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Institutional Effectiveness on Student Retention and Diversification for African American Female Engineering Students at Higher Educational Institutions

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Certification of Authorship

I certify that I am the sole author of this dissertation. Any assistance received in the preparation of this dissertation has been acknowledged and disclosed within it. Any sourcesutilized, including the use of data, ideas and words, those quoted directly or paraphrased, have been cited. I certify that I have prepared this dissertation according program guidelines, as directed.

Author Signature ______________________ Date MAY 04, 2022

Abstract

This quantitative research study examined higher educational institutions, specifically, Land Grant, Carnegie classification of 'Very high research activity', and Predominantly White Institutions in the United States. Furthermore, the evaluation analyzed HEI effectiveness in engineering programs to retain and graduate African American female students. Mainly, the research looked at retention, attainment, diversity, academic support systems, assessment, and initiatives as units of measurements to analyze the various types of support mechanisms at these institutions. The goal was to determine if these units of measurement are the necessary resources that HEI require to successfully assist, engage, and strengthen the educational attainment of African American female engineering students. An electronic survey was developed, distributed, and collected through Qualtrics. There were four surveys for four participant groups with a total sampling of 713 participants, which yielded 105 responses with a response rate of 18.5 percent. The findings for this research study resulted in non-statistically significance for all three research questions which was based on the requirement of statistically significance for all four participant groups. Although the data evidence did not yield statistically significance outcome, the review of the literature indicated that more research is needed to analyze and discuss diversification in engineering programs in higher education as a necessary component to sustain the U.S. globally within the science, technology, engineering, and mathematic disciplines.

Keywords: engineering, recruitment, retention, diversity, institutional transformation

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Dedication

I dedicate this dissertation to my wonderful family for believing and encouraging me to embark on this educational journey. I am blessed to have a family who endured this journey with me through patience, encouragement, and sacrifice. First, to my two beautiful, smart, and wonderful nieces, Kira Lee, and Nia Horton. Their aspirations to be a doctor and an engineer inspired me to explore challenges in science, technology, engineering, and mathematics (STEM) disciplines for African American females. Additionally, I want to recognize the latest addition to our family, my baby niece Mikah Stewart. Even though you were not present through this journey, you are also a part of the reasoning for me to embark on this path. Next, to my two sisters, Kori Parker, and Toi Dix, for allowing me to be your “role model” which encourages my persistence to prevail despite obstacles. Finally, to my best friend and mother, Carol Parker, who instilled in me at an early age to pursue my endeavors and interests. She is the “rock and glue” that formed our strong family values. My goal for choosing this educational direction is centered on increasing awareness of the issues, and to present alternative measures that Higher Educational Institutions can utilize to improve the retention and attainment rate of African American females in STEM disciplines.

Thank you, family, for building a version of me that has led to my highest educational attainment!

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Chapter I

Introduction

Imagine a girl of color, an African American girl born into a family with limited financial resources and living in an underserved community. The only available schools in her surrounding areas substantially lack tenured teachers, books, and after-school programs. What would her outlook on life be? Would she have a realization that vast life arenas are awaiting her calling? Now try to envision how she would navigate her life course. This scenario continuously presents itself in the lives of African American females in the United States (U.S.). They encounter race, gender, and class-based institutional and systemic obstacles from the day they are born. These obstacles are silent constraints built into social and institutional structures. The silent constraints are revealed through the individuals' education, career choices, politics, and economic growth (Nussbaum, 2011).

Imagine women in Science, Technology, Engineering, and Mathematics (STEM), such as Madame C.J. Walker (Inventor) and Jewel Plummer Cobb (Biologist). They advanced technology and science through hair product inventions and cancer research. Their work was vital for future advancements in STEM fields (Kennon, 2018; Kunjufu, 2014; Webster, 1999). These women and others discussed by Kennon (2018); Kunjufu (2014); Webster (1999) established the importance of women in STEM fields today. Webster (1999) further provided the significance of the role of Black females by sharing information regarding their contributions to STEM fields.

In the U.S., males have dominated the engineering field in higher education and the workforce. The National Science Foundation (NSF) (2017) documented statistics of this disparity within four-year institutions of undergraduate engineering disciplines for bachelor's degrees broken down by race and gender. In 2015, among Black college graduates who earned engineering degrees, Black females obtained 25.3 percent, while Black males obtained 74.7 percent. In comparison, White students earning their engineering degrees indicated that White females obtained 18.5 percent and White males earned 81.5 percent. For females in the engineering field in the U.S., these percentages represented the disparity in degree attainment, prompting a closer evaluation of higher educational institutions (HEI).

Beasley and Fischer (2012) offered Black women obtain their degrees in higher education at a higher rate than Black men, yet they are trailing in STEM degree attainment. Although Black men are members of the marginalized group, Black women encounter stereotype threats on two levels: race and gender. This threat is known as intersectionality, a threat level relative to race and gender, creating a different effect for Black women in their educational choice of engineering. Kunjufu (2014) added that women, especially minority women, are underrepresented in STEM career fields more than in any other discipline. He claimed Black girls must be introduced to STEM fields for clarity in aspiring to be a doctor, scientist, or engineer. Kunjufu (2014) further related that engineering is crucial to research and development in the U.S.; it requires a diverse body of workers to bring creative and innovative ideas to the marketplace.

This analysis will look at support services and engineering programs at HEI for African American female engineering students. The exploration will encompass how these institutions can better support the African American female engineering student’s degree completion to provide a more inviting learning environment with resource tools to assist their educational journey. Resource tools include academic support services and program initiatives aimed at retention, attainment, diversity, and cultural inclusion.

Background and Context (Historical Overview)

The abolishment of slavery became official in 1865 with the signing of the 13th amendment. The horrific institution of slavery, born out of restrictive measures, has left a lingering negative effect on African American people in the U.S. The adverse effects for this group present inequality in education, housing, economics, politics, and daily living. Even after abolishing slavery in 1865, the persistence of inequality continues today for African American people and women (Kennon, 2018; Marshall, 1987). The presence of inequality existed through measures, such as no provisions for educating Black people after abolishing slavery, Jim Crow laws, black codes, segregation, racial and educational discrimination, and the lack of educational resources in black communities. The presence of diminished instructional practices has created a deficit throughout the U.S. in learning for African American students, which carries into adulthood. African American adult learners often experience a culture of exclusion when attending a PWI. These exclusions, if not addressed, create inequities in their personal life, education, and the workforce. Kennon (2018) illustrates this point by discussing the inequality in opportunity for Black people – especially in STEM fields – that exists presently even after the legal abolishment of slavery.

Additionally, Lynn (2006) presented another compelling argument of the adversarial construct of educating African American people since slavery using the works of Ogbu (1982; 2003). The adversarial construct is a culmination of linking the critical race theory (CRT), and race and class stratification to discuss the impact of inequality in education for Black people. Lynn (2006) furthered the conversation by discussing a passage written by Carter G. Woodson that described education for African American people as being focused on training for manual labor and not to educate them:

> African people in the United States still have some prevailing misconceptions about their education and education in general. We were not brought to the United States or to the so-called New World to be educated. We were brought as part of a massive labor supply. Some slave owners saw fit to train their slaves in the repair of farm equipment and certain aspects of the blacksmith trade. What the slave masters permitted was training, not education. Africans in the United States were trained to serve. (p. 107)

The unfortunate reality of Woodson's passage and the ending of slavery over 150 years ago still represent the challenge of oppressing African American people in every aspect of their life, but more importantly in education, where all roads start at the path of gaining knowledge.

Slavery promoted institutions of racism that still exist in our moral, educational, and economic fibers. This culture of inequality created dysfunctional societies and sub-societies that lack resources and funding, poverty, sub-par education, unemployment, and crime-riddled environments (Watkins, 2001). Richardson's (2000) article discussed the residual effects of a biased system and individuals impacted by it. She stated that with racism, children are the byproducts of the repercussions of the decisions made by a biased system: "A child’s success in school is skewed by the relative position of their family of origin in the hierarchy of racially prescribed relations of domination and subordination" (Richardson, 2000, p. 301). Additionally, Harvard Philosopher John Rawls stated that:

> The very essence of a just society is that it is one where all human beings can obtain basic goods – including civil liberties and education – so that they can pursue these values and develop richly, in accord with their own aims and plans. (Waks, 2014, p. 9)

However, the concept of a just society for African American people in education is a fallacy stemming from the lack of a solid generational educational foundation. How can Black parents properly engage and encourage their children to learn mathematics and science if they lack the foundation for interacting with these complex educational concepts? History has revealed a hidden agenda of providing inequitable education for African American people that reproduces oppression/inequality. The presence of this hidden agenda extends from the abolishment of slavery to current day policies

The legal doctrine of separate but equal is an example of previous covert methods that became a part of constitutional law to continue discrimination against Black people. This doctrine allowed bypassing the Fourteenth amendment and the justification of not providing equal protection to Black people and confirmed by the 1896 Supreme Court ruling of Plessy v. Ferguson, 163 U.S. 537 (1896). The basis of this case continued the confirmation of state-sponsored segregation. With the assistance of the Black Codes, Jim Crow era, and the restriction of civil rights liberties for Black people, this mode of overt discrimination and segregation would continue until the Supreme Court overturned segregation laws starting with Brown v. Board of Education of Topeka, 347 U.S. 483 (1954). This law was a tremendous educational breakthrough for Black people, but unfortunately, even today, covert presentations are utilized to discriminate and segregate the races from education to capital advancement. For a while, the construct was altered to a covert process, but under the recent political climate of Trumpism there are laws and policies under blatant attack to rescind progress for BIPOC (Black, Indigenous, People of Color) American citizens. This current blatant attack is an update to the Jim Crow Law to rescind advancements in society for Black people disguised as a false narrative of election fraud.

According to the U.S. Department of Education (n.d.), Title IX, 34 C.F.R. § 106.1et seq., the U.S. Department of Education issued a regulation of Title IX of the Education Amendments requirements Act of 1972, 20 U.S.C. Â§1681 et seq. This regulation was an update to Title IX to cover education programs at institutions receiving federal funds. This update is an essential foundation of equality in education for many groups: women, minorities, individuals with disabilities, and sexual orientation. The updated Act is a legal resource for African American female students to address racial discrimination and inequities in engineering programs (U.S. Department of Education. Title IX and Sex Discrimination, 2021). Title IX of the Education Amendments Act of 1972 is a federal law that states:

> No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving Federal financial assistance. (p. 2)

Title IX Act strove to protect female students from gender and race discrimination to improve their opportunities in higher education. This Act is essential in addressing discrimination and inequities for African American female students in male-dominated disciplines such as engineering. According to Rolison (2003), another vital component of Title IX is to increase female faculty representation in STEM. Many HEI realized the importance of a diversified student population in STEM but have failed to apply this aspect to their faculty population (Rolison, 2003). Zare (2006) presented his perspective on the importance of applying Title IX to the STEM initiative. His perspective pertained to attaining gender equality in all aspects of STEM for students, faculty, programs, and the workforce.

In addition to Title IX policy, there are other relevant policies associated with this topic, case and statutory laws, precisely, the equal protection clause of the Fourteenth Amendment; Title VI of the Civil Rights Act of 1964 along with the remedy of Affirmative Action, 42 U.S.C. § 2000d et seq.; Grutter v. Bollinger, 539 U.S. 306 and Gratz v. Bollinger, 539 U.S. 244 (2003); Meredith v. Fair, 199 F. Supp. 754 (S.D. Miss. 1961); Regents of the University of California v.

Bakke, 438 U.S. 265 (1978); Pederson v. Louisiana State University, 201 F.3d 388 (2000); and Cannon v. the University of Chicago, 441 U.S. 677 (1979).

Despite these legal actions, there was still room for covert methods of inequity, especially for women. There has been an abundance of great Black people who were scientists and inventors to which some were well-known, such as George Washington Carver (Agricultural Chemist), while others like Alice H. Parker (Inventor) received no acclaim. Kennon (2018) presented information related to African American women who were doctors, astronauts, scientists, engineers, and inventors that received little to no recognition for their accomplishments. Webster's (1999) book created a timeline of the achievements of Black people in the U.S. in science and technology from 1706 to 1999. He categorized the book into eight essential sections: agriculture and everyday life, allied health, dentistry and nursing, life sciences, math and engineering, medicine, physical science, and transportation. Many Black women presented in Webster's book cannot all be named in this research but let us explore a few to establish the importance of Black women in STEM fields today. Additionally, Kennon (2018) and Kunjufu (2014) discussed some of these women and their role in STEM, such as Madame C.J. Walker (Inventor) and Jewel Plummer Cobb (Biologist).

In the agriculture and everyday life section of Webster's (1999) book, Madame C.J. Walker invented a pressing comb in 1904 and a scalp conditioner in 1905. In the life science section, Jewel Plummer Cobb, Ph.D. (Biologist), researched the effects of drugs on cancer cells, contributing to the development of chemotherapy treatment. Her publications consisted of 35 papers from 1981-1990 related to cancer research of melanin and melanoma. She also worked with programs to increase women and minorities in math and science disciplines. In the math and engineering section, Alice H. Parker (Inventor) invented a heating furnace in 1919 and received a patent for her work. The heating furnace regulated, and distributed heat using fuel and hot air ducts and connected to other independently controlled units such as a cold air box (Webster, 1999). Katherine Coleman G. Johnson (Electrical Engineer) “calculated interplanetary trajectories and orbits of spacecraft and satellites” at the National Aeronautical and Space Administration’s (NASA) Langley Research Center (Webster, 1999, p. 115). Additionally, she established methods to track human-crewed and crewless space missions at NASA. Mary J. Reynolds (Inventor) and Mae Jemison (Engineer/Physician/Astronaut) were essential in the transportation section. Reynolds invented a hoisting device to lift and move heavy loads from a truck to at least the second floor of buildings. In 1992, Jemison conducted experiments for motion sickness and weightlessness on NASA’s shuttle flight 'Endeavour.' In 1994, she assisted with the first International Space Camp. These women represent the successful capabilities of Black women in STEM fields and are a part of the rationale for diversification in the educational system and the workforce.

The history of STEM education has focused on reforming teaching and learning. However, through projects by researchers like Honey et al. (2014), the focus was centered on the challenges and benefits of integrated STEM education through the effect of data evidence. It also reviewed the evidence for the impact of integrated methods relative to factors such as increased student motivation, interest, awareness and achievement in STEM programs, improved college readiness, and increased percentages of students considering a career in STEM fields.

Integration within STEM disciplines explored bridging the divide in these fields by increasing the number of degree attainment for women. Despite efforts of integration, there is research highlighting inequities of experiences in K-12 classrooms, developing confidence in females before entering college in math and science subjects, and recruitment of women to enter

STEM disciplines. Even with these efforts, women are still underrepresented in STEM, especially engineering and computer science (Jacobs, 1996; Sax, 2008). Reports from the National Center for Education Statistics (NCES) showed minimal progress for the past twenty-five years for women obtaining bachelor's degrees in engineering (14% to 17%) and a decrease in obtaining bachelor's degrees in computer science (36% to 18%) (U.S. Department of Education, 2012).

Research expresses the necessity of diverse classrooms and work environments in establishing gender equity for STEM degree attainment. Diversity has the propensity to enrich the problem-solving skills of individuals and produces creative environments (Carnevale et al., 2011; Clark Blickenstaff, 2005). In support of diversity, Kanny et al. (2014) indicated that the lack of focusing on diversity has a potential negative output in the scientific field.

Statement of the Problem

Analyzing the support systems available within HEI is crucial in determining why African American female engineering students are not pursuing or persisting in engineering disciplines. Roy (2019) provided statistics for undergraduate enrollment within the U.S. in engineering programs by sex, enrollment status, ethnicity, race, and citizenship for 2018. He reported that 7,894 Black females enrolled in engineering while 70,527 White females enrolled in 2018. The total enrollment for all races and gender in engineering fields for 2018 was 622,502. These numbers represented a significant disparity between Black and White females, but even more alarming is the disparity in total enrollment in engineering between males (476,533) and females (145,969) for 2018. According to research conducted by Johnson (2011); Ong et al. (2011); Rice (2016), some African American females aspire to become engineers but face resistance in their pursuit of studies and careers in STEM. The resistance is related to the macrosystem (external environment) and microsystem (internal environment) factors. These two factors will be discussed further in the conceptual framework section.

