, attitudes, behaviors, and beliefs that are borne out of societal, group, and individual cures. Racism develops and evolves within the context of its place in history, but remains a constant through time because of the scaffolding. Racism morphs, but the scaffolding continues to hold it in place. (p. 7)

This continuous loop, scaffolding, allows for racism to continue to perpetuate within higher education as an invisible force to keep African American women and other URM groups out of the loop. F. Bonner (2004) argued that "gaining access to the loop is difficult, if not impossible…[however, African American faculty are] seeking from academe the same things that nonminority professors seek: opportunity, respect, and trust" which is what they have earned

through their prowess to educate the next generation (p. 1). When a faculty member is tenured and not promoted, they are still on the same track as other faculty; however, they are outside of the loop of being entirely accepted.

Chapter 3: Methodology

Purpose

This study utilized a methodology that encompassed the use of the theoretical frameworks CRT, BFT, and intersectionality. Therefore, this study utilized Critical Race Methodology (CRM) to guide and analyze the data collected to address the research questions. It is a necessity to incorporate CRM as the methodology for this study to ensure that the counter-stories shared by the African American women in engineering receive a platform to share their voice. In Chapter 3, this study examined the methodology, which includes a review of the research questions, research design, CRM, participant selection, instrumentation, data collection and analysis, protection of human subjects, and limitations.

Research Questions

The following research questions were utilized to better understand the academic career messages for African American women in engineering:

1. How many African American women are tenured and tenure-track by rank in academic engineering careers in the US as of fall 2017?
2. How does the historical data on engineering faculty demographics from 2001-2017 impact academic career messages and persistence for African American women?
3. How does the 2001-2017 faculty demographics attribute to a sense of belonging and mattering for African American women in engineering academic career fields?

Research Design

This study was designed to examine the lives and lived experiences of African American women in engineering and the academic career messages they receive through an evaluation of data collected through counter-stories. Through the lens of CRT, BFT, and intersectionality, I

selected CRM to employ the data collection and interpretation to ensure that the narratives receive the standpoint they deserve. Thus, creating an understanding of how academic career messages in engineering contribute to the lives of Triumvirate Women, while ensuring that their voices are heard and illuminated.

Through the use of CRM, the study was designed to bring rich meaning to the narratives of African American women in engineering by listening to the words they said, while understanding their standpoint as women within the engineering community and their institutions. Although the data collected by the ASEE allowed me to identify the number of African American women in engineering, it did not provide a clear understanding to academic career messages and experiences of Triumvirate Women.

Critical Race Methodology

I employed a design methodology to complement CRT, BFT, and intersectionality as these theoretical frameworks guided the research. Thus, CRM was incorporated to ensure that the counter-stories of academic career trajectories for African American women in engineering were understood from the most applicable standpoint. Oppression is rooted in a demand to retain power, social status, and the resources of a dominant group, over a subordinate group (Feagin, 2006; Tourse et al., 2018). As a result, CRM works as an analytical tool to create structural disruptions to existing dominate sources of power to promote social change within higher education (Tourse et al., 2018).

There is a basic foundation within CRM that consists of five key elements which are: (a) intercentricity of race and racism with other forms of oppression or subordination, (b) challenge to dominant ideology, (c) commitment to social justice, (d) centrality of experiential knowledge, and (e) transdisciplinary perspective (Solórzano & Yosso, 2002). These five key elements are not

indicative of themselves as new theories; however, Solórzano and Yosso (2002) asserted that collectively, these elements challenge existing forms of scholarship by naming "…racist injuries and identifies their origins" (p. 27). In other words, by naming and identifying forms of racism and oppression such as engineering fields, African American women can become empowered through hearing their stories and those of others within the margin—the Triumvirate Women (Solórzano & Yosso, 2002).

Counter-storytelling

Delgado (1989) argued that "those in power sleep well at night—their conduct does not seem to them like oppression. The cure is storytelling (or as I sometimes call it), counter-storytelling" (p. 2413-2414). Indeed, counter-storytelling is a powerful tool that is used in CRM "…for exposing, analyzing, and challenging majoritarian stories of racial privilege" and seemingly obvious oppression (Solórzano & Yosso, 2002, p. 32). Also, counter-storytelling has a rich history for African Americans and can channel sources of strength to empower and validate cultural, political, and social traditions of survival and resistance (Solórzano & Yosso, 2002). There are three general forms of counter-storytelling: (a) personal stories or narratives, (b) other people's stories or narratives, and (c) composite stories or narratives (Solórzano & Yosso, 2002). Each form captures the essence of the lived experience as experiential knowledge to provide meaningful data to guide researchers in understanding PoC.

Sources of Data

To extract sources of data with CRM, I will "unearth sources of data" through the use of two borrowed concepts that are coupled to create the counter-story data (Solórzano & Yosso, 2002, p. 33). The first concept is called theoretical sensitivity which Solórzano and Yosso (2002) cite Strauss and Corbin (1990) and argued that it is:

> A personal quality of the researcher. It indicates an awareness of the subtleties of meaning of data. One can come to the research situation with varying degrees of sensitivity depending upon previous reading and experience with or relevant to the data. It can also be developed further during the research process. Theoretical sensitivity refers to the attribute of having insight, the ability to give meaning to data, the capacity to understand, and capability to separate the pertinent from that which isn't. (p. 33)

Moreover, Solórzano and Yosso (2002) cited Delgado Bernal (1998) for the second concept, which is the notion of cultural intuition, which is explained as the following:

> A Chicana researcher's cultural intuition is achieved and can be nurtured through our personal experiences (which are influenced by ancestral wisdom, community memory, and intuition), the literature on and about Chicanas, our professional experiences, and the analytical process we engage in when we are in a central position of our research and our analysis. Thus, cultural intuition is a complex process that is experiential, intuitive, historical, personal, collective, and dynamic. (p. 34)

In addition, the two concepts are different as Delgado Bernal (1998) emphasized that cultural intuition "…extends one's personal experience to include collective experience and community memory, and points to the importance of participants' engaging in the analysis of data" (as cited in Solórzano & Yosso, 2002, p. 33-34). Therefore, by coupling the two concepts together, CRM "…created counter-stories from (a) the data gathered from the research process itself, (b) the existing literature on the topic(s), (c) our own professional experiences, and (d) our own personal experiences" (Solórzano & Yosso, 2002, p. 34). McCoy and Rodricks (2015) cited Museus,

Ravello, and Vega (2012) with the research of Solórzano and Yosso (2002) to further explain counter-stories by providing five functions for this method of inquiry:

> 1) illuminates race and racism's role at the individual, institutional, system, and societal levels; 2) potential to build community among those individuals who are at society's margins by putting a "human face" to educational research theory, and practice; 3) contest the perceived wisdom and knowledge of individuals at society's center by offering context that understands and transforms established belief systems; 4) may open new windows into the realities of people on society's edge by demonstrating possibilities beyond the ones these individuals are living and revealing that these are not singular experiences; 5) potentially educate others by merging elements from the story and current reality to construct another world that is richer than that portrayed by the story or reality alone. (p. 40)

Thus, counter-stories have the ability to provide meaning to allow this study to better understand the academic career messages for African American women in engineering.

Participant Selection

This study specifically included participants who identify and are characterized by their institution for reporting purposes as African American women tenured and tenure-track in engineering. Participants were identified by comparing the data collected from the 2017 ASEE profiles to track where the respondents were employed. There were 338 U.S. four-year, degree-granting engineering schools surveyed by ASEE in 2017, and among these were 81 institutions who collectively reported a total of 142 tenured and tenure-track African American women in the academic engineering career fields. Therefore, purposeful sampling was initially used to contact the 142 tenured and tenure-track African American women in academic engineering faculty

positions to participate in the study. This resulted in a total of 15 interviews and included participants who identified as assistant, associate, and full professors.

More specifically, two methods were utilized: (a) purposeful sampling and (b) snowball sampling. First, I created a directory of the 142 tenured and tenure-track African American women faculty identified from the 2017 ASEE profiles report though individual university and department directories. This allowed me to use publicly available contact information for purposeful sampling via blind emails. Then, through previously established relationships and networks, I contacted specific names off the contact list created to implement snowball sampling.

Therefore, through purposeful and snowball sampling, 15 participants responded and agreed to participate in this study. I provided consent forms to each participant via e-mail, and once this consent was signed and returned, I asked to schedule a time to conduct an interview via Zoom, Facetime, Skype, or phone. Each participant provided their availability, and the interviews ranged from roughly thirty minutes to two-and-a-half hours. The data collection period ranged between July and September of 2019. In order to remain objective, I allowed each participant to control the duration of the interview questions by allowing them to share lengthy, detailed narratives about their families, careers, background, students, colleagues, and experiences without interruption. This allowed the participants to provide context on their standpoint with as much or as little detail as they liked to share. This is why some of the interviews were much longer than others.

Furthermore, after identifying the participants for this study, it became abundantly clear that it would not be possible to provide a short description of the participants individually, without infringing upon their identity or alluding to one's participation in the study. Therefore, multiple measures were taken to ensure confidentiality and the trustworthiness of this study.

Pseudonyms were selected at random from a list of fifteen names of notable diamonds. The list of diamond names was used to illuminate the importance of this unique and multifaceted population of African American women who not only survive, but thrive in their field. In addition, diamonds are significant because every diamond is unique and has a different radiance that it creates to illuminate the dimensions of its strengths, resilience, and beauty. I believe that this description fits the criteria for appropriate pseudonyms for this study. The participants are named as follows:

1. Dr. Star of Africa—Full Professor
2. Dr. Vargas—Full Professor
3. Dr. Premier Rose—Assistant Professor
4. Dr. Great Mogul—Full Professor
5. Dr. Tiffany Yellow—Associate Professor
6. Dr. Eureka—Assistant Professor
7. Dr. Excelsior—Associate Professor
8. Dr. Golden Eye—Assistant Professor
9. Dr. Ocean Dream—Assistant Professor
10. Dr. Golden Jubilee—Assistant Professor
11. Dr. Star of the South—Assistant Professor
12. Dr. Blue Moon—Assistant Professor
13. Dr. Earth Star—Assistant Professor
14. Dr. Heart of Eternity—Associate Professor
15. Dr. Hope—Associate Professor

Instrumentation

The instrument used in this study was an in-depth interview via Zoom, Facetime, Skype, or phone. Due to anticipated time constraints during the summer, there was only one interview scheduled and no follow-up interviews were needed. The interview questions were designed to address six main areas: (a) background information, (b) the tenure and promotion process, (c) institutional goal-setting and department acclimation, (d) collegiality and networking, (e) global engineering community interactions, and (f) sense of belonging and mattering. Each interview allowed the participant to speak freely about their personal journey and experiences, which created a continuous flow of conversation and personal stories that were shared to provide context to the questions. See the full protocol in Appendix 3 for additional details. The interview questions were asked in the following order:

Background:

1) Tell me about your journey into the field of engineering?
2) How did you decide to stay in academia as opposed to a career in public or private engineering?
3) What did your path look like after earning your doctorate and becoming a tenure-track faculty?

Tenure and Promotion Process

4) What factors influenced your decision to work at this institution?
5) What is/was your journey like as a tenure-track faculty?
6) Can you tell me about other faculty members in your department who have gone through the tenure and promotion process?

Institutional Goal-Setting and Department Acclimation

7) What are some of the committees you are on?

8) Have you ever worked on a search committee for recruitment for new faculty?

9) Can you explain a typical work week?

Collegiality and Networking

10) Can you tell me about your experiences working with colleagues within the department and the institution?

11) Do you have a mentor?

    a) If so, what experiences would you like to share about your interactions?

12) Do you have a formal or informal network of colleagues?

    a) Are they within your department, institution, or field?

    b) Can you share with me your experience within these networks?

Global Engineering Community Interactions

13) Can you share your experience working with students?