In the scholarship related to STEM and engineering, underrepresented groups are categorized together when examining the issue of persistence (Beasley & Fischer, 2012; Hurtado et al., 2010). In these studies, an aggregated approach supports the generalization that all minority group experiences are the same in STEM. While some of the experiences are similar, their issues need to be addressed separately by group and discipline. Each STEM field has a distinctive organization of practices, systems, and methods (Brown et al., 2005). Brown et al. (2005) made a compelling argument of examining groups separately to analyze the root problem of persistence within individual groups. Additionally, analyzing groups separately by race and gender in science and engineering provides a closer look at their experiences in the context of higher education.

Tate and Linn (2005) indicated that there must be a study of the intersection of race and gender to grasp the complete picture of the attrition for female engineering students. They argued that this aspect is crucial because the identity framework for non-minority females could be different for minority females. Additionally, these authors discussed the *double bind*, which indicates the challenges of the intersectionality of race and gender in the STEM field (Tate & Linn, 2005). In addition to analyzing groups separately by race and gender and within just one discipline, engineering, it also became apparent that the body of research related to improvement measures for PWI's to address the inequities in STEM or engineering is scarce. There is insubstantial literature to describe the necessary process to transform and sustain the improvement measures of systemic institutional change in STEM disciplines (Elrod & Kezar, 2017; Hrabowski, 2011; Tsui, 2007).

Purpose and Research Questions of the Study

The purpose of this quantitative study is to analyze the initiatives at HEI geared toward increasing diversity and retention in engineering programs for African American females. Based on the review of the scholarly literature on the experiences of African American females pursuing studies in engineering, the various challenges for these students were documented, particularly in the context of PWIs and the impact the challenges present on degree attainment for African American females.

It also aims to understand how educational institutions can provide a supportive learning environment for African American female students in engineering programs. The conceptual framework for this research paper has been augmented in design by synthesizing existing literature that discusses the adversities and barriers that prevent or hinder the progression of African American females in their engineering studies. The aim will be to provide alternative constructs for educational institutions to enhance their culture to provide a diverse, supportive learning environment for African American female students in engineering programs. This research will look closely at how the absence of robust networks in engineering programs affects the degree attainment for African American female engineering students at HEI, specifically PWIs. The field of engineering in the U.S. lacks diversity in race and gender. To continue being competitive globally, educational institutions must address the barriers and inequities in the educational arena that block women and particularly Black women, from the successful pursuit of studies and professional careers in science fields, like engineering (Lichtenstein et al., 2014; Ong et al., 2011).

The analysis examined the relationship between six variables (retention, diversity, recruitment, initiatives, academic support services, and attainment) to determine if there is a direct correlation between the students' graduation rate and the type of academic support services provided at HEI. The objective determined if universities with assessment measures to analyze their academic support services, program initiatives, and student progress have a higher graduation rate and retention rate for African American female engineering students attending their institution. Finally, this quantitative study sought to provide recommendations for reforms that HEI can undertake to diversify disciplinary and professional tracks. Reform at HEI is a necessary aspect as technological advancements have accelerated globally, requiring institutions in the U.S. to re-examine the challenges of producing and sustaining a more diverse workforce in engineering.

The scholarship related to African American female undergraduate engineering students presented an understanding of these women's experiences in engineering programs at PWIs. After carefully exploring scholarly articles and journals about engineering programs at PWIs for African American female students, the research questions were formulated to guide and ground this research. There were three research questions which are as follows:

- Main research question guiding the proposed study: Does the presence of support resources/academic initiatives increase the attainment rate for African American female engineering students within the HEI accrediting regions?
- The sub-questions to the main research question will explore academic support services at HEI: Is the student attainment rate for African American female engineering students associated with the level of diversity for HEI administrators and the faculty roles?
- And the last sub-question: Are there assessment indicators at HEI that progress the academic attainment rate for African American female engineering students?

Significance of the Study

The significance of this analysis is to provide a historical context of learning inequity for African American students. This purpose of the analysis explained the necessity of HEI to evaluate their current initiatives to support the attainment of African American female engineering students. This study will contribute to the body of scholarly research by providing an overview of the necessity to support African American female engineering students and offer reform initiatives to transform the culture of engineering programs. Information regarding the best practice model of reform implemented over 25 years ago at the University of Maryland, Baltimore County (UMBC), serves as a model for institutional transformation in engineering programs.

Based on the recommendations provided by scholars to analyze Black females in the engineering field as opposed to a combined analysis of all STEM fields, this researcher was able to narrow the focus to examine the support mechanisms at HEI. In this examination, the criteria to select HEI were based on the following: Carnegie classification of "Very high research activity," Land Grant institution or Predominantly White Institution, and having African American females in their engineering programs. This comprehensive analysis probed the support structure of HEI for suggestions of transformational change to determine if there are issues of inequity and access in the engineering programs. The best-case model, UMBC, laid the practical foundation of measurement in support services and institutional change for HEI in this study.

This research aimed to enlighten administrators at all HEI within the U.S. that African American female students might require additional guidance to assist them with their degree completion in engineering programs. The criteria indicated how many African American women have benefited from the policy and whether there was an increased college graduation rate for these students. The future outcome focuses on diversity in programs at universities and in the workforce. Additionally, a recommendation of change to the academic support services at HEI to provide specific support for African American women in their educational pursuit in engineering. There are several benefits of providing support for these students: an increase in employment and school enrollment, an inclusive learning environment, increased degree attainment, and culture changes to reduce stereotypes related to gender and race. Additionally, measures such as providing diversity training for faculty and students; an assessment system to evaluate support services; re-allocation of support services staff or hiring additional staff; and establish assessment methods to benefit these students. These measures are crucial in advancing the degree attainment for African American female engineering students.

There must be an awareness of incorporating specific academic services such as living-learning communities and assessments to provide recommendations that include or change the type of academic support services at HEI. The assessment would monitor the effectiveness of the program but, more importantly, identify students who would benefit from its use, and finally, outreach to get these students involved in the services. The involvement would aid and guide successful retention and graduation rates. One emerging aspect of academic support services is living-learning communities, which provide an inclusive learning culture while promoting social relationships between students and the academic environment, such as faculty, administration, and mentors.

In examining prior studies related to this research, attrition and persistence are the causalities of Black female students' attrition and persistence in engineering degree attainment. Availability and presence of support systems contribute to attrition and persistence for these students (Lichtenstein et al., 2014; Perna et al., 2009; Perna et al., 2010; Rice, 2016; Tate & Linn, 2005). This quantitative research project will exam 94 HEI within the U.S. to explore their recruitment and retention initiatives, policies of diversity and inclusion, and academic support services.

Definition of Terms and Concepts

The following definitions or classifications will be used in the study to help provide clarification of the used terminology:

STEM stands for science, technology, engineering, and mathematics fields encompassing subsets of these disciplines. Excluded STEM fields are psychology and social science due to state and federal legislative actions of STEM access and education (Chen & Weko, 2009; as cited by Johnson, 2011).

Predominantly White Institutions (PWIs) are higher education institutions (HEI), with at least 50% of their student populace identified as Caucasian or white.

The term African American females will be used synonymously with women of color and Black females.

The term institutional transformation will be used synonymously with change initiatives, organizational change, reform, and transformation.

Stereotype threat is "the threat of being viewed through the lens of a negative stereotype, or the fear of doing something that would inadvertently confirm that stereotype" (Steele, 1999, p. 46).

The *double bind* is defined as women of color scientists experiencing oppression and discrimination based on their race or ethnicity and gender, resulting in them being the least recognized and valued, and the most invisible and marginalized, among underrepresented groups in STEM (Malcolm et al., 1976).

Researchers Perspective/Paradigm Orientation

For this quantitative examination, an objective epistemology assisted in looking at the evidence through an impartial inquiry. Science and disciplines require paradigms to provide a road map for researchers related to laws, theories, and generalizations to support a project or experiment. Paradigms are theoretical and philosophical frameworks of assumptions regarding epistemology, ontology, methodology, and values (Denzin & Lincoln, 1994). These paradigms provide the reality of constructs that shifts the foundation of the world.

This research approach was grounded by a post-positivist paradigm, which is also known as the 'scientific method,' empirical science, or quantitative research. It derived as an amendment to positivism not to reject the scientific method but as a reform. The aim is to ensure that researchers use characteristics critical to examining the social entity through a valueless lens. These attributes include broader rather than centralized research, allowing its utilization in a vast arena and co-mingled theory and practice. It also involves essential researcher motivation, commitment and eliminates the idea that research is concerned only with proper data collection and categorization techniques. This paradigm allowed the researcher to rigorously examine the quantitative data to provide validity, objectivity, and generalized findings (Crotty, 1998).

Chapter I Summary

Chapter one provided the importance of research and its significance to this body of literature. It discussed the background of the problem and a historical overview of STEM issues for African American women, and the complexity of slavery relative to education. This historical overview and background are related to the statement of the problem (African American female engineering students not pursuing or persisting) and the purpose of the study (analyzing diversity and retention in engineering programs at HEI).

Organization of the Chapters

The organization of this study includes five chapters: Chapter One introduces the study by providing a historical overview and background, problem statement, research questions, purpose of the study, the significance of the study, definition of key terms, and researcher's perspective; Chapter Two describes the conceptual framework and the literature applicable to the study; Chapter Three includes the research methodology used in this study by re-stating the research questions and hypotheses, discussing the design of the study to include the target population, sampling selection, variables of the study, reliability and validity, and procedures utilized relative to participant selection, data analysis method, instruments, surveys, and secondary analysis; Chapter Four will provide a discussion of the findings of the data in this study. It will also summarize the data in a statistical format related to the research questions and hypotheses. Chapter Five will summarize the research findings and recommendations for future research and implications for HEI.

Chapter II

Literature Review

The literature in this examination narrowed the research approach to reveal four themes applicable to the culture of the campus/engineering programs at PWIs, recruitment initiatives, retention initiatives, and policies of diversity and inclusion. These themes derived from the recurring factors that the authors discussed relative to institutional factors leading to the lack of persistence and attainment for African American female engineering students at PWIs. Collectively, these recurring themes provided the basis of the foundation that will assist African American females in their journey of becoming an engineer. Additionally, this research will address a gap in the literature relative to assessment methods within the higher education environment and recommend a transformative process to change its culture and initiatives. The assumption is that this research will link the lack of support initiatives for students to their low attainment rate. Therefore, implementing support initiatives foster a cohesive learning environment conducive to the educational success for all learners.

Methods of Searching

The peer-reviewed articles utilized in this examination were identified through searches in the DePaul library (EBSCOhost) and Google Scholar. The search queries included the following: persistence of African American female engineering students, Black females in engineering, retention of Black females in engineering, diversity initiatives at PWIs, organizational change in higher education, and institutional transformation.

The search method for this study changed as the synthesis of the articles evolved to make the scope of the analysis HEI that are PWIs and/or have a Carnegie classification of 'Very high research activity'. The existing scholarly literature primarily focuses on deficits of African

American female engineering students and the adaptation required of them to be successful in their engineering degree attainment. The literature also primarily emphasized the adversity and barriers at PWIs for these females, and how they must build resilience to persist in their degree attainment. From this outcome, it became apparent that this research required a different approach to analyze what processes and measures are required of the institutions to assist these students in achieving their degree attainment.

The organization of the study's content used a logical flow to describe the culture of engineering programs at PWIs. The next step discussed the recruitment and retention programs/initiatives utilized at these institutions to attract and sustain African American female engineering student's degree completion. This was followed by policies of diversity and inclusion relative to producing a diverse student and faculty body, and the last important concept discusses models of institutional transformation at HEI.

Conceptual Framework for the Study

Informing this study is the theoretical underpinnings constructed from various scholarly works that formed the methodological basis of the adversities and barriers that African American female engineering students encounter at PWIs. Synthesizing the existing concepts was a necessary aspect to develop a conceptual framework showing the relationship of the ideas, shedding light on unanswered assumptions that plague female and minority students, and providing a perspective of the resilience mechanism of these females. This theoretical framework provides the intersectionality of gender and racial diversity issues in engineering programs at PWIs.

Historically, engineering has been a competitive male field that has presented challenges for not only African American students, but other minority students and women in degree attainment. The conceptual framework for this analysis will draw upon existing theories when combined paints a broad depiction of the challenges and barriers African American female engineering students encounter at PWIs. This conceptual framework synthesized a system-level approach identified as the microsystem (internal environment) and the macrosystem (external environment). Additionally, it looked at the stereotype threat, domain identification, Wise's schooling intervention, social cognitive theory, sociocultural barriers, *double bind*, critical race theory (CRT), social transformation, and the theory of cultural capital. The last two theories, Pierre Bourdieu's Theory of Cultural Capital (1986) and social transformation provided the connecting lens of inequity and power structures in education and the context of institutional transformation.

Starting this synthesis is Rice's (2016) qualitative study which incorporated the life history theoretical framework for analyzing nine Black female participants' experiences working in the engineering field. An ecological model provided insight into the complex interplay between individuals, groups, communities, and the societal factors that shape relationships. This model also assisted in grounding the examination. In her research, two significant findings were identified that a supportive environment is essential to the educational journey of Black females in engineering. She categorized these findings on a system-level approach that were identified as the microsystem (internal environment) and the macrosystem (external environment). The microsystem includes 1) determination & persistence, 2) racial identity, 3) racial micro-aggression, and 4) negative stereotypes. The macrosystem is related to 1) academic support resources, 2) early warning detection systems, 3) supportive & cooperative peer culture, 4) information sharing of students by faculty, and 5) supportive & encouraging faculty (Rice, 2016; Rice & Alfred, 2014).

Other studies revealed similar findings but identified the issues on the sub-system level such as determination, persistence, negative stereotypes, lack of faculty support, academic preparation, financial, family assistance, and exclusion (Johnson, 2011; Lichtenstein et al., 2014; Ong et al., 2011; Perna et al., 2009; Perna et al., 2010; Riegle-Crumb & King, 2010). Rice's study (2016) is an essential piece of literature that combines all the issues in the STEM pipeline for African American female engineering students. Furthermore, it contributed to the research by examining the personal and structural elements that affect African American females' educational quest in engineering and into the workforce. The grouping of this information is an essential aspect for researchers examining issues plaguing African American females in engineering, but also provides a framework that identifies the interconnectivity of the issues preventing success.

Rice (2016) looked at support systems and challenges for African American female engineers through a holistic approach. For African American female engineering students, the microsystem and its sub-systems offered the struggles of the individual support levels that present challenges of succession (Rice, 2016). This system is vital because it maintains individuals' beliefs, self-image, determination, perseverance, and adjustments to the college rigor. Rice's study (2016) found that participants had difficulties adjusting to the rigorous demands of their advanced engineering studies. They had to recognize the need for support from their external environment (macrosystem) to persevere through challenges with unsupportive instructors, lack of women and minority students in the program, and feelings of exclusion within their peer environment. Through the articles of Johnson (2011); Perna et al. (2009); Rice (2016), the macrosystem is a personal and structural element of support that assists Black females in their engineering studies and careers. This system-level approach involves support from the family unit, K-12, college units, college experiences, and professional experience.

The last three elements include teachers and counselors, pre-college programs, university resources, minority networks, mentors, and managerial support. Within the educational arena, the absence of a robust macrosystem presents academic challenges of attainment for Black females within engineering fields (Lichtenstein et al., 2014; Winkle-Wagner, 2009 as cited by Leach & Chavous, 2018). Again, these authors contributed to the body of scholarship that discuss specific issues plaguing African American female students. The specific issues focused on the availability of financial aid, family support, mentors, classroom structures, bias and discrimination, and insufficient student advising.

Johnson (2011) also discussed the need for institutions to provide support services for their students. Support services would include resources focused on assisting women of color in their degree attainment. She identified these resources as student organizations, peer groups, learning communities, tutoring, mentoring from alumni-faculty-upper-level students, and undergraduate research programs. These resources assist African American female engineering students to overcome the barriers they encounter while attending PWIs. The barriers implicated inadequate academic preparation – elementary & secondary levels, availability of faculty, lack of African American or female faculty, size of classes, faculty tenure, and sociocultural barriers. HEI is the final connection between elementary learning and entry into the workforce. Thus, their function prepares and assists students with the knowledge and skills for post-graduate studies and to diversify the workforce. Therefore, these institutions must consider and address barriers that cause their students to fall short of their intended mission (Johnson, 2011). Additionally, the various sub-systems of the microsystem and macrosystem represent the interconnected avenues of barriers that Black females incur while pursuing their engineering career path.

According to Steele (1997), there are negative stereotypes that act as barriers to educational achievement for African American and female students. He argued that there are still stereotype threats in the air, even for academically prepared students in mathematics, with lingering effects on student achievement. These threats in the air are social stereotypes that can affect the academic performance and achievement of African American females. Social stereotypes pertain to the perception of these females related to gender roles, low expectations of them by male faculty members, and racial discrimination. The negative stereotypes identified by Steele (1997) illuminates the connectivity to the ideologies presented by Johnson (2011), and the importance of these works in collaborating solutions to these barriers.

Drawing on Pierre Bourdieu's cultural capital theory, he emphasized how the Social Economic Status (SES) of families, along with their intellectual class, maintains their societal privileges for their future generations (Jaeger & Karlson, 2018). Bourdieu indicated that the family position dictates opportunities of access for their children. Thus, societal privileges are demonstrated in children born into families of wealth who have an advantage in education, wealth building, and social networking. Jaeger and Karlson (2018) furthered the conversation indicating that the lens of cultural capital could increase equality for individuals or establish inequality. Cultural capital represents the assets that individuals acquire in a society including their acquired competencies and if misrepresented in the individual's life, it could result in symbolic violence. Thus, Bourdieu's theory is the undergirding of this study's conceptual framework and combined with the other theories in this section, provided essential aspects regarding social-economic class, educational attainment, and the societal stance for underrepresented individuals. Mainly, the class structure of a child's family plays a role of inequality for them in society that establishes their cultural capital in life, but more importantly, in education.

Bourdieu's work is grounded in cultures that are embedded with social stratification. He discussed certain cultures' influence social stratification for marginalized groups by examining how cultures are established and changed in its existence of power. Also, his contribution to the relationship between various types of capital – cultural, symbolic, economic, and social is essential in examining cultures (Bourdieu, 1986). Again, this study focused on Bourdieu's theory of cultural capital as it relates to institutions. Institutionalized form of cultural capital denotes the academic achievement of an individual tied to their cultural competence. Thus, an individuals' race, gender, and class indicate an inequality of access to resources at institutions based on their cultural competence (Bourdieu, 1986). Mobility for these individuals is linked to social inequality. Bourdieu's work discussed that having cultural capital and mobility is obtained through one's family generational position. This position creates opportunities for access and advantageous in academic achievement. For students, whose families lack cultural capital, there is a definitive link to a lack of status and power in society.

It is crucial to understand and analyze the academic achievement gap that exists between racial groups to provide an understanding of the inequity issues. Analyzing this concept will provide a contextual understanding as to the significance of addressing issues that still hinder the successful educational journey of African American female engineering students at PWIs. McGee and Martin (2011); Perna et al. (2009) indicated in their studies that there is an abundance of research relating to the impact of racial stereotypes on academic achievement. The theoretical framework discussed is known as the stereotype threat theory, which is "the threat of being viewed through the lens of a negative stereotype, or the fear of doing something that would inadvertently confirm that stereotype" (Steele, 1999, p. 46). This theory, established in 1995 by Claude Steele and Joshua Aronson, explored the learning inequities that stem from gender and racial gaps. It also provided a baseline in education regarding the gaps in academic performance for these marginalized groups.

Another theory discussed by Steele (1997) is the general theory of domain identification, as it relates to the connection between identity and education for women and African Americans relating to achievement barriers in education. The theory presented that these groups have been negatively stereotyped in education and become frustrated with schooling. It further related that the assumption of success in education requires students to feel a sense of achievement in school. Thus, the educational achievement for the individual could diminish. Steele (1997) offered another theory related to practice and policy known as Wise's schooling intervention. The theory premise is to research the negative path of academic accomplishment to either reverse or reduce the effects of the stereotype threat encountered by these students. Wise's schooling intervention included strategies to change negative educational situations or environments by offering resources and encouraging respectful interactions. Additionally, Wise's schooling intervention developed the capacity and skills of the students to address negative challenges.

According to McGee and Martin (2011); Trenor et al. (2008), the social cognitive theory provided a theoretical framework that analyzed the impediments (feelings of exclusion, low teacher expectations, lack of academic support) that affect Black female engineering students. The social cognitive theory (SCT) was first introduced by Albert Bandura in the 1960s and was initially called the social learning theory. SCT described the continuum observation of behaviors by an individual related to personal and environmental factors. The individual replicated learned behavior through observation, modeling, and imitating. There are four components of SCT - self-efficacy, self-reaction, self-observation, and self-evaluation which are interconnected to goal attainment and motivation (Bandura, 2001).

Trenor et al. (2008) presented an alternative finding of racial and gender stereotypes in their research. They utilized a mixed-method research approach and Bandura's SCT to analyze perceived barriers in engineering programs for female engineering students at the University of Houston in the Cullen College of Engineering. They concluded that data in their examination did not yield negative stereotypes for students of color but found the barriers varied among racial groups, educational level of parents, and preparation level in the K-12 grade level. At this university, student groups were diverse and inclusive, with no reported incidents of racism. They indicated that the university had established enough diverse support systems for all students to provide an environment of inclusion for all students. An essential aspect of their findings represented a complete portrayal of the social dynamics that place minorities at a disadvantage in education. Ultimately, this indicated their status in society is relevant to their perception and navigation of systems within their chosen HEI.

In the study presented by Wang et al. (2013), they indicated that prior researchers (Ceci et al., 2009; Eccles, 2009; Ferriman et al., 2009) provided an alternative explanation of the gender gap in STEM fields. Ceci et al. (2009) suggested that females are not interested in STEM fields due to other life choices and mathematical aptitude. Wang et al. (2013) findings indicated otherwise that math aptitude is not the decisive reason for the underrepresentation of females in STEM fields. These authors provided an alternate viewpoint from the previous authors/researchers' findings. This vital aspect indicated that racism is not necessarily explicit or perceived at the university level, but it is certainly implicit. Implicit racism connects to societal expectations while norms linger in the background and overarching power structures. These subtle norms still disadvantage African Americans and other minority groups in society, education, economics, and the workforce.

As Lynn (2006) discussed in his article, the gap in educational achievement between Black and White people in the U.S. has been carefully examined and documented by years of empirical study. The author also documented that Black people are deficient in learning based on their culture and genetics (Lynn, 2006). This concept suggested a context of continuing the oppression of Black people. An alternative suggestion would be to look at the historical aspect of oppression that Black people have endured. After analyzing this component, educational institutions must provide supportive measures to repair the damage, suffering, and inequities.

According to Tate and Linn (2005), they stated that Black females' identities affect their academic performance levels because they encounter negative stereotypes in their academic studies. Stereotypes enhanced the engineering program pressures for these students, and if it persists, the student could feel ostracized, leading to seclusion or separation. The authors went on to discuss how peer groups that Black females identify with aid in providing a coping mechanism for dealing with stereotypes. Bancroft et al. (2016) suggested examining the socio-cultural barriers that lead to a gender gap within the STEM field. The socio-cultural barriers included sexism, racism, and stereotype threat. They also suggested exploring the historical approach of racism in the U.S.

Johnson (2011) discussed women of color experiencing discrimination and oppression due to their gender and race in their pursuit of STEM fields. She stated that the *double bind* could be an invisible situation that continues subjugating women of color. According to Malcom et al. (1976), as cited by Johnson (2011), they introduced an ideology of *double bind* to describe underrepresented groups' marginalization in STEM. The evidence indicated that the *double bind* relates to the women's' account of experiencing racism and sexism within the academic environment of STEM fields (Johnson, 2011). According to Johnson (2011), the learning atmosphere for some undergraduate students included large lecture halls where instructor access is challenging due to the number of students competing for the instructor's attention. There are faculty members in the STEM field who discouraged women of color in their first year of the program to choose a different field of study. When these students had questions on difficult course material, they encountered negative responses from the faculty indicating the students' inability to navigate the coursework. This mindset left them with feelings of inadequacy and a lack of support.

Johnson (2011) further relayed that within this academic environment, there exists a feeling of exclusion, isolation, and not belonging amongst women of color. The culture of the STEM academic environment consisted of exclusion for these women due to avoidance when choosing whom to sit next to, a laboratory partner, informal study groups, and group assignments. An important rationale of this examination pertained to the exclusionary conversation of research and scholarship opportunities, and classroom assignments for African American female engineering students (Johnson, 2011).

The theoretical perspective of critical race theory (CRT) assisted with describing the challenges that African American female engineering students encounter at PWIs. The critical race theory framed the research for McGee and Martin (2011) to which they described CRT as "persistent racial inequities that persist in education, qualitative research methods, pedagogy and practice, the school experiences of marginalized students of color, and the efficacy of race-conscious education policy" (Ladson-Billings and Tate, 1995; Lynn and Parker, 2006, p. 257; as cited by McGee and Martin, 2011, p. 1352). Ladson-Billings and Tate (1995); Lynn and Parker (2006) discussed the narrative of CRT to offer an examination of the intersection of race, power, and law as it relates to society and cultures. CRT explained the racial climate of African American female engineering students' experience at PWIs (McGee & Martin, 2011).

In the article written by Ladson-Billing and Tate (1995), they discussed CRT as it relates to white privilege and inequity for Black people in society and schools. These authors indicated that racism in the U.S. is not isolated, unrelated incidents in education, because if it were, there would be equity and excellence within the U.S. public school institutions. These authors pointed to the works of Carter G. Woodson and W.E.B. Dubois, indicating how they use "race as a theoretical lens for assessing social inequity" (p. 50). CRT is used as a theoretical perspective to examine power structures in educational institutions that continue to marginalize women and minorities (Ladson-Billing & Tate, 1995).

Finally, the last theory provided an educational context that focuses on transformational change in higher education. The social transformation theory focuses on institutional improvement for minority students to increase representation, retention, and the attainment of minority students in higher education. The premise of the theory focused on enhancing the culture to obtain student attainment and addressing the broader transformative institutional change-process centered on inclusive excellence. The institutional change-process involved a sustained effort to transform organizational culture and behavior to enhance equity for minority students, including the development of an affirming campus climate. Vital strategic elements for implementation and sustainability included ensuring senior leadership support and accountability, developing an institutional vision, promoting buy-in, building capacities necessary for transformation, and leveraging resources. The proposed model of change used a long-term, highly successful diversity initiative involving students in science and engineering at the University of Maryland, Baltimore County (UMBC) (Maton et al., 2008).

As this researcher explored various theories looking for one that fits the scope of the study, it became apparent that a synthesis of numerous existing theories was the most appropriate solution. The connectivity of these theories painted a complete picture of the tribulations that African American female students encounter while pursuing their engineering degree at PWIs. This process also incorporated a theory related to institutional transformation. Together these theories and concepts informed the approach of this research and discussed the challenges for these students. Finally, the future outcome of this synthesis determined how well this process informed the findings of this study or if other measures are to be considered based on the findings of the data evidence.

Synthesis of the Literature Review

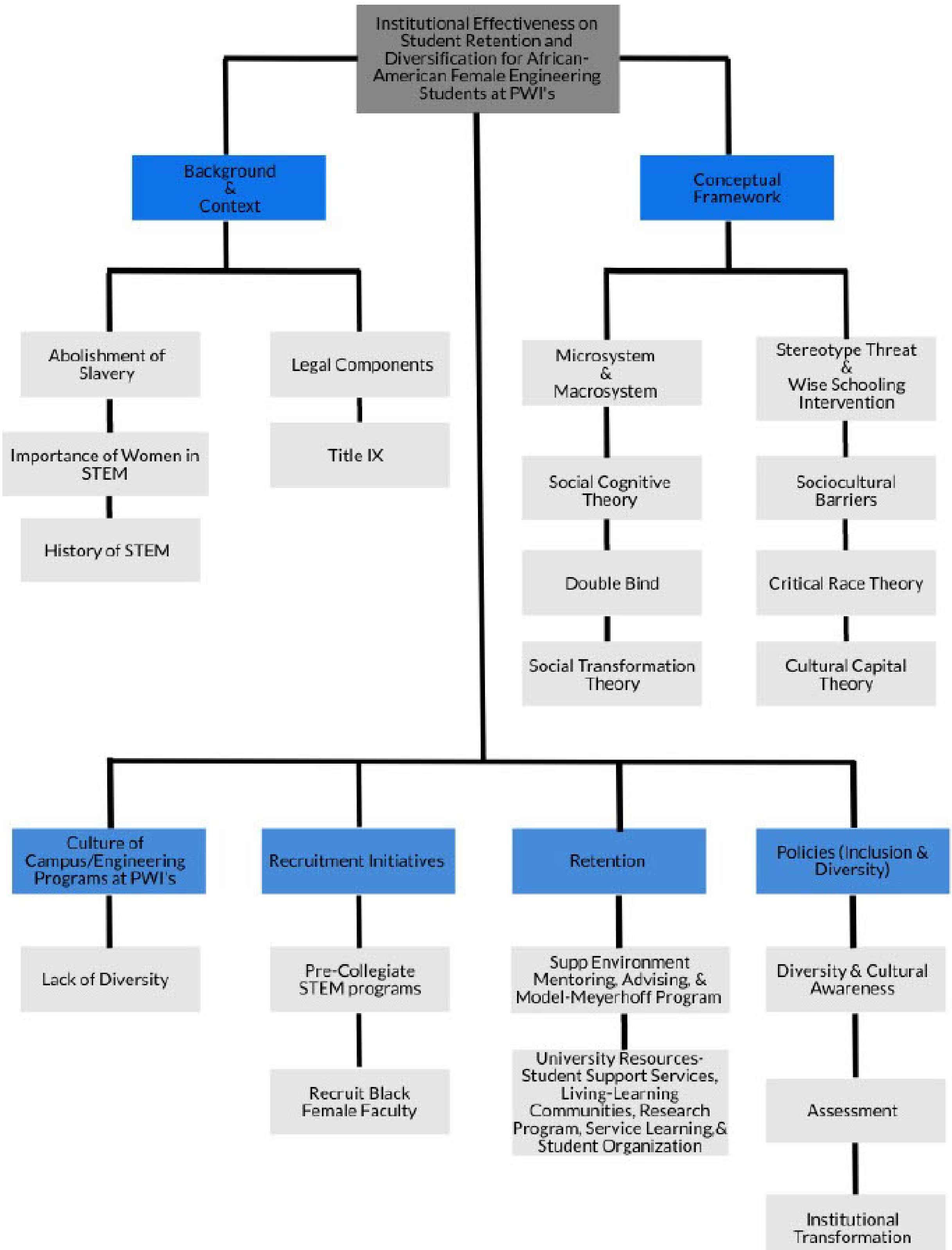
The scholarship relative to the challenges in STEM programs for African American females, not persisting in their higher educational pursuit in engineering, has been discussed as the causations plaguing African American female engineering students by authors, for instance Johnson, 2011; Leath and Chavous, 2018; Ong et al., 2011; Rice, 2016. The examination by Johnson (2011) looked at intersecting identities for women of color in STEM fields relative to their experiences of discrimination, oppression, sexism, and racism. Leath and Chavous (2018) discussed Black females' experiences at PWIs by comparing STEM and non-STEM majors. Ong et al. (2011) examined the *double bind* within STEM fields for women of color while addressing specific issues such as the STEM climate, peer and faculty relationships, family and community factors, and academic sense of self. Lastly, Rice (2016) examined the challenges and support systems for African American female engineers within the STEM pipeline by categorizing the challenges as microsystems and macrosystems.