14) Do you attend engineering conferences?

15) Can you share with me some of your experience in publishing your research?

16) Do you know other African American women in engineering?

    a) If so, what experiences would you like to share about your interactions?

Sense of Belonging and Mattering

17) Have you ever considered leaving your institution or engineering?

    a) If so, what was this experience like?

18) What strategies have you used or learned to continue to progress in this field and within your academic career trajectory?

19) What can institutions do to increase or support recruitment, retention, and promotion of African American women in engineering?
20) What are some of the important components about your identity as an African American woman tenured or tenure-track in engineering?
21) Can you share some of the positive attributes about being an African American woman in engineering?
    a) Also, as a faculty in engineering?
22) Is there anything you would like to share that has not been covered in this interview?

Data collection included interviews, which were recorded with an audiotape. This allowed me to focus on the narratives and counter-stories from the data expressed by the participants during the semi-structured interviews. Again, data collection extended from July to September 2019 and a research journal was used to take notes throughout the interview to highlight important details that were mentioned. The interviews were then transcribed verbatim, and the transcriptions were returned to the participants to ensure the accuracy of the data. After the participants confirmed the accuracy of the transcriptions, the audiotapes were destroyed to ensure confidentiality.

Data Analysis

Data analysis began in July and lasted until November 2019. See the protocol in Appendix 3 for additional details. When analyzing the data transcribed, I sought to implement a theory that would develop rich counter-stories that provided meaning to the narratives. Since CRM incorporates the work of Strauss and Corbin (1990) grounded theory, the data analysis for

this study is centered on this theory. Although several scholars focus on grounded theory, this study draws from the concepts analogous to the work of Charmaz (2006, 2012), where she utilized a three-phase process for analyzing data. This study drew upon the work of Charmaz (2006, 2012) because of her focus on social justice research and the inclusion of concepts such as oppression, equity, and power in her work, as they directly correlate to this study.

The three-phase coding process consisted of: (a) initial coding, (b) focused coding, and (c) theoretical coding (Charmaz, 2006). This three-phase process allowed me to examine the narratives, while incorporating the 16 themes identified in the literature review. Again, I identified 16 themes from the literature which are: (a) legal landscape for PoC, (b) history of exclusion, (c) hiring practices, (d) diversity, (e) recruitment and retention, (f) isms—racism, sexism, etc., (g) isolation and marginalization, (h) tokenism, (i) pipeline issues, (j) TAPP, (k) faculty research and publications, (l) faculty teaching, (m) faculty service, (n) standards for yearly faculty evaluations, (o) work expectations, and (p) mentorship. These themes will aid in the understanding and meaning of the narratives to provide rich data through the three-phase coding.

Three-Phase Coding

First, initial coding consisted of a critical line-by-line coding, which was used as a heuristic device to allow me to actively engage with the data (Charmaz, 2012). While this conceptualization of the data took place, I looked for actions and meaning to crystallize the significant points of the data as they emerged through the coding (Charmaz, 2012). There was consistent interaction between the data and I to ensure accuracy and meaning. During the second phase, I began focused coding. This involved utilizing codes that were salient and frequently emerged through the line-by-line coding to synthesize and explain larger pieces of the data

(Charmaz, 2006). This allowed me to determine which codes identified in the initial coding could be reduced to create conceptually rich categories that made analytical sense to explain the academic career messages received by African American women in engineering. The third phase is the theoretical coding, which integrates the codes identified in the focused coding to specify possible relationships among the emerging categories. Thus, creating analytic categories to then use to report the findings in this study.

Protection of Human Subjects

The required application was submitted to the Institutional Review Board (IRB) at Claremont Graduate University (CGU) prior to any contact with participants. Once the approved IRB application was received, I began to contact participants. I ensured each participant that there would be no harm during or after the study. In addition, there were minimal risks associated with participation in this study. Due to the nature of the questions, there were situations that imposed some level of personal vulnerability about personal or professional experiences that they may have encountered. The questions posed in this study may have caused participants to reflect on sensitive issues while responding to the questions. However, I reminded each participant that if at any time they begin to feel uncomfortable, they may discontinue participation, either temporarily or permanently.

Each participant was informed that the findings of this study would be used to improve policies, practices, and curricula to enhance the recruitment and retention of African American women in engineering academic career trajectories. Also, each participant was reminded that this study was voluntary, and even if they decided to participate, they were free to withdraw consent and to stop participation at any time without penalty. As previously mentioned, a pseudonym was provided at random for the use of reporting purposes. All data collected from the interviews

were maintained in a locked office on a computer with a password. Furthermore, the results of this study are presented to ensure that no information can directly reveal the identity of the participants.

Limitation

The primary limitation of this study is the number of African American women who meet the criteria for this study. Another important limitation is the inability to capture data on those who are no longer in the field for various reasons. The participation of the participants was limited by the availability of faculty during the summer, as there was an anticipated reduction in the number of responses that I would receive. Lastly, the amount of published literature that is available to research, track and analyze for African American women in academic engineering career fields.

Chapter 4: Findings

Purpose of the Study

The purpose of this study was to understand and emphasize the importance of access, equity, inclusion, and diversity in engineering by intentionally focusing on academic career messages for African American women through the lens of Critical Race Theory (CRT), Black feminist thought (BFT), and intersectionality. Therefore, through the use of Critical Race Methodology (CRM) and grounded theory, this study utilized a three-phase process for analyzing data extracted from interviews conducted between the data collection periods, from July through September 2019, and data analysis from July to November 2019 to address the research questions for this study.

Research Questions

The following research questions were utilized to better understand the academic career messages for African American women in engineering:

1. How many African American women are tenured and tenure-track by rack in academic engineering careers in the US as of fall 2017?
2. How does the historical data on engineering faculty demographics from 2001-2017 impact academic career messages and persistence for African American women?
3. How does the 2001-2017 faculty demographics attribute to a sense of belonging and mattering for African American women in engineering academic career fields?

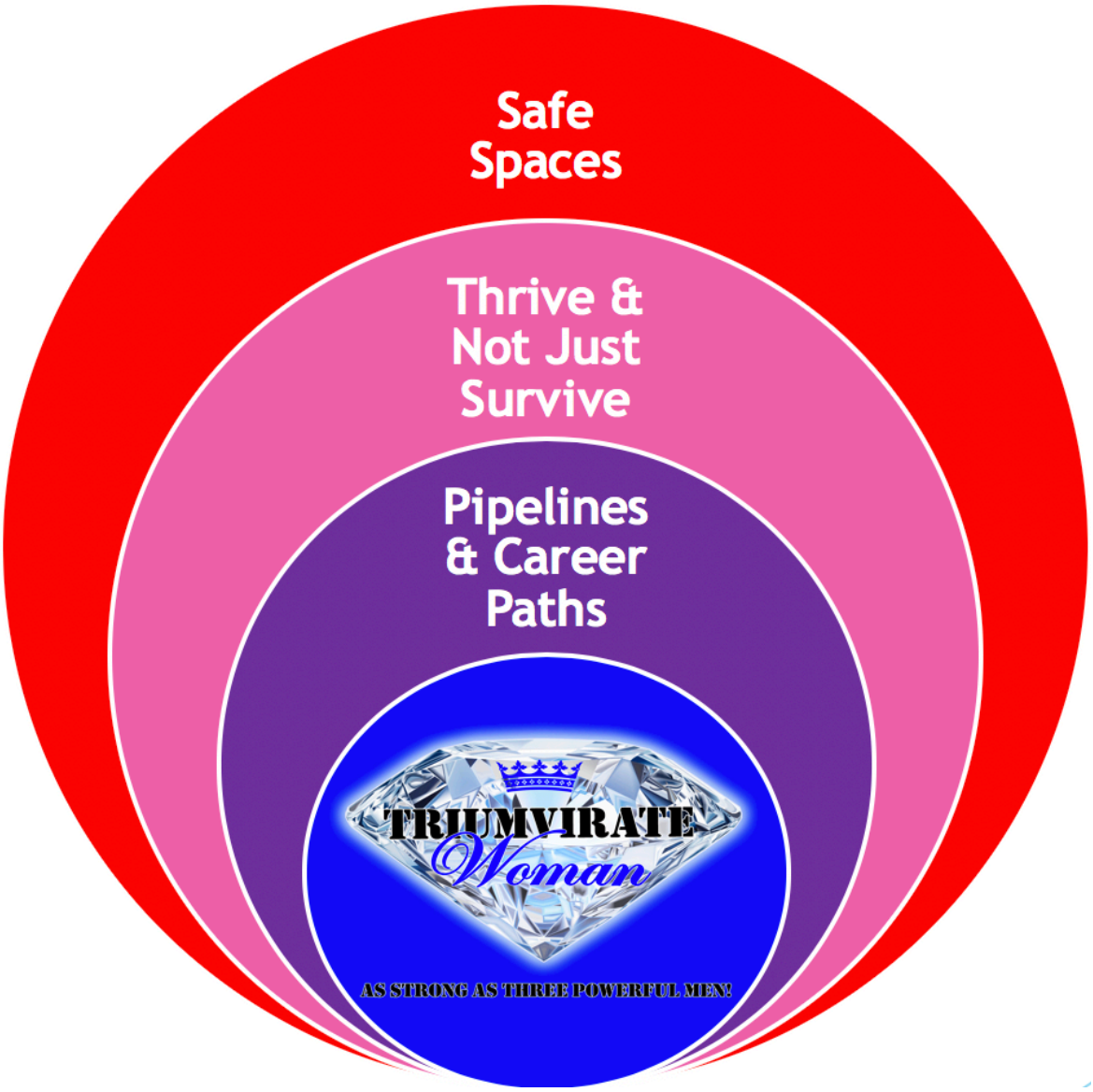
Counter-Story Themes Revealed in Interviews

The narratives and counter-stories shared by each of the participants were unique, expressive, forthright, and insightful, which allowed me to create meaningful data for this study.

Although each participant had their own narrative and counter-story, there were also salient themes that continued to emerge throughout the three-phase coding process. I was able to create three analytical and conceptually rich counter-story themes to present the data. These three themes repeatedly emerged among the majority of the participants. In addition, each of the counter-story themes was inextricably intertwined with construct of the Triumvirate Woman because they all intersect with the marginality of race/ethnicity, gender, and engineering as it relates to African American women in academic engineering career fields. Therefore, the data is presented with each theme and multiple quotes from the participants. The three counter-story themes are: (a) safe spaces, (b) thrive and not just survive, and (c) pipelines and career paths. Thus, Figure 2 provides a visual representation of the relationship between the construct Triumvirate Woman and the counter-story themes. At the center, you will find the Triumvirate Woman imbedded within each of the counter-story themes.

Figure 2

The Triumvirate Woman Counter-Story Themes Inextricably Intertwined



Safe Spaces

Fostering academic environments that focus on access, equity, inclusion, and diversity is vital to the overall success of students, faculty, and the institution. Safe spaces are formal or informal networks that are created to meet the needs of those involved who understand and relate

to the shared experiences of others. Moreover, creating safe spaces where faculty members are able to have candid conversations about professional and personal aspects of their lives is also essential to ensure balance mentally, physically, and emotionally. However, since African American women in engineering represent 0.52% of the faculty in engineering across the United States, these safe spaces are created through formal and informal networks, which may not be available on their campus or in their state.

On the one hand, there are organizations and initiatives that foster environments that support women in academia, STEM, and even engineering specifically. These organizations are well-meaning and resourceful for all women. Still, it is a disservice to merge all women into one category and assume they need the same resources to be successful. On the other hand, literature documents a history of exclusion, isolation, and marginalization for African American and URM women when interacting in professional socializing in the workplace. Furthermore, Meyers and Rios (2012) found that there are more barriers for minority women faculty than White women faculty and more discrimination than minority male faculty. This is highlighted in Dr. Star of Africa's narrative where she states that:

> It's rough out here for us when, when there's not a lot that looks like you, they do it… a lot. Marginalization, cultural taxation, pioneerism, all of that…they see White women [differently] no matter [what], our struggles are not the same. That's why people try to write books about women in STEM faculty and try to conflate the issues. We are not the same because they see her as their mom, their sister, their daughter, there auntie, I'm not going to be seen that way.