It is crucial to indicate other works of literature discussing the issues in STEM and engineering educational environments, for example Hurtado et al. (2010); Palmer et al. (2011), but many of these authors categorize minorities together or all women of different racial groups. Leath and Chavous (2018) elaborated further on this issue by indicating that there is a gap in the literature in approaching a within-group examination for Black women in STEM. Addressing this gap is necessary based on the perceptions and experiences that this group encounters within STEM fields. Their encounters on campus and in the classroom differ from other female racial groups or other women of color relative to their interpersonal experiences with racial stigmas.

To further illustrate these issues, policymakers, researchers, and institutions such as the National Science Foundation (NSF) have documented challenges and the importance of diversity in STEM fields. STEM progress for the U.S. represents economic growth and global positioning in technology. The importance revolves around equality for women and minorities, increasing opportunities in technology, innovations, and positioning the U.S. globally for sustainability. Addressing inequality in STEM represents shifting the imbalance in education and the workforce towards a level of fairness for females and minorities (Kennon, 2018).

So, prior to diving into the literature, Figure 2.1 provides a conceptual map for the synthesis of this research literature review to establish the interconnectivity of concepts relative to STEM, specifically engineering programs, within the context of higher education. More importantly, this chapter documents the relationship between higher education engineering programs and its effects on the journey and degree completion for African American female engineering students.

Figure 2.1. Conceptual Model



Culture of the Campus/Engineering Programs at PWIs

Culture is an important aspect any organization and cannot be minimized. It is exceptionally important within engineering programs at HEI where authors in this review described the culture as male-dominance and exclusion. So, Kuh and Whitt (1988) definition of culture noted:

> Culture as persistent patterns of norms, values, practices, beliefs, and assumptions that shape the behavior of individuals and groups in a college or university and provide a frame of reference within which to interpret the meaning of events and actions on and off the campus. (p. 6)

Within the culture of STEM programs at PWIs, research has also shown this culture as a male-centered and competitive environment, lacking the necessity of validation or room for errors, and often leaving women with feelings of exclusion and not being a part of the conversation (Dortch & Patel, 2017). Johnson (2011) discussed the engineering program's culture as it identifies with race (white) and gender (male): "The culture of science is a meritocracy that is competitive, difficult, and intellectually superior to other academic and professional fields because of the required technical and scientific expertise" (p. 81).

This cultural identification within engineering programs is a narrow viewpoint that does not support the inclusion of a diverse field. The problem is not in words used to describe the culture but the application of this principle that the authors present an exclusive arena of isolation. Also, this type of culture conflicts with the cultural values of Black women as they identify with ethnicity, race, and cultural background, making it difficult for them to relate and navigate the ideology of this engineering culture (Dortch & Patel, 2017; Johnson, 2011). They further discussed the presence of exclusion and isolation along with the lack of faculty support at

PWIs, resulting in these women feeling unsupported in their engineering studies. Johnson (2011) related exclusions, if not addressed, created racial inequities in the workforce, education, and the personal life of these women. The learning atmosphere for undergraduate students includes large lecture halls where access to the instructor is challenging due to the number of students competing for the attention of the instructor. Dortch and Patel (2017); Johnson (2011) further related that discouragement to proceed within their studies has created a normalization in engineering programs.

Enhancing the conversation further, Leath and Chavous (2018) discussed race and gender stigmas related to harassment and disrespect from males that women of color in STEM encounter. They indicated this type of subjugation often leads to these students leaving the STEM fields. Researchers also found that the racial climates at PWIs often include isolation and exclusion experiences for Black students. These students also experienced micro-aggressions that are subtle discrimination and prejudice practices (Leath & Chavous, 2018).

In comparison, Perna et al. (2010) suggested that there are differences in degree attainment across the various racial groups. Their study examined the Spellman College culture, a historically black colleges and university (HBCU), to determine the school's culture and influences that promote degree attainment for African American females in the STEM fields. They utilized a qualitative methodology to acquire a more in-depth knowledge of the culture at this institution. The case study approach grounded the research by assisting in understanding the unique contextual conditions of the policies, practices, and educational attainment characteristics for Black female engineering students. Perna et al. (2010) discovered that the success of promoting degree attainment in engineering for Black female students connects to their institution's culture and exclusionary practice. For example, their research findings at Spelman

College indicated a supportive culture at this institution to assist Black females in their attainment in the STEM fields. This type of supportive environment provided the foundation for Black females to overcome barriers that prevent degree attainment. The institution addressed barriers encountered by these students pertaining to the culture of the engineering program, academics, financial, peer groups, ease of access to faculty, class size, and academic support programs (Perna et al., 2010).

Adding to the conversation, McGee and Martin (2011) discussed racial climates in engineering programs at PWIs and the lack of addressing intervention efforts for racial micro-aggressions. Racial micro-aggressions are a component of prejudice and discrimination that African American female engineering students encounter in their lives. These women often experience subtle and covert prejudice behavior and discrimination from faculty members and peers (Leath & Chavous, 2018). Leath and Chavous (2018); Solorzano et al. (2000) discussed micro-aggressions indicators as racial implications related to hostile behaviors, racial and derogative terminology, and unreceptive environments that single-out an individual or a group.

Diving further into the STEM climate, Johnson (2011) suggested that researchers examine the climate of STEM departments and classrooms to identify the presence of a racial atmosphere contributing to the attrition or persistence of women of color in the STEM field on the undergraduate, graduate, and faculty levels. Tate and Linn (2005) provided an alternative means of addressing identity for females by investigating unique experiences of identity conceptions between non-minority and minority females in the engineering program. Dissimilar experiences described the differences in experiences of White females and women of color in STEM fields. They also suggested that the intersection between race and gender exists as it relates to the identity of women of color persisting, achieving, and engaging their studies in the engineering field.

Hurtado et al. (2009) discussed the level of disparity in STEM disciplines at PWIs related to females switching out of STEM majors and not persisting in STEM. The social and learning environments at PWIs are essential in establishing persistence for students of color and women majoring in STEM fields. Winkle-Wagner and McCoy (2018) discussed the campus climate for students of color and women at PWIs in comparison to HBCUs. The campus environment and STEM programs at PWIs have an atmosphere of alienation and isolation for these students. They indicated that these students often experience an unwelcoming environment by faculty and peers, which reduces their determination to persist in STEM. Similarly, Acnes et al. (2000) conducted a research study of 578 undergraduate students at a large Mid-Atlantic PWI to examine diversity at the university. Their results indicated that the students' perception of the campus atmosphere varied amongst the ethnic groups. However, this study analyzed the perception of the ethnic groups and did not include the perception of women within the ethnic groups.

HEI climates, cultures, along with their degree programs, are an essential part of establishing a positive, inclusive environment for their African American female engineering students. The scholarship in this section offered insight into engineering programs culture at PWIs. Some of the literature indicated the presence of explicit bias, while others indicate the implication of stereotype that the engineering discipline has historically been a white male-dominated field of study ('engineering is for white males') at PWIs (Rice, 2016). The next sub-section relates to the necessity of diversity in engineering programs and will be discussed as it relates to the culture, barriers, intervention strategies, and the lack of female and women of color faculty.

Lack of Diversity

Diversity in engineering programs is a problem that researchers, policymakers, and HEI are attempting to address. However, the solution to addressing this issue is complex. It requires a series of intervention strategies that include cultural changes. Winkle-Wagner and McCoy (2018) notated that diversity at HEI and its programs provide one component of success for STEM students of color at PWIs. Diversity assists in yielding inclusive and welcoming environments, which is essential in engineering programs. As indicated by other authors (Johnson, 2011; Ong et al., 2011), the culture of STEM programs often has an aura of exclusion for women and students of color. Alternatively, researchers have examined the positive, inclusive culture of HBCUs as a welcoming climate that provides support for women and students of color (Museus & Liverman, 2010; Perna et al., 2009; Perna et al., 2010).

The engineering field in the U.S. lacks diversity in race and gender. To continue being competitive globally, institutions must address the barriers and inequities in the educational arena (Chubin et al., 2005; Rice, 2016). Through the research of Hrabowski (2011), he offered different concepts for HEI to consider enhancing their culture and provide a diverse learning environment for all students, including Black females. The implementation of alternative constructs to address the inequity issues, not just in STEM programs, but the whole culture of the institution.

Zoltowski et al. (2017) offered another perspective of diversity and inclusion in engineering focused on examining the issues as they postulate the "interrelated with the epistemological (what do engineers need to know) and ontological (what does it mean to be an engineer) underpinnings of engineering" (p. 2). Their suggestion is to address complex issues through a comprehensive approach. Based on this aspect, these authors argued that improvements in engineering programs are slow because of their approach, which is to increase the number of underrepresented students and female faculty. Additionally, the transformational process is missing a comprehensive approach that incorporates inclusivity. So there mixed-method longitudinal research design focused on the lack of diversity and inclusion for the vulnerable population of students: low-income, underrepresented minorities, women, first-generation, and disabilities. The researchers applied a three-prong approach to examine the issues: "1) Better prepare engineers for today's workforce; 2) Broaden understandings of engineering practice as both social and technical; and 3) Create and sustain more diverse and inclusionary engineering programs" (p. 2). The approaches offered a foundation to address the issues of diversity and inclusion and a solution addressing more than a numbers issue. This study is the first part of a continuing study to examine diversity and inclusion, but through the data collection, the gathered information provided insight for the future transformation of engineering cultures and programs.

Another issue of diversity to consider is a lack of female faculty and women of color faculty members in engineering, which is apparent with the lack of these groups obtaining engineering degrees on the undergraduate level and the limitation of achieving doctoral degrees. Chubin et al. (2005) suggested that institutions utilize faculty recruitment and retention methods to diversify engineering programs. This aspect will be discussed further in the recruitment initiatives section.

From the literature, there is clarity that a collaborative environment provides institutional support for students, especially minority students and female faculty members. Also, identifying best practice models to establish a model tailored to guiding, assisting, and measuring the success of African American females in engineering programs. To help bridge the diversity gap in engineering, corporations that employ engineers should consider collaborating with educational institutions on all levels to improve and diversify their workforce. The next section addresses the importance of recruitment initiatives and provide relevant intervention strategies that some HEI are utilizing to diversify their institution.

Recruitment Initiatives

Recruitment initiatives for HEI are relevant to their inclusion, equity, and diversity policies in STEM programs. Recruitment is necessary for STEM based on the amount of mathematical and science courses required on the post-secondary level. These types of courses are not usually favorable to women and even less so for African American females with limited exposure to advanced mathematics such as calculus, physics, statistics, in addition to complex concepts such as probability and differential equations. There are components to recruitment that include pre-collegiate STEM programs and recruiting and retaining Black and female engineering faculty.

In Rice's (2016) qualitative study, she used a basic interpretive inquiry design utilizing the life history conceptual framework to examine the career experiences of these women related to recruitment and retention. The participants were nine African American females currently working in the engineering industry. The implications of the study indicated that support systems are crucial in the STEM pipeline, especially for women of color. However, the issues must be addressed on all levels beginning with K-12, higher education, and then into the workforce. There are challenges and barriers that women of color pursuing studies and careers in STEM fields experience at HEI.

Pre-Collegiate STEM Programs

There are pre-collegiate STEM programs developed and established to provide support for students desiring to pursue a STEM career. STEM coursework in higher education consists of complex science and mathematical equations requiring students to have extensive knowledge. Students who lack this knowledge cope with an unsupportive environment and often must decide whether to switch majors or leave school due to the financial burden of failing to persist in engineering (Beasley & Fischer, 2012). This led to the establishment of Federal TRIO programs which established support mechanisms to address inequity for underrepresented students. TRIO is not an acronym but refers to the creation of three programs – Upward Bound, Talent Search, and Student Support Services. Upward Bound was established first to address the problem of poverty and born out of the Economic Opportunity Act of 1964. The next student support services were created in 1965 which is the Talent Search grant-funded program that scouts low-income high school juniors to provide intervention strategies to assist them in attending college. Finally, the student support service developed in 1968 provides funds to HEI to increase the retention and graduation rates of students. By the late 1960s, the term "TRIO" was coined to describe these federal programs.

Over the years, the U.S. Department of Education expanded and improved the Federal TRIO Programs to address a need in student support services for minority students. Its goal was to reach as many students as possible and provide a broader range of services. The Higher Education Amendments of 1972 introduced the fourth program to the TRIO group – Educational Opportunity Centers. The Veterans Upward Bound program was next to provide veterans with academic assistance to include mentoring, tutoring, academic training in core classes in postsecondary education, counseling in academics, personal, and finance, and a slew of other support services to assist veterans in their academic preparation.

The U.S. Department of Education introduced another program:

> The 1976 Education Amendments authorized the Training Program for Federal TRIO Programs, initially known as the Training Program for Special Programs Staff and Leadership Personnel. Amendments in 1986 added the sixth program, the Ronald E. McNair Post Baccalaureate Achievement Program. Additionally, in 1990, the Department created the Upward Bound Math/Science program to address the need for specific instruction in the fields of math and science. (U.S. Department of Education, 2011)

The administering of regulations is the same for Upward Bound Math/Science and regular Upward Bound programs but applying for them requires separate applications. Finally, the Omnibus Consolidated Appropriations Act of 2001 amended the Student Support Services (SSS) program to permit the use of program funds for direct financial assistance (Grant Aid) for current SSS participants who are receiving Federal Pell Grants.

The McNair Scholars Program was created by the U.S. Department of Education (USDE) to assist and prepare underrepresented college students for admission toward graduate-level studies through participation in scholarly activities and research. This program provided additional preparation for students who possess strong academics and are underrepresented in their field of study. It also assisted students who have financial needs and are first-generation college students. McNair Scholars is one of eight federally funded TRIO programs provided by USDE at 151 educational institutions within the U.S. and Puerto Rico (U.S. Department of Education, 2012). Tinto (2004) also indicated that TRIO is an essential support services program which increases the number of underrepresented individuals receiving graduate degrees in STEM disciplines.

The Upward Bound program and GearUp were established by the U.S. Department of Education to assist and strengthen limited English proficient and underrepresented students' knowledge in math and science and to serve as an early intervention of support. The goal of Upward Bound is to assist these students with academic competence by providing services such as mentoring, tutoring, counseling, financial and economic literacy, and programs and activities geared toward preparation. Additionally, the program's outreach includes students with disabilities, who are homeless, in foster care, or aging out of foster care to assist these underrepresented groups in higher education (U.S. Department of Education, 2019). GearUp is a grant program to increase the representation of low-income students in higher education. The grant is provided to middle and high schools in poverty areas for a period of six to seven years so that these students can receive scholarships to attend college (U.S. Department of Education, 2019).

Despite the implementation of various pre-collegiate and collegiate STEM programs at HEI, issues of retention and attainment still exist for African American female engineering students. As Hrabowski (2011) discussed, many institutions need to recognize the issues of diversity and inclusion to address and implement initiatives focusing on these issues. The problem is that many of these institutions address the issues on a department or program level. Hrabowski (2011) has provided research that examines and address the institutional context of systemic factors from a holistic approach.

Recruiting and Retaining Black and Female Engineering Faculty

A persistent issue in engineering that keeps arising is relevant to diversity in the student and faculty body in race and gender. Roy (2019) reported that within engineering programs in the U.S., women comprise 17.4 percent of the tenured/tenure-track faculty and African Americans only 2.4 percent. Looking at the low statistical level for African American faculty, it enhances the argument for the need to recruit and increase the representation of this group in engineering programs.

Researchers such as Bettinger and Long (2005) analyzed secondary data from the Ohio Board of Regents HEI system for a public, four-year college in Ohio from Fall 1998 through Fall 1999. Their goal was to determine if female faculty have a positive impact on the interest and choices in specific disciplines for female students. Their findings indicated that female faculty members serve as role models in the fields of mathematics, statistics, journalism, geology, and sociology. However, their findings did not indicate that female faculty serves as role models to affect the interest and female students' choices in disciplines such as computer science, physics, and engineering. They contributed this to the small number of female faculty members, making it difficult to determine the role they play in females' choices and interests. These researchers indicated that additional research is required to explore the impact of faculty on student's performances and interests (Bettinger & Long, 2005).