Indeed, there are similarities, but the types of resources and support are different for African American women. Understanding the importance of safe spaces in formal and informal

environments is essential; however, creating diversity initiatives that are not inclusive and do not meet the needs of African American women perpetuates a cycle of structural-related gender biases. Moreover, when initiatives only focus on diversity without taking into consideration that there are within-group differences, they are further marginalizing African Americans and other URM women. This narrative shared by Dr. Star of Africa hones in on this topic by sharing the following experience:

> My school is desperate for diversity things. I had been on the diversity council, the president's diversity STEM task force, the diversity committee… I've been on about four different things called diversity something or another. And all of them had the same mission, help fix diversity on this campus and that's when I came to the conclusion, they want to meet about it, but they don't want to be about it, because how many different meetings [do I have to go to and] …give you some suggestions and I'll never see any of that stuff happen.

This was significant because, throughout the interviews, other participants shared similar experiences about the diversity initiatives on their campus and through different national and international organizations. These structural impediments are inauspicious and subconsciously silence the experience of African American women in engineering. Therefore, the need for safe spaces is essential so that African American women in engineering do not feel alone or isolated, although they may be the only one or one of few faculty members on their campus that identify as both African American and female in engineering. These microaggressions create experiences that others may not understand because they impact African American women in a way that they may not impact other women. So too, Dr. Excelsior shares her experience through the following narrative:

> Some people have already experienced that and can give you advice. Sometimes you, you think it's only you, like things are only happening to you, but it's, you know, you can see other women of color kind of experiencing the same types of things at different institutions, so it doesn't make you feel alone and isolated, and you do have something that you're going through, and it's nice to, you know, talk those out, have a safe space to talk those out.

This is echoed by Dr. Star of Africa when she shares the following about the importance of safe spaces:

> My sanity doesn't happen when I'm on campus. My sanity happens when I go to these events and see 20 other Black woman faculty in STEM and we're able to talk to each other and go, did this happen to you? Because it happened to me. Oh, yea girl that happens to me all the time because you'll be aware like, am I crazy? Did this fool just touch my hair? But you know, when you go to these other places, those things are normal. So, you need to do that to keep your sanity. And if not for that, that's where I found my mentors and my role models. That's what helped me to get to this position. Those were the relationships.

These safe spaces are unique because there is an unspoken understanding that African American women share. This is highlighted in the use of BFT. Among other things, this means that African American women share a level of communication that may not be verbal or visible to others around at times, but it is understood. What is understood between African American women in safe spaces is understood on a deeper personal level; it is a connection that oftentimes cannot be explained to those who are not African American women, but African American women understand it. This is highlighted in Dr. Premier Rose's narrative, where she states that:

> There's something beautiful about that and something that you can't necessarily get maybe in your traditional space with your, non-African American, non-women colleagues. Yeah, I mean they're the best! They're incredibly supportive! They're incredibly helpful! We share everything from when we were negotiating startup packages at new positions. What is everybody else getting? So, I can make sure I'm asking for the right stuff or salaries, all of that kind of stuff. Grant proposals, all of it.

These connections and networks may happen intentionally in any venue and at any time. Safe spaces are not just physical, but they can also be emotional and mental. There may be a situation where an African American woman knows that she is the only person in the room that is both African American and female, but as soon as another African American woman enters the room, there may be a brief glance or eye connection that ensures both women that "I see you and I understand." The two women may be strangers in a professional environment like everyone else, but they are connected by a commonality and an unspoken understanding that I am "my sister's keeper," and I am here with you. At this moment, nothing is said or done, but it is just understood mentally. This is almost an instantaneous bond, which is expressed by Dr. Golden Eye by sharing that "I think we have a lot of shared experiences, so bonds are formed pretty quickly." Indeed, these bonds can be formed quickly and can evolve into formal and informal networks.

Nevertheless, there are situations where African American women in engineering are alone and isolated on their campuses and they feel as if they do not have a network to collaborate professionally or a safe space to share personally. Thus, Dr. Great Mogul was able to share her experience when she was an assistant professor on a campus where she did not have a formal or informal network to collaborate on projects:

> So, what I did, I do what every focused Black woman does. I made my own collaboration. I went international...there were collaborations all over the country… So, you have to be intentional about collaboration. But I tell people, don't be down hearted if they don't want to collaborate with you. Create your own a network of collaborators.

The significance I gleaned from Dr. Great Mogul was the importance of creating these safe spaces to network and collaborate, even if it is outside of your institution. As a faculty in academia, it is essential to create and advance knowledge through teaching, research and service activities. Oftentimes, African American women may not be included in the inner-workings of different networks that utilize cultural capital to advance their careers; therefore, they are on track, but out of the loop. Thus, African American women create these safe spaces so that they are able to continue to progress in their careers.

There is also a connection that both African American men and women share that is similar to the notion of "my sister's keeper," which is "my brother's keeper." These terms of endearment are synonymous with the fact that African Americans share a common understanding of the lives and lived experiences of one another. Therefore, throughout almost every interview, the participants mentioned their involvement in the National Society of Black Engineers (NSBE). "NSBE's mission is to increase the number of culturally responsible Black Engineers who excel academically, succeed professionally and positively impact the community" (NSBE, 2016). This mission holds true, as Dr. Golden Eye shares her experience working with NSBE in the following statement:

> NSBE that there's such a, there's such a strong sense of community amongst academics of color that I really appreciate. I know that the tenure-track can feel very lonely and isolating for a lot of people and particularly with people with minority identities. And, I

> think that so many people have done such an amazing job in informing those communities as a response, [this] is something that I think is really great and positive.

Indeed, almost every participant in this study had similar stories and examples of the impact that NSBE has made on their professional career, their service expectations within their institutions, and the scholarly advancements that they have made through the networks provided by this organization. Even though NSBE is not exclusively for African American women in engineering, the organization ensures that there are safe spaces for these women to gather and connect on a personal and professional level. Moreover, there are also workshops within different organizations that foster safe spaces for African American women to meet and reunite in intellectually stimulating environments. Dr. Golden Jubilee shares her experience with safe spaces by sharing her interactions at a conference that hosted a workshop:

> [This workshop focused on creating an inclusive space for] Black women in engineering. We call it an intergenerational mentoring workshop because we wanted to bring together people [who] were junior faculty and senior faculty… We try to find ways to not only socialize with [each other], but get to work together, like to try an find overlapping research interest. What are some interesting problems or questions that we can't answer? Like the example that I mentioned, like hosting a workshop, which it turned out to be an NSF funded study on intergenerational mentoring across the two groups. So, when we can then, we try to identify ways that we can work together to accomplish some of our career goals, then in addition to just our personal goals of keeping in touch.

Several of the women in the study mentioned their participation in this same workshop and how impactful the experience was to their professional and personal growth. In addition, there were new bonds that were made and overlapping areas of interest that have created a space

for future collaborations. Moreover, the women were able to unite with other African American women in engineering in an environment that was conducive for candid conversations about situations either on their campus or within the field that they were unable to have with others on their campuses. These safe spaces allow African American women to feel included and surrounded by others that understand their lives and lived experiences.

Thrive and Not Just Survive

There is extensive literature that documents the experiences of African American women in engineering as it relates to work expectations, service, teaching, research, and standards for yearly faculty evaluations that coalesce into the requirements to meet for the TAPP. These themes are not exclusive to African American women in engineering. Nevertheless, because 99.48% of the faculty population as of fall 2017 in engineering consists of everything except African American women, it would be elusive not to address the plethora of racial and gender subconscious and systematic barriers that linger within the STEM culture that perpetuates structural-related biases and minimizes the possibilities for African American women. In fact, Dr. Great Mogul said "…things that I believe can be done is to address bias, bias is very real...and to be very intentional about confronting and removing opportunities for bias…" in order for African American women in engineering to not only survive, but to thrive in this field.

Institutions must be intentional in their efforts to address and eliminate biases that perpetuate cultures that are not conducive to the success and sustainability of a field. Moreover, Dr. Star of Africa reflects on her experiences as a graduate student who is now an alumna of a prominent and very well-known engineering program. Dr. Star of Africa states that:

> The diversity check. They came in the door, I got a number. Yeah. Oh, what's the retention rate? Are they graduating or better yet, how many of them are graduating?

> Because this is what I said when I left SCHOOL, and this is what some of the students say when they leave my school. I will never step foot on that campus. I will never give you a penny of my money. I will not come to homecoming. Don't call me, don't ask. So, they survived, but they didn't thrive! And that's me! I have actually been back to SCHOOL's campus now, but I will never give SCHOOL a red cent of my money because that was actually hazing and abuse that I went through when I was there. That wasn't education. So, that's a big one with me is you have to give people the resources to be successful.

The significant message that I gleaned from this narrative is the level of emotion that left an everlasting impression on an experience that should have cumulated into a lifelong relationship. The institution should have provided an environment that allowed for inclusive practices, but instead, it has tainted a relationship that may never be mended.

Although Dr. Star of Africa shared how she felt about her position as an alumnus, she also shared that there is a silver lining in the midst of the soiled relationship. Now, as a full professor, she has made it her duty to create the type of environment that fosters inclusive practices. Dr. Star of Africa said, "But because this is so important to you and you know, it's never going to change if you all leave, somebody has got to stay...I want them to understand that just because there's not a lot of us does not mean it's impossible." Indeed, it is possible to foster environments that allow inclusiveness, diversity, access, and equitable situations for everyone involved. However, for many African American women in engineering, this is challenging because, as Dr. Vargas shares in her narrative, "...usually almost a hundred percent of the time... I'm the only one of me. I'm the only person who is both woman and African American in all the

committees and stuff…".Although one becomes comfortable in these situations, there is still a heavy tax that African American women must pay in these situations.

Thus, Dr. Eureka shares in her experiences by expressing the following:

> [This is] what are they call "majority groups." [They have a system in place so] … that they kind of tag onto someone and they're not always starting from the bottom, you know, they can just kind of join in and some things are easy. So, I think, I guess I haven't quite done this, but it's like a thought or I know like that's part of what needs to happen to be successful. Cause if you're always creating everything from zero, it's just exhausting… So, when I've thought about leaving and, I mean, it's exactly that, that I just want to have more time and like energy for things that aren't work. Like I think this job is super taxing and I think, I think if the culture doesn't change, something dramatic is going to happen. Like I don't think the way it's going is sustainable for people. And I mean, there's already pretty well documented literature about mental health and graduate students. And so, I think it's similar. Like it's just gonna become, you know, more known of how crazy this is. Like if we continue to operate this way.

As an assistant professor, Dr. Eureka is not alone in her experiences, and several other women shared similar stories that speak to the notion of the sustainability of the engineering if the culture does not assimilate to the changing demographics with more inclusive practices. Furthermore, since Dr. Star of Africa is a full professor, she continues on with the notion of thriving and not just surviving by saying, "So that's a big one, we have to be there, but we can't be battered and bruised when we arrive because we gotta be able to bring other people behind us, you know?" The significance that I gleaned from this message is that it is vital to make it to full professor so that you are able to guide others to where they may be aspiring to reach in their

careers. However, it should not come at a cost that is so high that once you become a full professor, you are struggling to maintain your personal and professional endeavors as they relate to mental, physical, and emotional wellbeing.