Similarly, Price (2010) analyzed secondary data from the Ohio Board of Regents that included 13 public four-year universities in Ohio between 1998 and 2002 for freshmen students and compared to faculty member information. The goal was to determine if gender and ethnicity play a role in the students' persistence in STEM fields. Their alternative finding indicated that Black students were more likely to persist in STEM when Black faculty members taught the courses. However, the results indicated that female students were less likely to persist in STEM when taught by female faculty members. He suggested that HEI consider facilitating a program to determine a correlation between Black faculty members as role models for Black students to increase persistence. Another suggestion is to explore the mechanisms that promote persistence in STEM fields for minority students. Gasman and Nguyen's (2014) article presented an alternative outcome related to the importance of the same gender and race faculty role models in STEM fields for students. At HBCUs, students benefit from a diverse faculty body as the faculty tend to respect the needs and learning of Black STEM students. The lack of diversity in STEM could be problematic for Black students as stereotyping and discrimination is a possibility of encountering.

Chubin et al. (2005) also offered the need for HEI to diversify their engineering faculty body through recruitment and retention of minorities and females. They suggested looking at engineering networks like the Society of Women Engineers (SWE) and mentoring networks such as MentorNet. SWE is “a non-profit educational service organization of graduate engineers and women and men with equivalent engineering experience” (Salguero, 1993, p. 139). According to Salguero (1993), this organization was founded in 1950 with a mission to acclimate women to the engineering educational and workforce experiences. This is achieved by providing information centers at HEI, scholarships, membership in SWE, career guidance, mentoring, tutoring, seminars, serving as role models, assisting with science fairs, and career days. The organization also work with the Girl Scouts, community groups, elementary schools, high schools, and colleges/universities across the country, and judge science fairs at schools for students to participate at NASA Space Campership. Their goal is to assist females in education from the elementary grade levels thru the workforce. MentorNet is an online network founded in

1997 that supports the retention of women in science, engineering, and mathematics (SEM). This network pairs mentors with engineering students for retention using a database algorithm and then offer months of guidance to ensure an appropriate fit (Mueller et al., 2012).

The study of Rice and Brown (1990) provided an alternate finding of mentorship, which indicated that the preference of some students to have a peer mentor instead of a faculty mentor. They also found it supportive of having a professional mentor from their field of study. Nevertheless, these researchers pointed out that faculty have a better knowledge base than peer mentors, thus are better prepared to guide the students intellectually. In fulfillment of student needs, they also suggested that institutions provide students with a blend of mentoring that includes faculty, professionals, and student mentors (Tsui, 2007). Like mentorship, tutoring is a widely used intervention technique to assist students with persistence and performance in their field of study. Tutoring programs consist of faculty, staff, and upper-level students to assist students in academia. Moust and Schmidt (1994) found no differences in achievement outcomes of students tutored by either peers or faculty members. Tsui (2007) also noted that a student review of peer tutoring at several hundred institutions revealed positive feedback on its usage for both the tutor and the tutored.

Equally important as recruitment is retention policies as the latter assist the institution with a process to retain the established diverse student population and faculty body. Without developing a retention strategy, recruitment efforts would be compromised. Retention measures and its' relevancy will be reviewed next.

Retention

Retention in higher education is relevant for students and institutions to address the issues related to successful retention. According to Chang et al. (2014), there are several institutional factors that HEI must consider while analyzing the measures necessary to aid underrepresented students in their science and engineering quest. The factors they discussed relates to recruiting and retaining Black and female engineering faculty, mentoring relationships, student support services, research programs, living-learning communities, and service-learning. As outcomes of success for underrepresented students, the research related to the institutional environment implicates the interconnection between these factors. The suggestions for the institutions are to provide access and availability to all key individuals and departments to support persistence and academic attainment for these students. Research by Johnson (2011) discussed that institutions need to provide support services for their students. The support services would include resources focused on assisting women of color in their degree attainment, such as student organizations, peer groups, learning communities, faculty tutoring, and mentoring from alumni, faculty, upper-level students, and undergraduate research programs.

According to Rice (2016), there is a lack of diversity in STEM fields, especially for women of color warranting examination of the issues. Educational institutions must identify the issues for this marginalized group and then take a closer look at their processes to identify if a change is necessary. HEI must determine if they have analyzed and exhausted all the avenues that lead to the lack of retention in engineering for African American female students in engineering fields. Additionally, researchers have studied crucial components that affect success in degree completion for these women.

Moreover, Tinto (2006) discussed the necessity for HEI to continually move the student retention process from theory to action. He indicated that although there has been four decades of discussion on this subject, student retention and institutional effectiveness is still a work-in-progress. However, Tinto (2006) also indicated that numerous HEI have improved their student retention rate while others have seen minor change. The current national retention rate for women and men in engineering fields from the National Center for Science and Engineering Statistics (NCSES) are shown in Table 2.1 (NSF, 2018).

Table 2.1

All engineering disciplines enrollment rate for women and men

	2010	2011	2012	2013	2014	2015
All Women	13,693	14,658	15,981	16,934	18,626	20,057
All Men	60,706	63,441	67,282	70,878	75,324	79,849
Rate of difference Between sexes	22.5%	23.1%	23.7%	23.9%	24.7%	25.1%
Enrollment Change – males	-------	2,735	3,841	3,596	4,446	4,525
Enrollment Change – females	-------	965	1,323	953	1,692	1,431

Note. www.nsf.gov/statistics. Statistics for the years 2000 – 2015.

Table 2.1 illustrates a change in the five-year enrollment rate at HEI in engineering disciplines for females and males. This data further demonstrates the necessity to increase the rates of enrollment, retention, and attainment for females. However, it is important to indicate that consistently the enrollment numbers for males in engineering fields are significantly higher than females, and the increase of the enrollment numbers over the five-year period for males are 76% while females were 68%. If an analysis only looked at the percentage of change between males and females, the results would indicate only a slight difference of 8%. In providing a complete depiction of disparity, HEI must analyze the vastness in the enrollment numbers between the genders because 8% would not sound the disparity alarm.

Tinto (2006) also discussed that previous retention strategies were an individual issue not an institutional one, the lack of persisting was based solely on the students' inability to finish a program. In this article, Tinto's goal was to identify three areas that require further exploration: "institutional action, program implementation, and the continuing challenge of promoting the success of low-income students" (Tinto, 2006, p. 1). He suggested that researchers and institutions need to approach the complexity of student retention by analyzing the internal and external environments that impede student success.

However, Lau's (2003) article provided a different narrative from Tinto's viewpoint of student retention. This author indicated that Tinto discusses student retention based on the students' experience at their institution. Alternatively, Lau discusses institutional factors to improve student retention as well, but she also stated that students must be accountable for discovering support options provided by the institution. Students must take responsibility and motivate themselves in developing a sense of belonging to complete their degree. To a certain degree, the arguments of Tinto and Lau have similarities, but the difference lies with Lau's opinion of what is required of the student. She indicated that a freshman student requires more advising than a senior, but other authors/researchers (Hrabowski (2011); Johnson (2011a); Rice (2016) indicate otherwise that support should be continual throughout the students' educational experience. This sets the stage for the next sub-section, supportive environment and its' importance to retention and persistence.

Supportive Environment

The culture of HEI and its engineering programs are a vital element to assist African American females in their journey in engineering studies. Also, to support systems and the culture of the program, there is a necessity to reexamine the institutional environment related to the diversity of faculty members, mentoring relationships, student support services, research programs, living-learning communities, and service-learning. Each one of these factors indicated the significance of interconnectivity and the necessity to foster an inclusive and collaborative learning environment for African American female engineering students.

Studies are evaluating the causality of Black female students' attrition and persistence in engineering degree attainment. From those articles, attrition and persistence connect to the presence and availability of support systems for these students (Lichtenstein et al., 2014; Perna et al., 2009; Rice, 2016). Lichtenstein et al. (2014) directed their discussion toward U.S. federal policies, STEM initiatives, and seminal work related to retention and persistence over the past forty years aimed at increasing minorities and female representation in STEM fields. Additionally, their discussion referenced organizations such as the National Science Foundation (NSF) that focuses on diversifying and increasing the representation of women and minorities in STEM.

Mentoring relationships from faculty, peers, and advisors assist with normalizing underrepresented minority students (URM) experiences in their academic pursuit. URM students benefit in science and engineering programs that incorporate faculty member's guidance in research and a well-structured classroom. Research also shows that faculty guidance in research programs lends support and assist in navigating the STEM field (Chang et al., 2014). The mixed-methods study by Griffin et al. (2010) added to the limited literature related to Black STEM professors' experiences and factors that successfully helped them matriculate in their educational journey at PWIs. The purpose of their research was to offer insight for students of color in STEM programs and to provide individuals (Black faculty members) experiences who have navigated not only the educational segment expertly, but their teaching career paths as well. Their study's finding revealed the importance of advising and mentoring students of color in both the undergraduate and graduate levels in STEM-related fields that were consistent with other studies such as Patton (2009). Patton's (2009) qualitative study examined the mentoring experiences for eight African American females to acquire an understanding of their perception of mentoring. Specifically, the aim was to determine the participants' concept of mentoring, the importance of having an African American female as a mentor, and the insight of their current mentor relationship.

Mentoring is an essential factor for retention, academic performance, and graduation rate for African American STEM students. In an article by Kendricks et al. (2013), they examined a scholar's program, Benjamin Banneker Scholars Program (BBSP), initiated at Central State University (CSU), an HBCU in 2009. At CSU, the administrators used this program as a two-prong approach system in STEM to increase the number of students graduating through retention and improve the number of high-performing African American students in the programs. The design of BBSP has activities related to academic learning community, living-learning community, mandatory mentoring meetings, honors program participation, professional development workshops, graduate school visits, and undergraduate research. Program participants completed an annual survey for pre- and post-program satisfaction with the highest-ranking going to mentoring at 90 percent for having the most influence on their success. The outcome of BBSP had a significant impact on students' success in STEM, for which the authors offered those other institutions consider adopting this model in their STEM programs. The role of mentoring for African American students is a crucial aspect of retention in engineering programs at PWIs. As indicated, mentoring can be provided by their peers, faculty, advisors, or mentors in their field of study. Additionally, Tsui (2007) indicated that minority students are less apprehensive toward research when mentored by faculty of color or female faculty.

Distinctive academic advising has been linked to student retention and used as a strategy to decrease attrition. Additionally, research indicated that universities in the practice of employing orientation and advising programs have a higher graduation outcome. Advising assists students in academic preparation, which influences persistence. Some institutions have utilized an 'intrusive advisement program' that requires students to come in for advising several times during the school year as opposed to the standard one meeting during the school year. The latter can be problematic and not conducive to assisting the students to succeed, especially for first-year students (Tsui, 2007). However, Glennen and Baxley (1985) discussed the uncertain connection between successful advising and intervention programs in higher education. They discussed that there must be an examination to determine the funding of student services departments as funding levels assist in the success of the program. So, the question becomes, do HEI dedicate enough funding and resources to sustain their student services? If so, how does it benefit their students? Do they assess their programs to see how it is benefiting the students? The authors suggested that proper allocation of funds, ensuring program assessment, and assessment of students could be the solution to sustaining student services. HEI often boast about having student services, but often fail to allocate funds to support a growing populous student body.

The requirement for universities to identify sustainable funding sources leads to taking a closer look at the University of Maryland, Baltimore County (UMBC) Meyerhoff program. Robert and Jane Meyerhoff provided an initial funding of $500,000 to address the lack of diversity in STEM programs in higher education. Over the years, the Meyerhoff's have continued their financial support of this program through endowments (https://meyerhoff.umbc.edu/about/founders/). Additionally, UMBC has sustained this program through the growth of research grants and endowments. The program has been being replicated by other HEI and a recent partnership between Chan Zuckerberg Initiative, University of California Berkeley, and University of California San Diego to replicate Meyerhoff Scholars program at these institutions is in progress. The Chan Zuckerberg Initiative is providing $6.9 million to these two institutions to increase diversity in STEM programs (Hrabowski et al., 2020; UC Berkley, 2021). Additionally, UMBC incorporated other federally funded programs such as Louis Stokes Alliance for Minority Participation (LS-AMP), Alliances for Graduate Education in the Professoriate (AGEP), and ADVANCE to sustain the program and assist the scholars with the level of support identified by the program (Maton et al., 2008). This program is in response to the growing concern regarding the lack of African Americans in these programs, especially the males of this group. The program increased in size from 16 participants to the current size of 40 to 60 students per year. Although the participation increased over the years, it is still very limiting because they receive approximately 1,400 applications each year (Maton et al., 2000). This number represents the disparity and the need for additional programs to address the diversity issue in STEM.

According to Maton et al. (2012), the Meyerhoff Program is now considered a national model that addresses diversity issues in STEM. The design of the program addresses components of intervention by focusing on four critical areas: "(a) knowledge and skills, (b) motivation and support, (c) monitoring and advising, (d) and academic and social integration" (p. 612). Similarly, George-Jackson and Rincon (2012) also discussed these elements of intervention in their paper but termed it STEM Intervention Programs (SIP). The goal of the program was to respond to issues of social integration and academic isolation that the literature reported as a significant contributing academic problem for African American students majoring in STEM. The holistic approach of the Meyerhoff Program provides support to students, such as fostering close relationships with faculty, extensive research opportunities, assistance with financial, academic, mentoring, tutoring, advising with feedback, and social engagement (Maton et al., 2012). Another important aspect of this program is the assessment process of monitoring the students' progress, which detects issues early and provides the necessary support to resolve the issue(s). This model is an integral problem-solving tool in higher education to establish and provide a balance in the support process. Assessment is also crucial in detecting issues early and working with the students to move past the problems hindering retention and attainment.

However, in examining this program, there is a deficient component found related to assisting African American students who aspire to major in STEM but lack a solid educational foundation in science and mathematics. Tsui (2007) indicated that the Meyerhoff program selects African American students who are already excelling in science and mathematics to participate in a summer bridge program that focuses on providing tutoring, academic advising, counseling, study groups, research opportunity, family participation, faculty engagement, and academic course work in math, science, and humanities. The students must maintain at least a 'B' average, which is excellent to ensure that high achieving students continue to thrive and are supportive continuously throughout their academic journey. However, again, what about those who are not high achievers, where is their support, and how can higher education improve their outlook in life?

Numerous researchers have examined the Meyerhoff Program to determine its' effectiveness in diversity, retention, and attainment for marginalized students. Through the articles of various researchers such as Hrabowski and Maton (1995); Summers and Hrabowski (2006); Tsui (2007), the Meyerhoff Program was examined over-time for its effectiveness on student retention and attainment, provide information of the dynamics of the program, and data comparing the outcomes of cohorts. Additionally, Fries-Britt (1998); Maton et al. (2000) reviewed the long-term impacts that contribute to the effectiveness of the program. What they found were factors connected to providing a supportive family environment, emotional support to address feelings of isolation, peer networking, and addressing indicators that inhibit a welcoming environment for marginalized students.

University Resources

Student support services are vital components at any HEI, but the differences within these programs are how they are configured and utilized. The specific type of departments and services offered in student services is essential in providing the correct level of support, especially in assisting African American females in attaining their engineering degree. Some of the support programs and initiatives that assist these students are learning communities, research programs, service learning, and engineering organizations. Some HEI have implemented these support programs as an intervention method to assist students in their educational path**.**

Nevertheless, from the numerous articles in this review such as Hrabowski (2011); Rice (2016); Rice and Alfred (2014), HEI must address the issue of retention and attrition from a structural component. Also, they must continually communicate the importance of the available support resources to their students, not only during freshman orientation and on the website, but through lines of communication with administrators, advisors, and faculty. Additionally, it is equally important to have assessment measures of effectiveness for the universities support resources for students. This important topic will be discussed further in the section – polices of inclusion and diversity, specifically, the assessment sub-section.

Rice (2016) indicated that student engagement in universities' resources establishes relationships with both the financial and human aspects of the entities. Faculty member support is crucial to African American female engineering students' success. Also, she mentions that universities need to find funding sources for their support services that have specific aims to support their underrepresented students financially, academically, personally, and socially. Rice (2016) agreed that implementing this targeted strategy will assist these students with successfully pursuing their degrees and increasing the representation of women of color in STEM. As she concluded that HEI must implement a holistic approach to address the challenges faced by African American female engineering students.

The study of Rice and Alfred (2014) presents information related to personal and structural support elements for African American female engineering students. The structural elements relate to programs provided by the educational institution to offer student support. They discuss university resources and minority support networks that aid students with financial and academic support. Financial support includes financial aid and scholarships to offset expenses. The minority support networks consist of minority and peer groups designed to establish supportive relationships to assist African American female engineering students with overcoming barriers and challenges they encounter. The National Society of Black Engineers (NSBE) and the Society of Women Engineers (SWE) are two examples of successful minority groups for Black and female engineering students assisting them with their transition into university life, academic program, and ultimately to graduation.

Learning communities are being utilized in higher education to support the student's goals in completing degrees in their various areas of interest. These environments foster meaningful connections between faculty, staff, and students to help build a more inclusive learning culture and learning environment within their institution. Many institutions with learning communities and academic support programs have higher degree attainment rates for their African American female engineering students (Otto et al., 2015). Tinto (2003) described a learning community as an environment created on college campuses that promotes social relationships between students and the academic environment, using faculty members, administration, and peer mentors to help foster those internal relationships. It is also a support resource that assists African American female engineering students toward completing their degrees.

Tinto (1998) discussed two components of learning communities: shared knowledge and shared knowing. Shared knowledge is formulated by bringing the experiences of learners together organized around a theme or major courses (Tinto, 1998). Likewise, educational philosophers John Dewey and Alexander Meiklejohn explored approaches of educational reform. Dewey discussed a model of learning, 'shared inquiry,' as a transference of knowledge between teachers and students. Meiklejohn varied from Dewey's perspective by focusing on creating an integrated core curriculum. Dewey's educational approach laid the basis for the formulation of learning-communities. Based on the foundations of these philosophers, various types of learning-community models were developed to focus on residential-living, integrated curricula, disciplines, team-taught concept, and small student cohorts (Fink & Inkelas, 2015; Soldner et al., 2012).

The literature of Fink and Inkelas (2015); Otto et al. (2015) presented information on the learning-community models at eight community colleges and universities within the U.S. Their perspective was to provide the best practices of learning-communities in higher education. At these colleges and universities, the outcome varied for students participating and experiencing the learning-communities. However, the benefits were related to higher grade point averages, extended beyond the freshman year, retention of scholarships, graduated earlier than their peers, retention and graduation rates especially for low-income levels-first generation-underrepresented minorities-academically challenged students, making the academic connection between faculty members and students, group students by interests not by standard courses, small cohorts, advanced integrated studies, linkage of courses, and based on common themes. The learning-communities varied amongst the institutions and within an institution to target the need of their minority student population (Otto et al., 2015). Alternatively, Otto et al. (2015) discussed a minimal success rate of learning-communities at Middle Tennessee State University (MTSU) due to limitations of integrated curricula, faculty push-back, and resistance from students. However, they were able to obtain some success by polling faculty willing to collaborate, which is a crucial component of success with learning-communities. Additionally, Otto et al. (2015) indicated that best practices of learning-community models are rooted in the culture of the institution, resources established, faculty collaboration, student engagement, "community, diversity, integration, active learning, and reflection and assessment" (p. 9). Tinto (2012) discussed how institutions are connecting learning communities (support initiatives) to social and academic dynamics. They achieve this through the connection of different types of courses such as pairing a basic skill with a core course. This establishes a foundation to support students' academic learning and acclimate them within the social context of the academia culture.

Within engineering programs for student retention, Froyd and Ohland (2005) presented information regarding integrated engineering curricula as it pertains to learning-communities. Integrated curricula are smaller constructs of the broader context of learning-communities that assist engineering students to build social and engineering discipline connections. These authors share that some institutions have recognized the importance of ensuring that students realize the relevance of science and math courses as they pertain to their future work performance in engineering. Also, learning-communities provide an arena of integrative learning to improve retention rates and diversity in engineering programs.

For many STEM students, as they participate in undergraduate research programs in their areas of specialty, it helps develop future interest in graduate degree programs to help them further their career goals and academic interests and allows them the opportunities to conduct their research at the graduate level as well. The importance of undergraduate research programs is described as follows:

> Undergraduate research programs socialize students by connecting them with faculty and advanced peers who provide undergraduates with access to professional networks and new sources of information, and broader access to institutional resources and networks improves students' capacity to navigate the educational system. (Lin, 2001; McDonough, 1997, 1998; as cited by Eagan et al., 2013, p. 689)

Additionally, research programs are an essential piece of the puzzle to guide African American female engineering students toward graduate school and hopefully lead to long-term changes in faculty composition, which is often dominated by White, male Ph.D. tenured faculty.

According to Hurtado et al. (2009), as cited by Eagan et al. (2013), undergraduate research initiatives with support systems provide high levels of mentoring, peer relationships, and acquaint students with scientific norms. These support systems provide a supportive foundation to help give students access to opportunities at their undergraduate institutions to develop their exposure to the science field. The support systems assist in strengthening their "science identities in three ways: (a) by fostering knowledge growth, (b) by providing opportunities to display scientific knowledge and practices socially, and (c) by building one's acknowledgment as being a science person, especially by way of recognition by others" (p. 690). This type of support system aims to bridge the gap for students struggling to adapt to the university environment by helping them to understand the norms, behaviors, and expectations of the dominant discourse at the institution's university environment.

URM students that participate in well-structured undergraduate research programs receive added benefits, including knowledge enhancement in their engineering program and overall science comprehension (Chang et al., 2014). Eagan et al. (2013) have a different approach to these research findings on research programs specifically for Black and Latino STEM students. These researchers believe there is no direct connection in research programs that provide faculty support or mentorship in STEM fields. The participants did indicate that being in supportive and intentional learning environments provided social networks that assisted them with decision-making with post-baccalaureate studies.

Another source of student support geared toward retention is MentorNet, which is an online mentoring program. The program primarily connects female and URM STEM students to experts in the field and academia for a year of sustained mentoring. This form of electronic mentoring allows access to mentoring that otherwise is not available due to barriers of location and scheduling. In our current technological savvy age, MentorNet can offer a range of E-mentoring that was not available to STEM students in the past (Tsui, 2007). E-mentoring has now become a crucial aspect that universities need to incorporate as the world is dealing with the global pandemic, Covid-19. The student support playbook needs this update in the event the next pandemic occurs. Brainstorming to identify the types of future events that could impact the learning environment yields the preparatory measures to maintain effectiveness.

Expanding on student support is the essential concept of service learning, which is critical for student engagement and growth. It provides the student with necessary contacts and opportunities for building interest in graduate school, but rarely discussed in STEM fields. Duffy et al. (2008) defined service-learning "as a hands-on learning approach in which students achieve academic objectives in a credit-bearing course by meeting real community needs" (p. 19). They also stated when service-learning is applied to fields of engineering; the outcome is beneficial for students and the community. The practical outcomes of service-learning have led to increases in student retention, recruitment of minority students, cooperative learning, a better understanding of course work through a hands-on approach, critical thinking, self-efficacy, academic performance, acceptance of diversity, and interpersonal skills in team development. Important aspects to sustaining the service-learning initiative pertains to institutions identifying funding sources and community partners.

Duffy et al. (2008) indicated that the cost of service-learning projects can be kept to a minimum, formal implementation is not required, and maintaining existing projects provides continuity. Additionally, Duffy et al. (2002) conducted research that unearthed the usage of service-learning in engineering programs across the U.S. These authors suggested that implementation challenges pertain to HEI being able to incorporate course content in the project while meeting the requirements of real-world context. There project involved distributing surveys to 350 Deans of Engineering within the U.S., for which only fifty-two responded. The engineering programs encompass sixty-one engineering courses from undergraduate to graduate. The findings of their study showed that service-learning in engineering courses is not wide-spread, used only in a small percentage of courses, and sometimes only used once by faculty. The inference of Duffy et al. (2002) research lends to the importance of implementing this initiative into more engineering programs and then conducting additional research checking for increased participation.

University of Massachusetts Lowell (UML) incorporated service-learning into their undergraduate engineering program by combining core courses with community projects for students to solve a real-life issue (Duffy et al., 2008). The projects are a team concept consisting of a diverse body of engineering students and facilitated by faculty members. One service-learning project at UML included 340 freshman-engineering students divided into teams to work on various community projects such as assessing safety issues of force, deceleration, and impact at a local playground. These projects are just a few examples of service-learning at this institution for the undergraduate academic engineering level. The teamwork concept of service-learning projects promotes diversity in engineering programs through an interconnection of the educational institution, students, faculty, and the community. The process incorporates a social component for students to make the connection between the engineering constructs and experiments. UML's goal is to improve their student's learning process by replacing traditional analytical applications with service-learning projects (Duffy et al., 2008).

Another essential element of support with engineering programs are the design of Minority Engineering programs (MEP) and student engineering organizations which support minority students in higher education while assisting them academically and providing professional development. These programs are a part of academic intervention programs that promote student development, the interaction between faculty and students, and encourage engagement in student organizations such as the National Society of Black Engineers (NSBE) and Society of Women Engineers (SWE). MEP provides a supportive learning arena that assists minorities in their engineering journey by reducing obstacles and promoting student participation (May & Chubin, 2003). MEP is also necessary to address the barriers that minorities encounter in education, such as a lack of educational resources in their elementary and secondary schooling. These students often aspire to be engineers but lacked the proper preparation in advance mathematics and science. May and Chubin (2003) also indicated that student services play an essential part in connecting students to outreach programs, academic advising, counseling, summer jobs, engineering internship, and overseeing student organizations.

MEP was founded by Ray Landis in 1973 and instituted at California State University, Northridge. MEP is an extension of Mathematics, Engineering, and Science Achievement (MESA) initiated at over 100 universities and privately sponsored programs (May & Chubin, 2003). Although MEPs are on numerous types of educational institutions, they have similarities in their requirements of this program. There are similarities of the programs, which include the following: 1) outreach for pre-collegiate and at community colleges; 2) work extensively with first-year students and sophomore undergraduates; 3) work closely with their engineering colleges; 4) activities with an industry professional for the development of students; 5) consensus building through collaborative study group; and 6) schedule MEP students in the same courses to promote a team atmosphere. MEP extensively utilizes student services for initiatives such as summer bridge programs, freshman orientation classes, tutoring, counseling, monitor student progress, and offer supplemental teaching for science and mathematical courses (Tsui, 2007).

Good et al. (2002) reported that MEP at one institution provided the social connectedness that is lacking in engineering programs for African American students and had a higher retention rate than the non-MEP engineering students. Brazziel and Brazziel (1997) further emphasized in their study examining ten highly effective institutions that utilize MEP to assist underrepresented students to succeed in their doctoral studies in science and engineering. However, Morrison and Williams (1993) indicated that despite the efforts of MEP in increasing the enrollment of minority students in engineering, attrition is still substantial for these students. Tsui (2007) discussed a study conducted by Morrison and Williams (1993) of MEPs at 20 engineering schools and found that eight of them were successful in providing recruitment and attainment for minority students. These eight engineering schools were successful because they provided high school recruitment efforts, summer programs focusing on strengthening the students' knowledge and critical thinking, establishing faculty support, student centers, adequate tutors, and high funding levels. The takeaway from examining MEPs at institutions indicates that merely having this program is not enough; there must be an assessment of programs to identify its effectiveness or if adjustments are required. The successful outcome of a program is tied to continually assessing its effectiveness. Additionally, Hrabowski (2011); Maton et al. (2012) provided valuable information related to policies of inclusion and diversity at institutions as a course of action to establish effective change procedures to address the inequities within the engineering environment.

Policies (Inclusion and Diversity)

Inclusion and diversity in engineering have been examined by scholars such as (Iverson, 2007; Maton et al., 2012) to shed light on the importance of increasing diversity. Nevertheless, there is a dearth of literature related to policies of inclusion and diversity in higher education and engineering programs (Hrabowski, 2011; Maton et al., 2012). Hrabowski (2011) and Maton et al. (2012) discussed diversification on the institutional level by providing a system-wide approach. This plan of action was initiated through an extensive program (Meyerhoff Scholar Program) to address "financial, academic, and social support while encouraging collaboration, close relationships with faculty, and immersion in research" for students (Maton et al., 2012, p. 612). They found that the system-wide approach examined all programs, departments, policies, administrators, faculty, staff, and students in determining whether to implement a change process to their entities. Having a plan of action to address diversity issues indicate a recognition of the problems and a willingness of administrators to implement solutions.

Therefore, some universities are examining the issues of inclusion and diversity to determine the course of action required and measures to address inequity. Iverson (2007) argued that having a diversity action plan is a means to address inequity, diversity, and exclusion in higher education. She also suggested that developing and establishing a diversity action plan demonstrates the institutions' commitment toward building equity, diversity, and inclusion. Iverson (2007) described diversity action plans as an institutional policy that identify the problems and implement strategies of diversification.

Diversity is a social problem requiring a comprehensive solution. As such, The University of Illinois at Urbana-Champaign’s Provost established a diversity plan in 2017 which includes an Office of Diversity, Equity, and Inclusion after initiating an external review of diversity at this university. Based on the outcome of this review, the provost established a diversity and equity strategic framework to address diversity, inclusion, and equity at the campus and college/unit levels (The University of Illinois at Champaign-Urbana, 2018). The new strategic plan included the realignment of existing offices and the creation of new offices. A new

Vice-Chancellor was hired after an extensive search to spearhead the new initiatives and realignments. The realignment involved restructuring the previous Office of Diversity, Equity, and Access to the Office of Access and Equity. The Office of Access and Equity has eleven key components to ensure compliance, facilitate compliance awareness, and promote inclusivity through initiatives related to education, diversity, and outreach efforts. The University of Illinois at Champaign-Urbana (2018) presented information on the eleven key components on:

> 1) Investigating and resolving Title IX, sexual misconduct violations in accordance with university policies and procedures, federal laws, and state laws; 2) Ensure that inquiries by faculty and staff related to the American with Disabilities Act Amendments Act (ADAAA); 3) Create and initiate an affirmative action program; 4) Oversee the academic search and selection process in compliance with Affirmative Action and Equal Employment Opportunity; 5) Collaborate with Illinois Human Resources in the civil hiring process to comply with Affirmative Action and Equal Employment Opportunity; 6) Provide training to faculty and staff on Affirmative Action plan, ADAAA, harassment, discrimination, Title IX, and other relevant topics; 7) Serve as a liaison to assist units, departments, and university constituencies on affirmative action, equal opportunity, access, and non-discrimination; 8) Collaborate with the Vice Chancellor for Diversity, Equity, and Inclusion to cultivate awareness, appreciation, and engagement with diversity and its relevance in a University environment; 9) Assists in the recruitment and retention of women, persons of color, individuals with disabilities, veterans and members of other underrepresented groups, 10) Monitor and support University compliance with federal laws, state laws, and University policies prohibiting discrimination, harassment, and

> retaliation; and 11) Conduct investigations and resolve complaints of discrimination, harassment and retaliation in accordance with University procedures. (p. 6-7)

Although the University of Illinois at Urbana-Champaign has implemented a strategic measure to address diversity and inclusion issues at their institution, the change process is too new to analyze and provide statistical data on the initiative's effectiveness. This research study will provide information on another national best practice model, the Meyerhoff Scholars program. This program was initiated at the University of Maryland, Baltimore County (UMBC) in 1988 and funded by Robert and Jane Meyerhoff. The goal of this program is to increase the representation of underrepresented minorities (URM) in STEM fields to provide diversity. Before initiating the program, the university assessed the issues that impede academic success for minority students. The outcome produced four sets of factors related to "academic and social integration, knowledge and skill development, support and motivation, and monitoring and advising" (Maton et al., 2012, p. 612). The proposed program had to address these factors in a comprehensive plan to provide students with support with academics, financial, social, research, and collaboration with faculty. The comprehensive plan of this program integrates thirteen components: financial scholarships, recruitment weekend, summer bridge, study groups, program values, program community, staff academic advising/staff personal counseling, summer research internships, and academic year research, faculty involvement, administrative involvement, community service, external mentors, and family involvement. The next section will address taking diversity and cultural awareness to the next level of sustaining these concepts through professional development for the educational entity to include the student populous, especially during orientation for first-year students.