As a result, many of the women shared that their institutions are changing the process for incoming new tenure-track hires by "shielding and protecting" them from some experiences such as institution acclimation, research, teaching, and service activities. For instance, Dr. Excelsior shared the following experience:

> When I say it was a little stressful in comparison to what we do now in my department, [I mean] my department now for new faculty that come in, they don't teach their first semester, and some of them don't teach the first year. And the reason is because they're trying to allow faculty to really get their research off the ground. So, like I said, trying to do that and teach classes that you have to prep is kind of, is a bit much unless you're trying to work all night.

This means that although African American women in engineering may endure cultural taxations that impede specific components of their professional and personal experience with the cultural climate in engineering, there are other areas where institutions are recognizing that faculty members may only be surviving and not thriving. Thus, mitigating unsustainable work expectations and standards for yearly faculty evaluations. Likewise, Dr. Eureka said:

> My department has pushed a lot for publications and grants, [but as far as service and teaching expectations], I think they have just laid off because I wasn't getting as much stuff [research, publications and grants] as they wanted. So hopefully, I mean, I kind of assume, I think they kind of shield the assistant professors from too much of that and

yeah, I haven't been asked to do very much besides those, you know, those other two committees.

Nonetheless, every woman was able to share their experiences and gratitude from their personal journeys to illuminate their ability to thrive and not just survive. This experience was reflected on by several of the assistant professors as they shared their journey and daily experiences as pre-tenured faculty members. Dr. Premier Rose said, "I think we're resilient, we're far more resilient than people give us credit for. We bounced back, right? I think if you're consistently fighting against rejection or barriers or challenges that we find a way, I think we can also do more with less." This new practice was expressed and apricated by the associate professors because they remember the recent struggle and how taxing it was prior to becoming a tenured professor. Dr. Tiffany Yellow said, "…I have a voice that they want to hear from, but if I don't, um, contribute, then it's not there." Furthermore, the full professors shared their experience with ensuring that new tenure-track faculty members are able to do more than survive their tenure-track years, but to thrive as academics and colleagues in the field. Dr. Great Mogul said, "I think as African American women we are very resilient. History has taught us to be so."

Pipelines and Career Paths

Engineering is a multifaceted field that has evolved with a myriad of possible career paths. Likewise, access and equity to resources that promote career aspirations in academia are steadily increasing with technology and innovation. Every interview began with the women sharing their journey into the field of engineering. Several personal narratives spoke to their personal life-changing events that encouraged them to embark on their journey to become engineers so that they can solve some societal need. This had led several of these women to become notable figures and subject matter experts globally in their areas of study and their

contributions have vastly impacted the field of engineering in terms of innovation, sustainability and environmental justice. The notion of pipelines and career paths is deeply intertwined in their narratives both personally and professionally. Therefore, this section shares experiences about these interactions and how they are interrelated as priorities for all of the women who participated in this study.

Dr. Golden Jubilee began her journey into the field of engineering by saying:

> I hadn't heard about engineering until I was a junior in high school… They had a women in engineering day, and so my counselor, piled me and three other women into her beetle and she took us to COMPANY to women in engineering day. And I was fascinated by what I heard. There was like a panel. They had a lot of stuff planned for us, like tours and stuff like that. But one of the things that they did was they had a panel discussion where they had about 20 women, women engineers, all kinds of disciplines that worked at COMPANY. And they talked about the stuff that they did. And I left that day knowing I want to be an engineer. I didn't know what kind I'd be one, but it brought together a lot of things that I really was passionate about… it was like to serve some societal need.

So too, Dr. Premier Rose said:

> I latched onto engineering [and as a child and] for years now, I never made the connection between the micro-messages and this moment that somebody said that this was something I could do, but being reflective, I think those two things together, hearing that this was a pathway that was considered prestigious, that was considered impactful, that was considered to give, you know, sort of like uplifting socioeconomically… So, there were all these sorts of like micro-messages over time that engineering was the place to be. Combined with somebody finally saying, you know, look, you're good at math,

> and this is a potential pathway for you that I latched onto engineering, so the rest of my high school career I decided that's what I was going to be, the next big crossroads for me.

The significance and common theme among all of the narratives was the exposure to a career, lifestyle, societal impact, and intellectually stimulating experience that would allow them to use their skill set to advance technology, innovation, and global issues to make the world a better place. In terms of career paths, the second question in the interview asked the question: How did you decide to stay in academia as opposed to a career in public or private engineering? The responses consisted of those who went straight from their PhD programs to academia and others who went to work in the industry and then transitioned to academia. Nevertheless, as of today, all of the women have worked in some capacity of industry and academia. This means that they have all expanded their portfolios to include multiple revenue streams outside of academia. This is included but not limited to government organizations, private LLC, consulting, city, state and local government, international government agencies, areas of public policy and legislation, and several non-profit organizations.

Dr. Ocean Dream shares her experience with the following narrative:

> After my doctorate, I was not interested in academia. I was just burned out, and I just really didn't know if I could do that job all year. I could see my advisor, it just seemed like a really great job to go from being a fresh PhD to running a research lab and teaching. So, probably… [I was] a bit scared about that or just didn't see myself doing it… I enjoyed industry, but I just felt like that wasn't the career path for me. I enjoy new research a lot more. I really missed the research environment. I didn't like the people I work with and learned a lot from being in industry. I worked for COMPANY and then eventually decided, I called my advisor and decided to ask if the postdoc position was

still available. And he said yes, come on back. And, that was really that period of time where I explored what it was like to be a professor. I taught a class; I wrote grants and really got my feet wet. And my advisor at the time was doing a lot of administrative roles on campus…then from there, I just applied. I actually applied to like positions, and yeah, so that's how I ended up in academia.

Dr. Tiffany Yellow shared her experience through the following narrative:

I finished my bachelor's in like YEAR, and I was in consulting for like almost eight years before I went back to Grad school. So, I was doing like engineering design work. I was doing some construction management, and I was really kind of dissatisfied with like how, like not creative it was in terms of like, there were, there's a design manual on that, like that's all that you can do. So, that's why I went back to Grad school and like during Grad school, I realized that I loved research, and that's when I decided that I wanted to become a professor. So, I feel like I started on that pathway when I went into Grad school rather than after I finished my doctorate, then I made sure that I like got the experiences that I would need and made the, you know, connections that I needed before graduation… Really, it was having that experience before Grad school, where I knew what I didn't want to do that really like drove the passion to stay in academia.

Dr. Golden Eye shared her experience in graduate school with the following narrative:

I did an internship with a… big tech company. And with that, I thought I was going to love working and wanting to get a job with after I graduated, and I ended up hating it. I didn't like the culture; I didn't like what I was working on.

Many of the women shared similar stories about working in public and private sectors of engineering and how they felt as if they were not utilizing all of their skillsets or receiving the

level of intellectual stimulation that they thought they needed at the time. This standpoint is expressed by Dr. Excelsior when she shares her experience once she began working in academia by saying, "[As a faculty member,] … I have the ability to work on problems that are interesting to me, as opposed to things that are mandated by someone else. So, [it] would be like a big, big thing for me." The majority of the women shared the importance of work autonomy because they have a passion for engineering, and Dr. Vargas expands upon this when she shares that "…we have to be creative enough to come up with innovative ideas to solve problems." The notion of innovation and creativity, coupled with societal impacts and environmental justice, are prevalent in the lives and lived experiences of each of the women.

Nonetheless, there are systemic issues that create leakages in the pipelines for African American women to embark on academic career paths in engineering. Dr. Golden Jubilee explains her understanding of these leakages in the pipelines with the following narrative:

> [When it comes to pipeline issues, and how it relates to academic career paths and recruitment, you have to] realize that there is a long trajectory, career trajectory before someone is actually eligible to be a faculty member. So, there are things that institutions can do when someone is in undergrad or graduate school to make sure that they are successful for a variety of career paths, including academic career paths, that I think can help to build a pipeline right now. I'm not quite sure if they… I think there are many institutions when they start their recruitment… they look at who's graduating. But I think that there are so few people, African Americans, graduating with degrees that are necessary to be in academia that I think there is room to look earlier, for institutions to do things where they can look earlier in the pipeline, or to try to build a pipeline for people that they can recruit, for talent that they can recruit… positions are filled by who, you

> know, and a lot of times, diverse talent are not in the circles of, who you know, or at least the people who are making a hiring decisions. So, I think that learning how to, institutions learning how to search more broadly would also help with finding and recruiting diverse talent. I think there's also bias and some discrimination that happens in some hiring processes that I [can] think of… [there should be] some training or professional development or something that needs to happen with the search committees themselves. [However,]… academia has given me the best of many worlds in that, I can still focus on the technical content of engineering where I can teach that to students, but then I can also study interesting problems that help to address a lot of like an educational need[s], like how to prepare engineers for their careers.

Findings by Research Questions

This study adds to the research literature by illuminating the career messages that African American women faculty in engineering receive during their experiences in academe by answering the following research questions:

Research Question 1

1. How many African American women are tenured and tenure-track by rack in academic engineering careers in the US as of fall 2017?

In 2010, Nelson and Brammer released the second edition of the report, *A Nation Analysis of Minorities in Science and Engineering Faculties at Research Universities*, which reported the tenured and tenure-track faculty demographic composition of the top 100 science and engineering departments, which served as a baseline for the status as of the 2007 fiscal year. This report consisted of a comprehensive demographic analysis of an independent survey of the top 100 science and engineering departments as ranked by the National Science Foundation

(NSF). There are two main points that stood out from the Nelson and Brammer (2010) report which are:

1. "URM women faculty, especially 'full' professors, are almost nonexistent in physical sciences and engineering departments at research universities" (p. 1).
2. When valuing the survey populations for female URM professors in the top 50 departments, the "numbers are headcount[s], rather than percentages…[and] 'full' professors are so few that we collected an approximation of national origin information for them" (p. 16).

Since Nelson and Brammer (2010) utilized the ranking from the NSF, I contacted the NSF to request the most recent information on the specific number of African American women tenured and tenure-track in engineering. The data in the *Women, Minorities, and Persons with Disabilities in Science and Engineering* provided informative graphs and tables. However, in the note sections, faulty tables state that the "numbers [are] rounded to [the] nearest 50. Detail[s] may not add to total[s] because of rounding or suppression" (NSF, 2019, p. 3). Therefore, I began to contact national agencies and organizations that collect or report faculty demographics. After several unsuccessful sources were contacted, I received a recommendation from NSBE to explore the resources and data published by the American Society for Engineering Education (ASEE).

Data Collection. In order to collect the data for this study, I examined the publicly available data on the ASEE website and I purchased the 2017 edition of the *Profiles of Engineering and Engineering Colleges*, which provides a comprehensive evaluation and directory of profiles on engineering colleges. This textbook is over 500 pages and provides extensive details on all levels of higher education; more specifically, it provides the demographic

composition of tenured and tenure-track faculty as of fall 2017. The ASEE collects this over a five-month process, which is implemented in three phases. In the first phase, institutions that elect to participate in the survey are able to enter their data into the Web-based survey (ASEE, 2018). In the second phase, individual institutions are responsible for ensuring the accuracy of their profile through a web-based data verification process (ASEE, 2018). Then, in the third phase, ASEE conducts internal evaluations of the data for quality control and make contact if there are questions about the information reported (ASEE, 2018).

As of fall 2017, 338 U.S. four-year degree-granting engineering schools were surveyed by ASEE and reported an aggregate total of 27,178 tenured and tenure-track faculty in the US (ASEE, 2018). More specifically, the ASEE reported the demographic composition according to race/ethnicity, gender, and institution for all tenured and tenure-track faculty. This allowed me to identify 81 individual institutions, which collectively reported 142 tenured and tenure-track African American women in the US as of fall 2017. I then utilized the individual profiles of each institution to further disaggregate the data to create a data set of the specific number of full professors, associate professors, and assistant professors.

A three-phase process created a new data set by gathering, synthesizing, and analyzing the individual profiles for each of the 81 institutions. The first phase consisted of gathering each institution's 2017 profile data, which ranged from approximately 20-75 pages per institution, which is available on the ASEE website. During the second phase, I synthesized the data collected in the first phase to only the information related to African American women who are full professors, associate professors, and assistant professors in an Excel spreadsheet by race/ethnicity, gender, rank, and institution. In the third phase, the data were analyzed to ensure accuracy, and the ASEE initial 2017 tenured and tenure-track report validated the totals. More

specifically, when you examine the data and disaggregate by race/ethnicity, gender, and rank, there were 33 (0.12%) African American women full professors, 50 (0.18%) associate professors, and 59 (0.22%) assistant professors tenured and tenure-track faculty in engineering (ASEE, 2018).

The tables list the institutions with African American women in each of the following categories: Table 2-overall tenured and tenure-track professors (33 institutions with 2+); Table 3-full professors (seven institutions with 2+); Table 4-Associate Professors (seven institutions with 2+); and Table 5-assistant professors (nine institutions with 2+). While this study sought to explore as much data as possible, the category of "lecture" was not included in the disaggregated data; however, as previously mentioned in this study, it was used for the overall number of faculty in Table 1 which listed the faculty by percent from 2001-2017. As you may note, several institutions are colored in red, which represent HBCUs. This data allowed me to create the following tables:

Table 2

All U.S. African American Women Tenured and Tenure-Track Faculty in Engineering Fall 2017

University of Florida	7	Stanford University	2	University of Dayton	1
Morgan State University	6	Tuskegee University	2	University of Georgia	1
Howard University	5	The University of Alabama	2	University of Houston	1
The Johns Hopkins University	4	University of Maryland, College Park	2	The University of Iowa	1
Mississippi State University	4	University of South Florida	2	University of Kentucky	1
University of Tennessee, Chattanooga	4	Virginia Polytechnic Institute and State University	2	University of Louisville	1
Arizona State University	3	California State Polytechnic University, Pomona	1	University of Maryland, Baltimore County	1
Georgia Institute of Technology	3	Case Western Reserve University	1	University of Massachusetts Amherst	1
North Carolina A&T State University	3	Columbia University	1	University of Minnesota -Twin Cities	1
North Carolina State University	3	Duke University	1	University of Nebraska, Lincoln	1
Northeastern University	3	Florida International University	1	The University of New Mexico	1
Rutgers, School of Engineering	3	Indiana University-Purdue University Indianapolis	1	University of Pennsylvania	1
Texas A&M University	3	Iowa State University	1	University of Rhode Island	1
University of Central Florida	3	Kennesaw State University	1	University of San Diego	1
University of Illinois at Urbana-Champaign	3	Missouri University of Science and Technology	1	University of Southern California	1
University of Michigan	3	The Pennsylvania State University	1	University of Tennessee, Knoxville	1
Auburn University	2	William Marsh Rice University	1	The University of Texas at Austin	1
Bradley University	2	Rose-Hulman Institute of Technology	1	The University of Texas at Dallas	1
Clemson University	2	Smith College	1	The University of Texas at El Paso	1
Cornell University	2	South Dakota State University	1	The University of Texas at Tyler	1
FAMU-FSU College of Engineering	2	Tufts University	1	The University of Toledo	1
Louisiana State University	2	University of Arkansas at Little Rock	1	University of Wisconsin, Milwaukee	1
Massachusetts Institute of Technology	2	University of California, Berkeley	1	Villanova University	1
Michigan State University	2	University of California, Davis	1	Virginia State University	1
New Jersey Institute of Technology	2	University of California, Riverside	1	Washington University in St. Louis	1
Northwestern University	2	University of California, San Diego	1	West Virginia University	1
Purdue University	2	University of Connecticut	1	West Virginia Univ Institute of Technology	1

Note. This data is from the 338 U.S. four-year degree-granting engineering schools surveyed by ASEE as of fall 2017. Source of the data collected by ASEE (2018).

Table 3

All U.S. African American Women Full Professors in Engineering Fall 2017

Howard University	3	Bradley University	0	West Virginia Univ Institute of Technology	0
Georgia Institute of Technology	2	California State Polytechnic University, Pomona	0	University of Arkansas at Little Rock	0
Massachusetts Institute of Technology	2	Case Western Reserve University	0	University of California, Berkeley	0
North Carolina A&T State University	2	Clemson University	0	University of California, Davis	0
North Carolina State University	2	Columbia University	0	University of California, Riverside	0
University of Central Florida	2	Cornell University	0	University of California, San Diego	0
University of Tennessee, Chattanooga	2	Duke University	0	University of Connecticut	0
Louisiana State University	1	FAMU-FSU College of Engineering	0	University of Dayton	0
Missouri University of Science and Technology	1	Florida International University	0	University of Georgia	0
Morgan State University	1	Indiana University-Purdue University Indianapolis	0	University of Houston	0
New Jersey Institute of Technology	1	Iowa State University	0	University of Kentucky	0
Northeastern University	1	The Johns Hopkins University	0	University of Louisville	0
Northwestern University	1	Kennesaw State University	0	University of Maryland, Baltimore County	0
Texas A&M University	1	Michigan State University	0	University of Massachusetts Amherst	0
Tuskegee University	1	Mississippi State University	0	University of Nebraska, Lincoln	0
The University of Alabama	1	The Pennsylvania State University	0	The University of New Mexico	0
University of Florida	1	Purdue University	0	University of Rhode Island	0
University of Illinois at Urbana-Champaign	1	William Marsh Rice University	0	University of San Diego	0
The University of Iowa	1	Rose-Hulman Institute of Technology	0	University of South Florida	0
University of Maryland, College Park	1	Rutgers, School of Engineering	0	University of Southern California	0
University of Michigan	1	Smith College	0	University of Tennessee, Knoxville	0
University of Minnesota -Twin Cities	1	South Dakota State University	0	The University of Texas at Austin	0
University of Pennsylvania	1	Stanford University	0	The University of Texas at Dallas	0
Virginia Polytechnic Institute and State University	1	Tufts University	0	The University of Texas at El Paso	0
Virginia State University	1	Vilanova University	0	The University of Texas at Tyler	0
Arizona State University	0	Washington University in St. Louis	0	The University of Toledo	0
Auburn University	0	West Virginia University	0	University of Wisconsin, Milwaukee	0

Note. This data is from the 338 U.S. four-year degree-granting engineering schools surveyed by ASEE as of fall 2017. Source data collected by ASEE (2018).

Table 4

All U.S. African American Women Associate Professors in Engineering Fall 2017

Morgan State University	3	University of Maryland, Baltimore County	1	Northwestern University	0
University of Florida	3	University of Michigan	1	William Marsh Rice University	0
Auburn University	2	The University of New Mexico	1	Smith College	0
FAMU-FSU College of Engineering	2	University of Rhode Island	1	South Dakota State University	0
Mississippi State University	2	University of Tennessee, Chattanooga	1	Tuskegee University	0
Rutgers, School of Engineering	2	The University of Texas at Austin	1	Virginia Polytechnic Institute and State University	0
University of South Florida	2	The University of Texas at Dallas	1	Virginia State University	0
Bradley University	1	The University of Texas at Tyler	1	Washington University in St. Louis	0
Case Western Reserve University	1	The University of Toledo	1	University of Arkansas at Little Rock	0
Cornell University	1	University of Wisconsin, Milwaukee	1	University of California, Berkeley	0
Duke University	1	Villanova University	1	University of California, Davis	0
Georgia Institute of Technology	1	West Virginia University	1	University of California, Riverside	0
New Jersey Institute of Technology	1	West Virginia Univ Institute of Technology	1	University of California, San Diego	0
Northeastern University	1	Arizona State University	0	University of Central Florida	0
North Carolina A&T State University	1	California State Polytechnic University, Pomona	0	University of Connecticut	0
North Carolina State University	1	Clemson University	0	University of Georgia	0
The Pennsylvania State University	1	Columbia University	0	University of Illinois at Urbana-Champaign	0
Purdue University	1	Florida International University	0	The University of Iowa	0
Rose-Hulman Institute of Technology	1	Howard University	0	University of Maryland, College Park	0
Stanford University	1	Indiana University-Purdue University Indianapolis	0	University of Massachusetts Amherst	0
Texas A&M University	1	Iowa State University	0	University of Minnesota -Twin Cities	0
Tufts University	1	The Johns Hopkins University	0	University of Nebraska, Lincoln	0
The University of Alabama	1	Kennesaw State University	0	University of Pennsylvania	0
University of Dayton	1	Louisiana State University	0	University of San Diego	0
University of Houston	1	Massachusetts Institute of Technology	0	University of Southern California	0
University of Kentucky	1	Michigan State University	0	University of Tennessee, Knoxville	0
University of Louisville	1	Missouri University of Science and Technology	0	The University of Texas at El Paso	0

Note. This data is from the 338 U.S. four-year degree-granting engineering schools surveyed by ASEE as of fall 2017. Source data collected by ASEE (2018).

Table 5

All U.S. African American Women Assistant Professors in Engineering Fall 2017

The Johns Hopkins University	4	Tuskegee University	1	North Carolina A&T State University	0
Arizona State University	3	University of Arkansas at Little Rock	1	North Carolina State University	0
University of Florida	3	University of California, Berkeley	1	The Pennsylvania State University	0
Clemson University	2	University of California, Davis	1	Rose-Hulman Institute of Technology	0
Howard University	2	University of California, Riverside	1	Tufts University	0
Michigan State University	2	University of California, San Diego	1	The University of Alabama	0
Mississippi State University	2	University of Central Florida	1	University of Dayton	0
Morgan State University	2	University of Connecticut	1	University of Houston	0
University of Illinois at Urbana-Champaign	2	University of Georgia	1	The University of Iowa	0
Bradley University	1	University of Maryland, College Park	1	University of Kentucky	0
California State Polytechnic University, Pomona	1	University of Massachusetts Amherst	1	University of Louisville	0
Columbia University	1	University of Michigan	1	University of Maryland, Baltimore County	0
Cornell University	1	University of San Diego	1	University of Minnesota -Twin Cities	0
Florida International University	1	University of Southern California	1	University of Nebraska, Lincoln	0
Indiana University-Purdue University Indianapolis	1	University of Tennessee, Chattanooga	1	The University of New Mexico	0
Iowa State University	1	University of Tennessee, Knoxville	1	University of Pennsylvania	0
Kennesaw State University	1	The University of Texas at El Paso	1	University of Rhode Island	0
Louisiana State University	1	Virginia Polytechnic Institute and State University	1	University of South Florida	0
Northeastern University	1	Washington University in St. Louis	1	The University of Texas at Austin	0
Northwestern University	1	Auburn University	0	The University of Texas at Dallas	0
Purdue University	1	Case Western Reserve University	0	The University of Texas at Tyler	0
William Marsh Rice University	1	Duke University	0	The University of Toledo	0
Rutgers, School of Engineering	1	FAMU-FSU College of Engineering	0	University of Wisconsin, Milwaukee	0
Smith College	1	Georgia Institute of Technology	0	Villanova University	0
South Dakota State University	1	Massachusetts Institute of Technology	0	Virginia State University	0
Stanford University	1	Missouri University of Science and Technology	0	West Virginia University	0
Texas A&M University	1	New Jersey Institute of Technology	0	West Virginia Univ Institute of Technology	0

Note. This data is from the 338 U.S. four-year degree-granting engineering schools surveyed by ASEE as of fall 2017. Source of data collected by ASEE (2018).

The three institutions with the highest number of tenured and tenure-track African American women faculty are the University of Florida-7, Morgan State University-6, and Howard University-5, respectively (Bonner, 2019).

Research Question 2

2. How does the historical data on engineering faculty demographics from 2001-2017 impact academic career messages and persistence for African American women?