Professional Development (Diversity and Cultural Awareness)

Professional development is a means to assist educators in a collaborative environment to discuss best practices in curriculum, personal development, and teaching strategies. Additionally, it provides ways to improve the institution's effectiveness and discussions of policy changes. It is important to note that professional development workshops are organized differently from institution to institution (Brawer, 1990). Professional development is one of several components of faculty development that focuses on the advancement of their role in higher education (Camblin & Steger, 2000). Thus, professional development is crucial to sustaining academic preparation for educators to keep them apprised of current technology, curriculum enhancement, and new developments of policies. It is essential to ensure that the institution operates effectively for its educational consumers (students) and establishes a commitment to meeting the changing dynamics within their institution. In any field, there are always advancements that the organization must address to ensure optimal operating capacity. Without responding to these changes, fluidity decreases within each unit level and the entity. As O'Sullivan and Irby (2011) indicated that "faculty development is one mechanism for improving the instructional competencies of teachers and the institutional policies required to promote academic excellence" (p. 421). This statement provides the importance of supporting faculty development and makes the connection of strengthening the competency of educators, which in turn establishes a supportive environment for students.

Building on the professional development approach, scholars like Lattuca et al. (2014); Yuen et al. (2016) discussed a different methodology to this complicated principle, student-centered approach to teaching. These authors presented how traditional engineering teaching practices focused on instructor centered. Although, they also suggested that many instructors at

HEI are moving away from this approach and toward a collaborative teaching and learning environment that is inclusive of all types of learners, not just the well-prepared students. However, as the many scholarly literature in this review suggested, there is still improvements and transformation required in HEI engineering programs. Fink et al. (2005) described it best by stating that engineering reform is required to meet the twenty-first century challenges within engineering programs. As with any entity, program, students, faculty, change is continual, and educators must evolve to overcome the challenges of the new era.

The policies of diversities and cultural awareness is a complexity that affects institutions, administrators, educators, staff, and students. Based on this enigma, there is a dearth of scholarly literature that addresses the importance of incorporating cultural awareness into the training for administrators and educators. Implementing this important process is based on the realignment of educator's roles at universities of not just instructing but engaging students in research, mentoring, advising, and facilitating learning (Diaz et al., 2009). HEI must rethink faculty roles to maintain efficacy within the institution, especially for establishing a positive learning environment and developing relationships between the key stakeholders. Universities need to foster a vision of building relationships between internal and external stakeholders, but first establish a process that addresses how the relationships will be developed and disseminated to the administrators, faculty, and other staff members.

Building on developing professional development process, especially for engineering educators, Adams and Felder (2008) indicated incorporating numerous elements for the faculty, administrators, and staff within engineering programs. Their approach suggested to employ a process that addresses the engineering education culture, the role of an engineering educator, models (learning communities, mentorships, continuing education, etc.) and theories/pedagogy that shape the multi-dimension of engineering programs, and an assessment to evaluate the established professional development process. Carefully designing, employing, and assessing professional development for engineering programs allows administrators and educators to address the complexity of the engineering culture and learning environment in a collaborative space.

Another gap in professional development is student advising as discussed by Allen et al. (2012) relative to HEI creating and monitoring the Designated Faculty Advisor (DFA). The DFA includes three essential components for to develop this faculty role: “training components, student and faculty responses, and future plans” (p.1). These authors indicated that research has focused its’ attention on discussing the issues plaguing the retention and attrition for underrepresented minorities and women in engineering disciplines but lacks a focus on addressing the necessity and development of engineering faculty advising. Allen et al. (2012) made an analogy that traditional advising for engineering faculty advisors is like that of a “doctor” providing a treatment plan for the course for the student “patient”. The outcome is transactional between the two parties whereas the doctor prescribes the “medicine” (a list of courses and passing the courses). The authors indicating the problem with traditional faculty advising does not require “bedside manner”, an understanding of student needs. So, as indicated previously by Diaz et al. (2009) that engineering is an enigma requiring a comprehensive approach in addressing the complexity of the program, student learning, and student-faculty interactions.

After establishing supportive professional development for the administrators, faculty, and staff institutions must continually assess the effectiveness of the provided training.

Assessment is essential to ensure positive outcomes for all stakeholders. Assessment is vital to determine what processes are working, and which ones need to be improved or eliminated.

Assessment

Assessment measures of student achievement is an early detection resource that benefits the institution and the students by indicating that there is an issue requiring intervention (Tinto, 2012). However, assessment measures apply to other aspects of the university, such as the effectiveness of a department, program, faculty, curriculum, policies, and student satisfaction. Besides, it can provide leadership with valuable information about engagement and satisfaction. Elrod and Kezar (2016); Hrabowski (2011) discussed the use of metric tools for accountability, effectiveness, evaluation of programs, policies, student achievement and satisfaction, faculty engagement and satisfaction, and institutional commitment. Rincon and George-Jackson (2016) took the assessment dynamic further indicating it is a systematic evaluation of the internal and external processes in determining decisions of funding levels and continuation of the processes.

Technology has evolved to provide administrators with assessment metrics to properly identify and engage issues that impede the academic success and retention of students. These measures include early warning detection that prompt administrators or faculty that intervention is required (Baepler & Murdoch, 2010; Tinto, 2012). Furthermore, these authors discussed the *Signals* project used at Purdue University that utilizes predictive modeling and data mining for identification of student performance levels. This is just one of many software platforms that institutions could employ to track student performance and to trigger when intervention is required. The process of automated tracking is a viable tool for HEI to identify and employ holistic efforts to support the retention and attainment rate of their students. Additionally, Baepler and Murdoch (2010) went further to discuss the concepts of data mining and academic analytics, its importance, dynamics, and usage.

Hrabowski et al. (2011) indicated a relevant aspect of continually assessing new initiatives to determine which ones are effective and ineffective. Determining this is crucial to sustaining the institution's desired outcome of enhancing their culture and retaining students within the programs. Additionally, there needs to be continual monitoring of established initiatives to maintain long-term goals. Another vital aspect of Hrabowski et al. (2011), related to assessing every aspect of the institution for sustainability. The value of sustainability and its connection to accountability in high-quality post-secondary institutions must not be underrated.

Perna et al. (2010) discussed a deeper aspect of assessment through the benefits and disadvantages of early warning systems for faculty about challenges that students are encountering in their studies. The goal of this system would be to encourage the staff and faculty within a program to share student information as a positive intervention to help students obtain their goals. Information sharing is an excellent resource tool, and if managed correctly, it provides a positive intervention method of assistance. Institutions utilizing this method need to organize the collected data through the utilization of the student support services. Similarly, Jokhan et al. (2019) discussed early warning systems as predictors for administration and faculty of student performance, progress, and behaviors. It is a strategic monitor that provides indicators for use in intervention methods to address issues and lend support to students. The goal of utilizing assessment measures to identify underperforming students and provide them early intervention. There are vast reasons why a student is underperforming, but the key is identifying that a problem exists to provide the appropriate intervention method. A proper technique for HEI is to consider using "academic analytics, involving data mining, statistical analysis, and predictive modeling, is an excellent approach to help monitor the effectiveness of online learning tools, and help improve pedagogical practices" (Jokhan et al., 2019, p. 2).

Institutional Transformation

In this section, policy elements were examined relative to diversity and inclusion that affect the attrition dynamic for African American female engineering students at HEIs. After identifying processes that does not promote a positive diverse and inclusive environment, HEI leaders must implement a holistic institutional transformation to address the issues. There are authors and researchers like Alexander (2005); Elrod and Kezar (2017); Hanson (2001); Hrabowski (2014); Hrabowski et al. (2011); Kofman and Senge (1993); Maton et al. (2008); Reinholz et al. (2015); who discussed various aspects of transformation such as the importance of it, issues that necessitate change, and methods to employ it. Some authors described the process as institutional transformation, change initiatives, systemic change, institutional change, reform, and learning organizations. These terms are synonymous in describing a change process, whether programmatic or system-wide, that will be sustainable. Eckel and Kezar (2003) described institutional transformation as:

> The type of change that affects the institutional culture, is deep and pervasive, is intentional, and occurs over time. Accordingly, deep change reflects a shift in values (for example, from espoused to enacted) and assumptions that underlie daily operations (for example, the flawed expectation that cross-racial interactions will magically occur on their own). Pervasiveness indicates that change is felt across the institution in the assumptions and daily work of faculty, staff, and administrators. (As cited by Harper and Hurtado, 2007, p. 20)

Additionally, Keup et al. (2001) provided an in-depth definition of institutional transformation being a process that modifies various components of the institution that “1) alters the culture of the institution by changing select underlying assumptions and institutional behaviors, processes, and products; 2) is deep and pervasive, affecting the whole institution; 3) is intentional; and 4) occurs over time” (p. 3). Within this context, change was discussed as reform for which Hanson (2001) defined it “as major change leading to a restructuring of core processes, programs, and/or procedures” (p. 637). In the business industry, this is known as the project’s life cycle. A project’s life cycle encompasses four phases (initiation, planning, execution, and closure) which identify the progression of a project from the start to the completion. Each phase of the project has its own schema for implementation which comes with a plan and challenges (Westland, 2007).

Whether it is the definition from Eckel and Kezar (2003); Hanson (2001); or Keup et al. (2001), it is apparent that institutional transformation involves a structured process that evaluates the current environment, departments, policies, programs, and curriculums to identify areas needing an update or change. Environments and people are continuously evolving which necessitates continual assessment by the organization. The outcome of transformation is to provide improvement for all involved stakeholders – administrators, faculty, staff, and students in promoting a positive diverse and inclusive culture.

Institutional transformation is not a new process, but through the various scholarly articles in this research project it appears to be an enigma within higher education. There is not a dearth of scholarly literature that discusses issues within higher educations’ culture, climate, practices of teaching and learning especially within the STEM fields, and policies. However, despite all the information identifying the issues, the mystery that still exists is why numerous higher educational institutions struggle with implementing institutional transformation. Well, the research of Hrabowski (2014) can shed light on the issues of stagnant growth in the transformational process within higher educational institutions. As discussed previously, this research project related to institutional effectiveness used the transformational process instituted at the University of Maryland, Baltimore County (UMBC) as the model institution for this study.

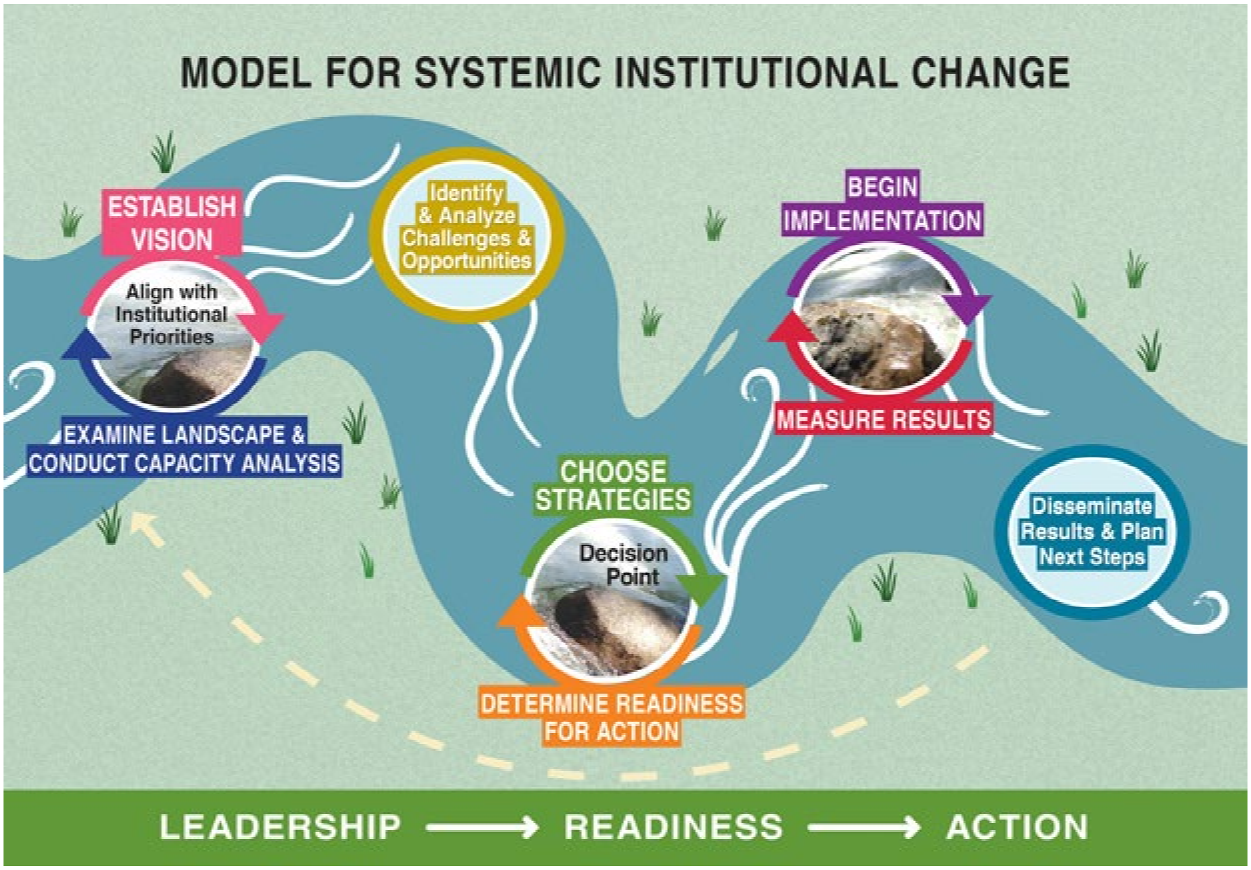
Another important model for institutional change was discussed by Reinholz et al. (2015), Science Education Initiative (SEI), which also provides a holistic approach to addressing issues within STEM departments. SEI is composed of a two-prong approach (outside-in and middle-out) that addresses the three-levels of the university: faculty, departments, and administration. The change process views these three-levels as interconnected systems requiring a strategy that focuses on the systems and not the individuals. The goal of the model is to build on the performance of teaching and learning practices by including strategies to improve the culture of STEM departments. These authors, like many other authors in this research study, argued the importance of improving STEM cultures to ensure a sustainable change initiative.

There are many factors within an institution that necessitate transformation such as the culture, climate, policy changes, practices of teaching and learning, student retention and attrition in STEM fields, and the lack of diversity. The important aspect for leaders to consider is addressing the changes through a systemic approach as opposed to a fragmented plan. The model of change chosen by an institution requires several aspects for sustainability, such as assessing what requires change, planning committees to analyze and prioritize the changes, fiscal analysis, micro not broad changes, implementation, and continual assessment of effectiveness (Hrabowski, 2011). Additionally, institutions differ in their structure and leaders must choose a model that will address the specific identified components.

To illustrate institutional transformation, Elrod and Kezar (2017) discussed their research project of eleven higher education campuses in California which included a model of transformation of an eight-step reform process, the KECK/PKAL model (Figure 2.2). They discussed the stages of transformation as “develop a vision, review the landscape and capacity, identify and analyze challenges, choose strategies/interventions/opportunities, determine readiness for action, implementation, measure results, and disseminate and plan next steps” (p. 27). This model has been identified as a ‘river’ because the flow of its change process represents the positive movement of change for success in STEM fields for students (Elrod & Kezar, 2017). The authors also identified other aspects not included in the change process such as academic support programs, professional development for faculty, advising, mentoring, and student research. Incorporating these components in the change effort creates a comprehensive approach to reforming STEM programs. An excellent example, as mentioned previously, is the Meyerhoff Scholars Program at the University of Maryland, Baltimore County (UMBC). Lee and Harmon (2013) are additional authors who discussed the dynamics of the Meyerhoff Scholars Program at UMBC by indicating that the program has devised a holistic model that addresses the social and academic issues impacting the successful degree completion for African American STEM students. The model also includes intervention strategies for these research-intensive programs.

Figure 2.2

The KECK/PKAL Model



Note. Elrod & Kezar, 2016.