When determining the impact of academic career messages and persistence for African America women in academic career trajectories in engineering, this study utilized multiple measures to better understand how these messages transpired through the matriculation of

undergraduate, graduate, doctoral and faculty positions for the women who participated in this study. This means that, through the narratives and lived experiences of the women who represent this data, this study was able to provide meaning to their persistence and standpoint on the cultural climate that they have experienced during these stages of their academic and professional career trajectories. Furthermore, since the majority of the women have navigated through the academic pipeline for over ten years, they were able to share how their experiences have shaped and molded their careers and the careers of other African American women. For instance, some of the full professors who participated in this study have taught and mentored assistant professors who also participated in this study. Therefore, this study was able to not only obtain information on the theories and practices used, but also how these practices are implemented in the academic and career trajectories of others.

Dr. Blue Moon shared her experiences as a graduate student, and now a tenure-track faculty member, and she repeatedly mentioned that Dr. Star of Africa mentored her. When questions were asked about mentors or knowing of other African American women in engineering, she shared how Dr. Star of Africa impacted her life and provided the guidance she needed to remain persistent in this field. This is because Dr. Star of Africa understands the importance of encouraging and supporting others in the pipeline like Dr. Blue Moon. Furthermore, Dr. Star of Africa advocated for Dr. Blue Moon to provide her with the foundation she needed to progress in her academic career trajectory, by continuing to remind her that her presence and representation matter, since there are not many African American women in this field. Dr. Blue Moon continued by expressing that it is imperative that students and junior faculty members have a safe space to share, grown, and progress in this field.

This was mirrored in Dr. Star of Africa's narratives when she says:

> You just don't bring a number. This is not like accounting being counted, check. Three Black girls here, check; two Black boys here, check… How are they doing? What do their grades look like? Are they crying every night in the dorm? You know, that's a big one… ...I want to change the face of engineering, and I want to change that for my people.

This is significant because Dr. Star of Africa understands that the number of African American women who actually matriculated through higher education in engineering is small. It is crucial to understand their struggles, and she mentioned that it is her duty to ensure that she provided her mentees with the resources that they need to be successful in engineering.

Dr. Great Mogul shared similar experiences by expressing her standpoint with the following narrative:

> You'll probably hear much of the same from other women of color because oftentimes, we're tapped to be advisors because people know that we really are passionate. I really care about the students… I have made it my business to be, not just vocal, but to align my statements with what we say the vision of the institution is, as well as, what is in the best interest of those who are students. And so, for that reason, I'm really known for promoting diversity and inclusion… I am hopeful that your work to be a source of inspiration, to encourage more. I've been afforded the fortunate to graduate four African American female PhD's, and only one consider a career in academia.

The significant message I gleaned from Dr. Great Mogul's narrative is the importance of her role and responsibility as a full professor to use her voice and position to impact change within the culture of engineering. When Dr. Great Mogul said, "I have made it my business…" there was a level of passion, compassion, and dedication to not only say that diversity and

inclusion are essential, but to show it in her actions. Moreover, she stated that she still keeps track of all the African American women in engineering who have graduated from her institution and will continue to support them in their future endeavors because she understands the importance of representation. This was reflected in Dr. Great Mogul's closing remarks when she says the following:

> Well, the best part of it is how much the minority students appreciate it... my African American female students to my Hispanic female students, I mean just how much they appreciate having someone who looks like them there, that is extremely touching. I had a mentee this summer… I was presenting as part of the ORGANIZATION, who recruited summer intern undergrads and [there was] this…young African American woman. She had never even seen a Black female engineer, much less, a Black female engineering professor. The gratitude, [the] opportunity to encourage and empower them in their career is one of the greatest things about being an engineering professor, a Black female, and an engineering professor.

In addition, Dr. Tiffany Yellow shared her experiences of the impact of academic career messages and how she was able to persist at her institution with the following narrative:

> I ended up having to go directly to speak with my dean because of some issues I was having in the department. But I also met other women faculty, like full professors, who became advocates and were really supportive of me at that time. And I mean, I just didn't know that I needed that or that like tenure was an issue for me until it was time…So right before tenure, when I was getting mixed signals from my chair, one of the things that he told me that was incorrect was that if I wanted a higher salary, that I needed to have another offer, which is like a very, old school message. And I ended up talking to my

> dean, he was like, no, please don't get another offer that will cost me way more money than if you just asked me for more money. But I didn't realize that I was being underpaid at that point. And I think that happens to a lot of women, not just Women of Color, you know, in academia.

This is significant because Dr. Tiffany Yellow encountered a department chair that was fixated on sending "old school messages" that are well documented in the literature as contributing factors for reasons why African American women in engineering leave the academy and transition into other positions in the private and public sector of engineering. However, because of full professors who acted as advocates in this situation, Dr. Tiffany Yellow was able to negotiate a retention package when she was promoted to associate professor. In addition, Dr. Tiffany Yellow shared that she is able to advocate for others, and she encourages her mentees to find their voice and to become self-advocates so that they can persist within the field of engineering as well.

To further expand upon the impact of administers and the cultural climate of engineering, Dr. Excelsior says:

> It's a little bit of sensitivity to like [understand] how, or what's the best work environment for women? And I think, having those people in management [who perpetuate systemic and structural inequalities] is probably like a toxic situation, right? So those people should not be in positions or in the chair or anything like that because they're just not capable of, mentoring a junior faculty member appropriately.

Indeed, perpetuating toxic environments for African American women in engineering is counterintuitive, and they impact the academic career messages and persistence of faculty members who want to change the culture in ways that promote diversity, inclusion, access, and

equity in academia. But these changes are not the sole responsibility of African American women in engineering, but all faculty members and the administration. Dr. Golden Eye shares here experience by stating the following:

> One of the trends that I've seen in higher education is a push to make institutions more equitable, diverse, and inclusive. I think that a lot of that work falls on a faculty of color, and at the same time, that work is not recognized by the college. This service work is not recognized by the college in the same way that another committee work might be. And so, I think it's really key that if universities want to have that worth, that they either work really hard to make sure that all faculty care about those initiatives or at least a critical mass of faculty care about those initiatives, not just faculty of color. And also, to recognize that it is work that people carry out and to compensate faculty for that in some way, either by removing other service work or providing additional research support or things like that.

The significant message I gleaned from Dr. Golden Eye is that all faculty members and administrators need to understand the contribution of African American women in engineering faculty positions by valuing these contributions and commitment to their careers in a way that recognizes and supports their contributions. On the one hand, institutions are pushing for equitable, diverse, and inclusive environments. While on the other hand, there are mixed messages that do not acknowledge the value in the amount of service that is required to attain their mission. There should be a clear understanding of the amount of cultural tax that this imposes on African American women in engineering.

One salient theme that was consistent across every interview is that there are numerous institutions that have one or only a few African American women who are tenured and tenure-

track in engineering. This was mentioned when the women spoke of safe spaces and how they know that they are the only one, or one of less than ten on their faculty. Therefore, these women not only want to survive, but they have made it their duty to thrive in engineering and become subject matter experts by and large. Thus, Dr. Vargas shares the following narrative:

> I'm sure my identity as a Black woman just, you know, gone through life as a Black woman, obviously color is everything that I do, but that's more of a subconscious coloring. [Oftentimes, when working I'm wearing] …more my engineering hat because I think in those cases, if I am not excellent technically, you know, for what they're asking me to come and weigh in on that work, that is probably [viewed] more negative around me or the only Black woman in the room, than maybe some of the other folks… the White guys, because there are many of them, so if one isn't capable, another one may be. So, it's okay [for them], but if I'm not capable, it's kind of like, oh, the Black person, that woman, you know, so it's a bigger deal. So, there's a little extra pressure to be absolutely on point with everything I do all the time. So, that's something I've always been aware of. I probably always overprepare for almost all the things that I do because I just feel like you can't afford to miss this.

The message I gleaned from this is that I know that even as a full professor, Dr. Vargas knows that she is the only one in many spaces to represent all African American women in engineering in a way that does not reflect negatively on faculty demographics. So too, Dr. Vargas knows that it is vital to not only have a seat at the table but to show others that African American women have a valuable contribution to add to engineering on all levels. Moreover, all of the women who participated in this study shared similar expectations from themselves, their work, and the work of any person that they mentor or collaborate with on everything that they

do. Therefore, the historical data motivates them to bring the very best version of themselves in everything that they do so that they can persist in this field and encourage others to join the ranks as well.

Research Question 3

3. How does the 2001-2017 faculty demographics attribute to a sense of belonging and mattering for African American women in engineering academic career fields?

When determining how the faculty demographics attributed to a sense of belonging and matter for African American women in engineering academic career fields, I felt that it was essential to understand the standpoint of each woman by asking if they would ever consider leaving engineering? Although the women are well aware of the demographic makeup for faculty in engineering, there was an intense sense of belonging and mattering that transcended across almost every woman that is unequivocally and undeniably clear.

To take a case and point, Dr. Excelsior response by saying, "NOPE! No, no. I mean, I'm saying no, I've never, no to either question. Like, no, I've never thought of leaving my institution or engineering." Dr. Premier Rose said, "NAAHH…I'm not going anywhere!!" Dr. Star of Africa said, "I'm never gonna leave engineering or engineering education!" Dr. Earth Star said, "No, I don't. I would not consider leaving. I am an engineer at heart!" Dr. Heart of Eternity said, "I don't think I would leave engineering. I definitely feel like engineering is my home!" Dr. Hope said, "I haven't considered leaning academia or leaving engineering!" Although some of the women expressed their interest in going to different institutions for various reasons or expanding their careers to work in transdisciplinary studies, it is clear from their narratives that they belong, and they matter.

In addition, some of the women shared that they had to find their "groove" and identify their "lane" so that they can continue to progress in their fields. For example, Dr. Ocean Dream shared her experience as a new faculty member her first few years in the following narrative:

> [I began]… feeling more confident and collaborating with people and reaching out to people to write proposals together, or collaborate on research. Whereas I think in the early days, I wanted to be more independent or just didn't feel confident reaching out to who I perceive are like famous and senior. Whereas now I'm like, just hey, like what's up? You know, we're gonna write this grant together and then feeling more comfortable in my own skin about my, what I have to offer to a collaboration, and feeling good about that. And that's really made a big difference. It's made things a lot easier to go after and [working on] grants together with other people, to writing good papers together with other people, learning other people's writing styles, seeing how they pursue, going after proposals or how they write the proposals… I think in the early days I sometimes, especially if I went to conferences I never went to before, that they're kind[s] of [feelings, a sense of] nervousness because I get this a room of like thousands of people and like, they don't know me, right. Like, you know, who are you? And they might have their own network and then as the years went by, I would keep going to these conferences. Then I was a person who had the network. Right. It's not like the first time, they may not know, even know you, and over the years and as they see you speak and engage, then they get to know you.

This means that although Dr. Ocean Dream was not confident at the beginning of her career, but she knew who the senior subject matter experts were in her field, and she continued to

master her craft so that she too can work with others and become what other's may perceive as famous or a more senior junior faculty member.

There is also a notion that many African American women in engineering experience tokenism, which creates a false sense of belonging and mattering. Consequently, tokenism is well understood by African American women, and they can identify when they are being used as tokens to represent diversity. For example, Dr. Star of Africa said that "Everybody calls on me for marketing, for development, for fundraising…I'm on the local news there at least three or four times a year cause they got to show some diversity in the faculty that they don't have…," so Dr. Star of Africa understands the faculty demographics, and the institution understands this as well because they are continually seeking her out because she is an African American women faculty members, among other things. Dr. Golden Jubilee shared her experiences understanding of the faculty demographics as it relates to a sense of belonging and mattering in the following narrative:

> Tokenism is a big problem in the academy because oftentimes when you see diverse candidates or diverse faculty, they may be one of many or two of many. And so, there is a tax that comes with being a token. I think that having a critical mass of diverse talent helps to alleviate that burden on those individuals. But also, creating a work environment that fosters a sense of belonging, not just bringing people to the institution, but also making sure that it's a welcoming environment where they're supported, they have the professional development, [and] resources they need in order to be successful. All those things are helpful in terms of recruitment and retention… I think that performance evaluations that give very clear feedback about what's going well and what can be improved and building capacity, like making sure that people have what they need in

> order to do well. Not just giving them feedback on their shortcomings, but also equipping them to be able to be successful because there are many aspects of the academic position that your PhD just now prepare you for. And so, I think that the sooner this decision is realized that there's some capacity building that they can do as part of helping faculty be successful, I think that that will be fruitful.

This is significant because Dr. Golden Jubilee understands the faculty demographics and that there should be systems in place to combat the myriad of themes expressed in the literature that create barriers for African American women to be successful in academic career fields in engineering. Moreover, I gleaned from this narrative a desire to want to belong and the wherewithal to collaborate on collective efforts to achieve an academic environment that promotes success for everyone involved.

In addition, Dr. Blue Moon also shares her experience through the following narrative:

> So, I'm a millennial. So, in my mind, the reason why I'm saying this is because I joined like a millennial faculty learning community with other millennials. They are also faculty members…so we all share the same sense of, kind of, I'm bucking the system, almost radicals in the system. And so that had that perspective from our generational context that has actually, it's made it sometimes difficult to progress. I'll explain it a little bit more in, in simplicity. We don't understand why this system is like it is. We don't understand why things have to be so hard. We don't understand why, you know, academia continues to do things that don't make sense. And so, we tend to question that oftentimes. And that has gotten us into a lot of struggle. It's cost us a lot of frustrations, but we stay in, and I say this knowing that a friend of a colleague of mine just made the decision to leave academia and go to another job. But she's in the arts. But you know, it's interesting. We

> stay because we feel like we can make a change too, we can change things. We stay because we see those other individuals who are coming into the ranks, and we want it to be better for them. But in a sense, we're still a little selfish. We want it to be better for us. And so, if we can be the trailblazer to make that change, then we want to experience it. But we also want other people to experience it as well. And so, this process has somewhat been experimental in my eyes. It's been, times when, you know, I've actually made progress and did some things that were different from what, my department chairs or others see as, oh, this is interesting. We never thought about it or doing it that way. This is different, my teaching style, and the practices in the classroom that I do, you know, my colleagues see the students really like that. And so, they are changing their teaching styles and they're doing things a lot differently. And, I think that when I see those things as I progress, I, you know, I feel better about the negatives that come into place or the resistance that comes into place when you're trying to do something different that actually might improve how academia is operating.

Although Dr. Blue Moon is the only African American woman in her department, she understands that her voice and standpoint are needed to create an environment that is equitable, inclusive, and diverse. Furthermore, she shared that it is important for her to remain authentic in respect to her cultural capital and the benefit that it brings to the institution and the classroom. In addition, Dr. Blue Moon shared that it is imperative that she encourages others to join her in improving the culture of engineering and academia.

Summary of the Findings

This study adds to the research literature to better understand the academic career messages for African American women in engineering. Therefore, the purpose of this chapter

was to present the findings from an in-depth analysis of the data available on faculty demographics to provide the most recent number of assistant, associate, and full professors as of fall 2017. In addition, there were 15 interviews that I conducted with African American women who are tenured or tenure-track in engineering to better understand their standpoint to answer the remaining research questions. These significant findings are as follows:

1. As of fall 2017, there were 142 (0.52%) African American women tenured and tenure-track in engineering. To further disaggregate this data, there were 33 (0.12%) African American women full professors, 50 (0.18%) associate professors, and 59 (0.22%) assistant professors tenured and tenure-track faculty in engineering (ASEE, 2018).
2. The historical data on engineering faculty demographics from 2001-2017 impact academic career messages and persistence in both positive and negative ways, which was expressed through lived experiences and narratives shared by the women in this study. The overarching theme showed a clear consensus that there are people and systems in place that contribute to African American women continuing to progress in engineering despite the barriers they may encounter.
3. The 2001-2017 faculty demographics attribute to a sense of belonging and mattering for African American women by encouraging them to use their voice and find their lane so that they can master their crafts for future generations to come. In addition, the women in this study are dedicated to doing the work needed to create access, equity, inclusiveness, and diverse environments within academia. Although they know that they may be the only one or one of less than ten, they are here to stay, and their voices will be heard.

Chapter 5: Summary, Findings, Discussion, Implications, Recommendation, and Conclusion

Summary of the Study

The purpose of this study was to better understand the academic career messages for African American women in engineering. This was achieved by utilizing publicly available data on faculty demographics in engineering as of fall 2017 to create a directory for all of the African American women tenured and tenure-track in the United States from the 338 U.S. four-year degree-granting engineering schools surveyed by ASEE. Then, I conducted individual interviews with 15 African American women from July to September 2019 and utilized their experiences and narratives to make meaning to create counter-stories from July to November 2019 to answer the remaining research questions. Next, I reported these findings and shared portions of their narratives to provide context for the three themes that emerged from the coding process. Thus, answering the original three research questions in this study in a clear and concise manner.

Findings

First, I reported that there were three counter-story themes that emerged from the coding process, which included the need and use of safe spaces, thriving and not just surviving, and pipelines and career paths. Then I answered the first research question, which provided data as of fall 2017, reporting that there were 142 (0.52%) African American women tenured and tenure-track in engineering. This information was disaggregated to report that there were 33 (0.12%) African American women full professors, 50 (0.18%) associate professors, and 59 (0.22%) assistant professors tenured and tenure-track faculty in engineering (ASEE, 2018). Next, the two additional research questions were answered, which determined that African American women in engineering understand the historical and current faculty demographics as they relate to

academic career messages, persistence, sense of belonging, and mattering. Thus, they experience positive and negative situations; however, they are engineers, and they are here to stay.

Discussion

In 2016, I began to explore and evaluate the standpoint of African American women in engineering, and this exploratory study resulted in an extensive literature review, which has evolved into a full dissertation with data, lived experiences, narratives, and a better understanding of this multifaceted field within academia. Once I was able to synthesize the data for the actual number of African American women who were tenured and tenure-track in engineering, I only saw the numbers. Now, I am able to see that these women are more than just numbers. This study has allowed me to understand the lives and lived experiences of women like Dr. Earth Star, Dr. Great Mogul, Dr. Hope, Dr. Heart of Eternity, and so forth. The women in this study have taught me that although there may be only one person here or there, they are essential, and their narratives matter. These women are changing the face of engineering, and as Dr. Ocean Dream says:

> We're solving a lot of humanities problems or trying to, you know, with climate change, understanding social networks, understanding transportation of the future, how to make things cheaper, faster, better, and a lot of really interesting challenges. So, it's super fun! And engineering is a discipline that is multifaceted. [There are] many disciplines. And then, you know, again, the people part, there are many. You can go into academics, company, law...Yes, it opens up a lot of doors. So, I've enjoyed it!

Together, these women are impacting not only academia but our global community. One of the most insightful parts of the study was sitting and listening to the women share very personal parts of their lives that were utilized to create meaningful data to share with others. The

interviews were more than just questions and answers, but authentic narratives and experiences that were insightful and full of characters, life lessons, some heartfelt moments, laughs, and I am sure some of their experiences may have had tears during those points in their lives. Now, when I look at the data that was created from this study, I have a deeper understanding of what it means to be the only person who looks like you in a department and within a field that historically did not have a place for African American women. However, these women have created a space from themselves in the field of engineering, and they are determined to create a path for others to come as well.

Another critical part about the interviews that I believe provided the breadth and depth of the study was the amount of passion that these women have for their craft. They are the epitome of what is needed to do the work and change the culture of engineering to create more access, equity, inclusiveness, and diversity within the field for everyone. Although these changes may take some time, these Triumvirate Women are ready and willing to do the work. For example, towards the end of our interview, Dr. Great Mogul said the following:

> We are generally not going to back away from something that we've worked this hard for without a fight. And so, I think that's one of the qualities I've also witnessed in other African American females in engineering faculty… But it is just worth the struggle, and it's also a great career. I have loved my career. I really have to fight the difficulty, and I would love to see more of us, and so this is great!

I can say, without reservation, that I have a better understanding of the academic career messages for African American women in engineering and I believe that the data presented in this study represents the standpoint in a way that illuminates their resilience, determination,

persistence, and their ability to be exceptional engineers who are dedicated to serving their students, their institutions and the field of engineering.

Implications

There were two salient themes that continued to resurface throughout this study, which are the two implications that I believe will aid in future research from this study: (a) recognition and equitable evaluations, and (b) representation.

Recognition and Equitable Evaluations

Although institutions create policies and practices that meet the unique needs of their institutions, there should be a clear set of policies that recognize the level of service, teaching, and research for faculty members. African American women in engineering are oftentimes taxed with heavy service loads, and they may not receive the recognition that they deserve for their additional efforts. Therefore, institutions should provide some level of recognition or rewards for their services. Several of the women shared that they are sometimes mentoring students who are not in their department or field, but since they are the only African Americans or African American women faculty members the students are able to find, they mentor and guide them without receiving any form of recognition from their departments or institutions.

In addition, several of the women mentioned that the standards for yearly faculty evaluations and the TAPP could create a level of bias and inequalities in terms of evaluations. Thus, creating equitable evaluations that area transparent in their performance standards and expectations would be beneficial to not only African American women, but to all faculty members. There are institutions that have these standards, policies, and practices in place, such as Dr. Golden Jubilee's institution. She shared her experience by saying:

> I think that there is a culture; I do think that SCHOOL seems to be a place where they want faculty to be successful. And I mentioned that because they are, I have heard of, like an ethos at other institutions where there's usually like 20% of people who don't get tenure or whatever, but I don't know of any instances in my department where someone was unsuccessful in the tenure process. And I think that that speaks to, really clear expectations...giving you the resources that you need in order to be successful. I think that they're transparent in performance evaluations is what I'm trying to say.

Transparency is critical, and it is possible to achieve a level of equitable evaluations to ensure that African American women in engineering are able to have the resources that they need to be successful. Therefore, they are able to do more than just survive tenure-track, but to thrive in their careers and continue to persist in their fields.

Representation

The culture and representation of engineering should provide access, equity, inclusiveness, and diversity in every way possible. Engineers come in every size, shape, color and, gender; therefore, they should be represented in a way that does not fit a stereotype but allows for others to see themselves in the visual imagery and the faces that represent a very multifaceted field. Dr. Star of Africa shared her insights on the importance of representation by sharing the following narrative:

> The look on people's faces when you tell them [I'm an engineer]. It's kinda funny. A lot of time I travel, so I'm on a plane or if I'm getting my car done at the dealership, getting, you know, maintenance. I'll be sitting there grading, or I'll be writing papers, or I'm grading in the airport or I'm Skyping with somebody and you know, normally Caucasian people…I'll get off the call, or I'll look up, and they'll go, are you a college student? Not

> as old as Methuselah. You know I'm no college student. No, I'm not. I teach. Oh, you teach high school? No, I teach college. Well, what do you teach? I teach FIELD engineering. Yeah. Like that. Because unfortunately, like I told you about…[looking like an engineer, it] is breaking the mold. We know the mold is broken when we get to the point that people are like you, an engineer? Ah Huh. So, a big thing with me is just educating the common man that all engineers don't look like Dilbert and MacGyver; all engineers don't look at their feet when they talk to you. I actually can carry on a conversation.

There should be an intentional effort to redesign the face of engineering so that future generations have someone that they can aspire to become, and other African American women will also want to become engineers in academic career trajectories. This means that there should be more than just talks or conversations about access, equity, inclusiveness, and diversity in academic environments. Implementing the use of the term Triumvirate Woman is a way to empower other African American women, which will allow them to know that they belong, they matter, and they are represented in engineering. Also, there should be a clear indication that engineering is a field that wants to include everyone willing and able to be a part of their culture. Thus, institutions and organizations should ensure that they are promoting a vision of inclusiveness and diverse on all levels.

Recommendation

Although there is a plethora of recommendations given by countless scholars as mentioned in this study, two primary recommendations are essential to truly understand the standpoint of African American women in academic engineering career fields. These recommendations are to eliminate data suppression, while creating effective and efficient

reporting standards with a level of uniformity so that they can be compared by multiple entities. It is important to examine data suppression in conjunction with reporting standards because one effects the other. Government, private and public entities should work together to distribute information that could be easily accessible, understandable and comparable in the most effective and efficient way possible.

Data Suppression and Reporting Standards

When I began my journey to explore African American women in engineering, there were multiple sources that reported data on faculty demographics; however, the reporting standards were inconstant, and there were several instances where the data was suppressed or unavailable to begin my study. For example, as mentioned previously, specific organizations round to the nearest 50 when reporting data, which makes it difficult to truly capture the exact number of African American women who are faculty members in any given year. Therefore, creating a universal reporting standard that does not suppress the actual numbers will allow researchers to compare data from previous years and understand how this information is changing over time. Moreover, this data should be readily available for anyone interested in learning more about faculty demographics in engineering.

While I sought to interview the women for my study, the participants interviewed me. Indeed, some of their questions began before I could start my interview questions, while others waited to the end and pulled out their notepads to ask about the data and my data collection process. The women all had a rough estimate of how many African American women were tenured and tenure-track across the U.S. because they have formal and informal networks that they use to stay connected. Still, many of the women wanted to know things such as the top ten schools that employed the most African American women in engineering or if there were other

women at nearby schools that they would be able to connect with if they did not already know each other. Therefore, this information should available, and it should be assessable to those interested in this area of research.

In addition, the ASEE included data from 338 U.S. four-year, degree-granting engineering schools, but there are institutions that did not provide data for their faculty demographics, or they did not disaggregate the data by race, gender, and rank. Essentially, I am arguing that it is counterproductive to suppress this meaningful data that can be used for further research. Therefore, institutions should proactively seek to provide this data so that organizations can continue to publish the most up to date and accurate information available.

Limitations

As previously mentioned throughout this study, the primary limitation is the number of African American women who meet the criteria to participate and the inability to capture data on those who are no longer in the field for various reasons. Also, due to the fact that the interviews were conducted during the summer and the beginning of the fall, there were a limited number of participants that were available to participate in the interviews. Although I sought to interview as many women as possible, there may have been a different outcome in the number of participants if the interviews were conducted during a different time of the year. Lastly, the amount of literature published on African American women in engineering, such as previous faculty demographics and additional institutions participating in providing data from their institutions.

Conclusion

This study sought to explore as much literature, data, and participants as possible, and although this study is not exhaustive of every resource, I provided as much information as possible to better understand the academic career messages for African American women in

engineering. Therefore, I believe that there are several areas to explore for future research, and this data will allow others to continue to expand upon the data provided to continue to enhance the literature base and the field of engineering. In closing, I would like to thank ASEE for continuing to allow open access to the profile database, which made this study possible. And lastly, but not least, I would like to thank the African American women in engineering who took the time to participate in my study and to share their experiences with me. I am honored and will always be grateful that I was able to listen to your narratives. We are the next generation, and our time is now!

"Not everything that is faced can be changed, but nothing can be changed until it is faced."

— James Baldwin

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Appendix 1: Consent Form

Agreement to Participate In
Understanding academic career messages for
African American women tenured and tenure-track in engineering

CONSENT TO PARTICIPATE IN RESEARCH: You are asked to participate in a research study conducted by Latrice Berry, a Ph.D. student in the School of Educational Studies at Claremont Graduate University.

PARTICIPANT CRITERIA: To participate, you must meet the following criteria: (a) you must be 18 years of age or older; (b) you must identify as African American; (c) you must identify as female; (d) you must be a currently faculty member tenured or tenure-track within engineering; Your participation in this study is strictly voluntary. If you are not eligible to participate, the information obtained from you during screening will be omitted from this study and shredded to protect your privacy.

PURPOSE OF THE STUDY: The purpose of this study is to understand the experiences and academic career messages for African American women tenured or tenure-track in engineering across the U.S. In particular, this study is concerned with understanding factors that influence academic career messages within tenured and tenure-track faculty in engineering. Information collected from this study will be used to inform institutional leaders on how to improve recruitment and retention for African American women in engineering academic career trajectories. As a result of how this interview is designed, no individual will ever know how you responded in the interview.

DESCRIPTION OF THIS STUDY: During the interview, you will be asked a series of questions about yourself, your college experience, and your career trajectory and your perceptions of different climates within academia and or engineering. The interview is designed to last 60 to 90 minutes in length. There is a total of five question sections with multiple sub-questions in most of these areas.

POTENTIAL RISKS AND DISCOMFORTS: If at any time you decide not to continue with the interview, you can end the conversation at any time. There are minimal risks associated with participation in this study. The questions posed in this study are personal in nature, and may cause you to reflect sensitive issues while responding to the questions posed. If you begin to feel uncomfortable, you may discontinue participation, either temporarily or permanently.

POTENTIAL BENEFITS: There are no direct benefits for participation in this study. That being said, study findings will be used to improve policies, practices, and curricula in order to enhance the recruitment and retention of African American women in engineering academic career trajectories. There are no costs associated with study participation.

PAYMENT/COMPENSATION FOR PARTICIPATION: You will not be paid or compensated directly for your participation in this study.

CONFIDENTIALITY/PRIVACY: All data collected from this interview will be maintained in a locked office on a computer with a password. When the results of the research are published or discussed in conferences, no information that can potentially reveal your identity will be included. Federal regulations require that the Institutional Review Board (IRB) periodically review all approved and continuing projects that involve human subjects. To ensure that your rights as a subject are being protected in this study, it is possible that representatives of the Institutional Review Board may come to this research site to inspect study records.

VOLUNTARY PARTICIPATION: Participation in this study is voluntary. If you decide to participate, you are free to withdraw your consent and to stop your participation at any time without penalty.

CONTACT INFORMATION: If you have any questions about your rights as a participant in this study, you may contact an IRB representative at Claremont Graduate University (909) 607-9406 or irb@cgu.edu. You may also contact Latrice Berry at (949) 281-8144 or latrice.berry@cgu.edu.

CONSENT TO PARTICIPATE/RIGHTS OF PARTICIPANT: Having read and the information as mentioned above, would you like to participate in this study? Your signature below means that you understand the information on this form, and you voluntarily agree to participate in this study.

Name (Printed)

Name (Signature) and Date

Appendix 2: Participant Demographic Data Collection

African American Women in Engineering
Demographic Information

Part 1: Biographical Data

Name _____

Phone (____) _____ Ext_____

E-mail _____

Age: Please circle your age group

18-24 25-29 30-34 35-39 40-44 45-49 50-54 55-59 60-64 65-69 70-74 75-79

Place of Birth _____

Relationship Status: (Please circle one)

Single Married Partnered Divorced Widowed Other

Number of children if any with age and sex (optional) _____

Part 2: Educational Background (Please provide degree type, field, & GPA as applicable)

High School

_____

Associates

_____

Bachelors

_____

Masters _____

Doctorates

_____

Part 3: Professional Experience

Years of experience in K-12 education

_____

Positions held

_____

Years of experience in higher education

_____

Positions held

_____

Years at your current institution

_____

Positions held

_____

Part 4: Tenure and Promotion Data

Your current title

_____

Years of tenure

_____

Years tenure-track

_____

Part 5: Institution Data

Name of your institution

_____

Name of your department

_____

Part 6: Associations and Awards

Please list all of your professional associations

_____

_____

Please list all of the professional awards you have earned

Appendix 3: Proposed Interview Protocol

PROPOSED INTERVIEW PROTOCOL[1]

RESEARCH STUDY:
The purpose of this study is to understand the experiences and academic career messages for African American women tenured and tenure-track in engineering across the U.S.

RESEARCH QUESTIONS:
1) Does the historical data on engineering faculty demographics from 2001-2017 impact academic career messages and persistence for African American women?
2) Does the 2001-2017 faculty demographics attribute to a sense of belonging and mattering for African American women in engineering academic career fields?

INTERVIEW SUBJECT:
Understand factors that influence academic career messages within tenured and tenure-track faculty in engineering.

Interviewee Name:
Interviewee Title and Institution:
Interviewer:
Date/Time/Location/Mode:

INTERVIEW SECTIONS:

1. Interviewee Background
2. Tenure and Promotion Process
3. Institutional Goal-Setting and Department Acclimation
4. Global Engineering Community Interactions
5. Sense of Belonging and Mattering

Documents obtained:
Post-interview comments or leads:
Send a follow-up thank you e-card for their time:

[1] *Adapted from sample interview protocol from Stanford University, National Center for Postsecondary Improvement, 2003 (updated 5.29.15)*

INTRODUCTORY PROTOCAL
Thank you for agreeing to participate.

To facilitate our note-taking, I would like to audio record our conversations today. Please sign the release form <or, if conducted via SKYPE/phone: You should have signed a release form which we have with us today.>

For your information, only researchers on the project will be privy to the recorded interviews, which will be eventually destroyed after they are transcribed.

In addition, you must sign a form devised to meet our human subject requirements. Essentially, this document states that: (1) all information will be held confidential, (2) your participation is voluntary and you may stop at any time if you feel uncomfortable, and (3) we do not intend to inflict any harm.

This interview should last no longer than 60—90 minutes. Because there are several questions to cover, if time begins to run short, it may be necessary to interrupt you and request an extension of our time or to push ahead and complete this line of questioning. Thank you in advance for your patience and assistance.

INTRODUCTION TO STUDY
You have been selected to be interviewed today because you have been identified as someone who could provide insight into how academic career messages for African American women tenured or tenure-track within academic engineering careers. This research study focuses on how your experiences within engineering contribute to the academic career messages that you receive.

In particular, this study aims to understand how these messages attribute to your sense of belonging and mattering within academic career trajectories in engineering.
The ultimate goal is to provide a better understanding of the forces influencing educational policy and initiatives for African American women in engineering to increase retention, recruitment and programming at different levels of the institution, as administrators and other faculty members attempt to actualize organizational goals while still satisfying the needs of the students and the global engineering community.

This study does not aim to evaluate your work; rather, the goal is to better understand the challenges encountered by you in engineering as an African American woman within academia so that those challenges can be addressed and the strengths of African American women can be better actualized to illuminate the importance of representation within the field.

[1] *Adapted from sample interview protocol from Stanford University, National Center for Postsecondary Improvement, 2003 (updated 5.29.15)*

Appendix 4: Interview Questions

Interview Questions

Background:

1) Tell me about your journey into the field of engineering?
2) How did you decide to stay in academia as opposed to a career in public or private engineering?
3) What did your path look like after earning your doctorate and becoming a tenure-track faculty?

Tenure and Promotion Process

4) What factors influenced your decision to work at this institution?
5) What is/was your journey like as a tenure-track faculty?
6) Can you tell me about other faculty members in your department who have gone through the tenure and promotion process?

Institutional Goal-Setting and Department Acclimation

7) What are some of the committees you are on?
8) Have you ever worked on a search committee for recruitment for new faculty?
9) Can you explain a typical work week?

Global Engineering Community Interactions

10) Can you share your experience working with students?
11) Do you attend engineering conferences?
12) Can you share with me some of your experiencing publishing your research?
13) Do you know other African American women in engineering?

Sense of Belonging and Mattering

14) Have you ever considered leaving your institution or engineering?
15) What strategies have you used or learned to continue to progress in this field and within your academic career trajectory?
16) What can institutions do to increase or support recruitment, retention, and promotion of African American women in engineering?
17) Is there anything you would like to share that has not been covered in this interview?