Additionally, Elrod and Kezar (2017) pointed out that a multi-level team approach is required for successful implementation and sustainability. This approach includes buy-in from the leaders of the departments, programs, and senior leadership including administration. There are other successful major STEM change initiatives such as the Association of American Universities (AAU) and the American and Public Land-Grant Universities (APLU). AAU change initiative focuses on "pedagogical reform, appropriate scaffolding and support for faculty to carry out pedagogical reform, and cultural change" (p. 27). The APLU created an "analytical rubric to help campus leaders make improvements in science and mathematics teacher education programs" (p. 27). Another prominent evolving group of transformers are the Accelerating Systemic Change Network (ASCN) which provide knowledge-based information to approaching institutional change. The last important element of Elrod and Kezar (2017) research is the system approach of change initiatives. The structure of their approach includes organizational learning which indicates the gathering of information and data to determine the direction of the intervention strategy. Organizational learning will be discussed further within this section.

Within the STEM disciplines, there has been research and articles that have investigated issues and created theories around the issues of systemic institutional change. However, as indicated by Elrod and Kezar (2017) the identified issues have not been widely addressed within higher education. They also discussed how many change initiatives have not reached a reform level to address issues in STEM. This is due to the recognition that issues in STEM require change on an institutional level and not just by addressing the department level. Thus, HEI are in the business of learning, growing, and transforming their clients (students). In any type of enterprise, executives have a responsibility to their many stakeholders to ensure that their institution is operating and producing at an optimal level. Another consideration is to build autonomy within the terms of the transformation which involves decentralized decision making. This concept leads to a needed conversation of learning organizations at HEI.

Next up is a discussion of the last piece of the holistic transformational process which is the concept of learning organizations. Senge (1990) defined learning organizations as:

> Organizations where people continually expand their capacity to create the results, they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning to see the whole together. (p. 3)

Senge's discussion of learning organization presented a framework relative to adaptability, flexibility, and productivity in adjusting to continual change in society and organizations. The ability to prepare and adapt to future changes positions an entity to being able to address challenges. Absent this ability, sets an arena of 'survival learning' which was discussed as 'adaptive learning'. 'Adaptive learning' is not enough for organizations to analyze the complexity of their entity, brainstorm required adjustments, and adjust to these changes. To establish the desired outcome of being a learning organization requires coupling with 'generative learning'. Generative learning is important because it builds an environment to create necessary components, when paired with 'adaptive learning', the organization can create and sustain their desired outcomes (Senge, 1990).

Senge's (1990) book dives deeper into the concept of learning organizations by discussing the approach to this critical facet. His framework provided detailed information relative to the foundation of learning organizations which is systems thinking. System thinking indicates that leaders must address the whole entity as each part impact the others. Additionally, Senge (1990) pointed out that significant issues of long-term success of implementation is aligned with the type of framework utilized. He indicated that organizations often apply simplistic frameworks to more intricate systems based on time factors. The argument becomes affecting change in the least possible time, whereas Senge (1990) strongly indicates that the goal is not about time but relative to effectiveness and sustainability. Applying principles of learning organizations would assist higher educational institution in implementing a holistic transformative process by addressing each intricate interconnected system.

Furthermore, Maton (2005) supplemented the conversation through an analysis of Pierre Bourdieu's ideology of autonomy in higher education as it relates to the sociology of culture.

His critical exploration identifies the external structures (politics, economics, and social aspects) and internal components (various levels of the institution) that influence policies in higher education. The interconnectivity of these structures influenced the culture and values of the organization. HEI who embraces Bourdieu's concept of autonomy within higher education develops an approach to address pressures that influence policies (Maton, 2005). This embracement will allow the project team the structure to thoroughly assess the institution to document which programs, departments, policies, and culture require change and categorize which process will be addressed first. The chosen model of change can then be applied in accordance with the guidelines of the transformative model. The last crucial step is to continually monitor the change process to determine effectiveness, specifically, what is working and what might need re-vamping.

There were some models of change presented in this section as there are numerous other models not discussed here. However, there are several key components that models of change share such as knowing your organization and its culture, adhering to the institutions vision, analyzing the structure by gathering information, formulating a change model, implementing actionable strategies, assessing for effectiveness, and then identifying the next goal. Finally, as discussed by Elrod and Kezar (2017); Hrabowski (2011); Maton et al. (2008), negative factors such as resistance and a thorough assessment of initiatives/resources that hinder the forward progress of change at HEIs thereby requiring administrators to identify an approach to address negative factors. A failure to address this process could result in a failure of successful change process, lack of buy-in, and a continuation of the failed processes.

Chapter II Summary

Collectively, these recurring themes provide the basis to address the issues that plague African American females in their journey at HEI in becoming an engineer. Educational institutions that have not yet addressed these concepts should consider examining their institutional culture and programs to foster a cohesive learning environment conducive to all learners and their needs. Addressing the lack of diversity in STEM fields to curtail stereotypes and discrimination is apparent from the discussion provided by many authors in this review. It has become apparent from the articles in this review that interconnectivity exists between the themes and sub-themes within this study. There is an overlap in discussing the challenges and barriers for these students in HEI engineering programs. The next chapter describes the research methodology utilized in this research, along with the research approach, research setting, population sample, and how the data will be collected and analyzed.

Chapter III

Research Methodology

This chapter provides a summary of the research methodology utilized in this study. The description of the process includes the research design, research questions and hypotheses, target population, sample, variables in the study, reliability and validity, data collection management, instrument, assumptions, and limitations. The rationale for this quantitative non-experimental research was to examine retention, recruitment, attainment, academic support services, initiatives/programs, and diversity in engineering programs at HEI to increase these components for African American female engineering students. The examination explored the relationship, if any, between the variables in this study.

Ravid (2015) described the quantitative methodology in educational research as "research that focuses on explaining cause-and-effect relationships, studies a small number of variables, and uses numerical data" (p. 5). This methodology allowed an approach to analyze and uncover similarities in the data between the institutions. Additionally, this researcher-maintained objectivity in the analysis as the results of the data provided the relationship between the variables and the effects they have on each other.

Research Design

The research design for this study involved a quantitative approach of analyzing non-experimental data. This approach involved a causal-comparative and descriptive approach to determine the association between the variables in the study that did not include manipulation of the independent variable. Causal comparative allowed the exploration of the cause-and-effect relationships of the research. In quantitative research, the variables are a combination of independent and dependent on which the outcome of the study determined the relationship between these variables relative to the population (Ravid, 2015). Non-experimental is a method that uses descriptive or correlational research, which involves either describing a situation or phenomenon only as it stands or describing a relationship between two or more variables, all without any interference from the researcher (Ravid, 2015). The five research variables are independent & continuous variables related to academic support services, retention rate, diversity rate, attainment rate, and initiatives/programs.

The research approach of this examination utilized a non-experimental research type to synthesize secondary data derived from National Center for Education Statistics (NCES) and Integrated Postsecondary Education Data System (IPEDS) related to academic support services geared toward diversity, equity, and inclusion for the years of 2014 and 2018. Based on the variables identified, the secondary datasets from NCES and IPEDS were compiled for the diversity rate, retention rate, attainment rate, and enrollment rate. Additionally, the research approach was inductive to extrapolate the results of the data in deriving at a generalization regarding the target population.

Research Questions and Hypotheses

The scholarship related to African American female undergraduate engineering students indicated a need to explore resources at HEI to recruit and retain these students, and assessment measures of the available resources. The research questions design used relationship-based to describe an association or trend between two or more variables within the demographic group. After carefully exploring scholarly articles and journals on engineering programs at PWIs for African American female students, the main research question was formulated to ground this research:

- The main research question guiding the proposed study: Does the presence of support resources/academic initiatives increase the attainment rate for African American female engineering students within the HEI accrediting regions?
- The sub-questions to the main research question will explore academic support services at HEI: Is the student attainment rate for African American female engineering students associated with the level of diversity for HEI administrators and the faculty roles?
- And are there assessment indicators at HEI that progress the academic attainment rate for African American female engineering students?

Each research question resulted in the development of hypotheses as indicated in Table 3.1.

Table 3.1

Research Questions and Hypothesis

Research Questions	**Hypothesis**	**Statistical Analysis Tool**
RQ1	(H_a): There is a positive association between academic/support initiatives within HEI that on the degree completion for African American female engineering students	t-test & ANOVA
RQ2	(H_a): There is no diversity in ethnicity, gender, and age range for HEI administrators and the faculty roles that contribute to negative outcomes in the student attainment rate for African American female engineering students	t-test & ANOVA
RQ3	(H_a): The non-presence of assessment indicators for academic support at universities negatively impact the attainment rate for African American female engineering students	t-test & ANOVA

Note. RQ is an acronym used for research question. H_a represents the research/alternate hypotheses for this study.

Target Population

The process of identifying the target population was an evolved process of choosing participants with specific knowledge and roles within their institution. The participants were the representing agent for their institution based on their specific roles. There were 94 higher education institutions selected for this study based on a four-step process: the first step was to look at the six accreditation regions from the Council for Higher Education Accreditation, which are New England, Middle States, North Central, Southern, Western, and Northwest. This process provided a process of choosing institutions within the U.S. in these regions to provide an accurate representation across the U.S. and to establish variance in the analysis; the second step was to look for Land-Grant Institutions within these regions; the third step was to identify HEI and/or PWIs with Carnegie classification of 'Very high research activity'; and the last step was to check IPEDS to ensure that the selected institutions had African American female students enrolled in their mechanical, civil, and chemical engineering programs.

Additionally, the six accreditation regions are broken down to contain each state within the U.S. except for Alaska, Hawaii, and Puerto Rico. Also, the regions include some international regions, Latin America, and the Virgin Islands which were not included in this study. Appendix E provides a listing of the states used in this study. The six accreditation regions include New England Commission of Higher Education (NECHE), the Middle States Commission on Higher Education (MSCHE), North Central Higher Learning Commission (HLC), Southern Association of Colleges and Schools Commission on Colleges (SACSCOC), Western or WASC Senior College and University Commission (WSCUC), and Northwest Commission on Colleges and Universities (NWCCU) (www.chea.org).

Roy (2019) listed the top ten engineering programs where females typically have degree completion. These degrees are mechanical, chemical, computer science, biomedical, civil, industrial/manufacturing/systems, electrical, computer engineering, environmental, and metallurgical and materials. The type of engineering programs varies at HEI which also became a criteria selection for the HEI chosen for this research study. As HEI were identified, the process became narrowed based on the mechanical, civil, and chemical engineering programs had a higher propensity of a student body consisting of African American females. The study was limited to two types of classifications to analyze research-intensive institutions or Land-Grant Institutions. It did not matter if the institution type was public, private, Ivy League, or HBCU's, but was relevant if they were classified as Land-Grant Institutions with a Carnegie classification of 'Very high research activity'.

Sample

The selection criteria for participants have the specificity related to administrators such as Directors of Student Affairs & Academic Affairs/Diversity/Equity/Inclusion Office, Deans of Engineering, Student Advisors, and Faculty Chairpersons from chemical, mechanical, and civil engineering programs at HEI. Based on the role and experience of these participants, the information they provided was essential to this examination. Purposive sampling techniques was an ideal technique to select the participants. This technique is a non-probability technique that uses the judgment of the researcher in selecting the sample (Ravid, 2015). Although this technique is not random, the criteria that this researcher used is directly related to representing the target population. The sample size is 94 institutions with the four sub-groups mentioned above. The participants came from the six administrative groups within the chosen population. This research explored a unique quantitative approach to examine HEI policies related to recruitment and retainment, academic initiatives, and student support services for African American female engineering students. The approach required the creation of four surveys for each institutional role whereas each role served as a representing agent for their university. The total number of invitations emailed to participants were 713 and were distributed to the groups as indicated: 254 Advisors; 218 Faculty Chairs; 83 Deans of Engineering; and 158 Directors of Student Affairs/Academic Affairs/Diversity/Equity and Inclusion. The participatory number for each group resulted in the responses of 50 Advisors, 37 Faculty Chairs, 19 Deans of Engineering, and 22 Directors of Student/Academic Affairs/Diversity/Equity and Inclusion. The participation yielded response rates of 20% for Advisors, 17% for Faculty Chairs, 23% for Deans of Engineering, and 14% for Directors of Student Affairs/Academic Affairs/Diversity/Equity and Inclusion. The combined response rate for all groups is 18.5% for which all responses were included in the analysis. The analysis tables indicated the number of 'missing' responses by participants, whereas they agreed to participate, but did not respond to all questions in the study. There were also participants who agreed to participate in the study but did not answer any questions. These participants were removed from the total responses to reduce the possibility of skewing the data.

After receiving approval from the Independent Review Board (IRB) in December 2019, an invitation email (Appendix A) tailored for each survey group was sent to all participants via an online survey platform, Qualtrics (https://Depaul.Qualtrics.com), on December 20, 2019. The invitations included the information sheet and the informed consent (Appendix A) of the study for which the participants had the options to agree to start the study, come back to it later, or opt-out of participating. There was a total of four follow-up emails (Appendix A) sent separately to each survey group between February 20, 2020, and March 18, 2020. The final email (Appendix

A) requesting participation was sent to all survey groups on April 13, 2020. It is important to note that the original survey distribution had to be modified as the researcher received feedback from potential participants indicating that they would participate but the survey was too lengthy. The lagging responses prompted a revision to all surveys on February 14, 2020, to reduce the number of questions to the following: Advisor's survey were originally 46 questions and was reduced to 17 questions; Deans of Engineering from 96 questions to 23 questions; Faculty Chairs from 60 questions to 22 questions; and Directors of Student Affairs/Academic Affairs/Diversity/Equity and Inclusion from 105 questions to 23 questions. Upon reducing the number of questions and sending the second follow-up email, the participants for all groups began to increase but still at a sluggardly pace.

Demographic characteristic is essential in providing a visual depiction of the participants who engaged in the study. Tables 3.2, 3.3, 3.4, and 3.5 provides a breakdown of the demographic characteristics for each survey group.

Table 3.2

Demographic Characteristics of Advisors

Ethnicity	N	Percent
Black or African American	5	12.5%
White	26	65%
Hispanic	3	7.5%
Asian	1	2.5%
Native American	1	2.5%
American Indian or Alaska Native	2	5%
Multiracial	2	5%
Gender		
Male	4	11.1%
Female	29	80.6%

Note. N = 36 for ethnicity and gender with cases missing for both.

Table 3.3

Demographic Characteristics of Faculty Chairs

Ethnicity	N	Percent
Black or African American	0	0%
White	24	85.7%
Hispanic	3	10.7%
Asian	0	0%
American Indian or Alaska Native	0	0%
Multiracial	1	3.6%
Gender		
Male	20	71.4%
Female	5	17.9%

Note. N = 28 for ethnicity and N = 28 with cases missing for both variable.

Table 3.4

Demographic Characteristics of Deans of Engineering

Ethnicity	N	Percent
Black or African American	3	12%
White	18	72%
Hispanic	2	8%
Asian	0	0%
American Indian or Alaska Native	0	0%
Multiracial	2	8%
Gender		
Male	13	61.9%
Female	7	33.3%

Note. N = 21 with cases missing for ethnicity and gender. The roles were from the mechanical, civil, and chemical engineering departments.

Table 3.5

Demographics of Directors of Student & Academic Affairs/Diversity/Equity/Inclusion

Ethnicity	N	Percent
Black or African American	7	26.9%
White	12	46.2%
Hispanic	1	3.8%
Asian	1	3.8%
American Indian or Alaska Native	1	3.8%
Native Hawaiian	1	3.8%
Multiracial	3	11.5%
Gender		
Male	7	35%
Female	12	60%

Note. N = 36 with cases missing for ethnicity and gender.

Variables in the Study

According to Ravid (2015), variables describe the measured characteristics in a study. Based on the criteria of this study, the variables will be continuous due to being discrete and their array of values which analyze data with distinct values. The measurements will utilize ratio scale as the data contains percentages such as attainment rate, and the evaluation of frequency data such as yes or no answers as well as how many times respondents provided the same answer to a given question. There are six continuous variables: HEI regions, academic/student support resources, assessment indicators, gender, ethnicity, and age range.

Reliability and Validity

In any research study, reliability and validity are important concepts, but in a quantitative study, these concepts are especially significant because statistics requires consistency and accuracy in analyzing the data. Reliability is necessary because it allows for the study to be replicated using the same settings. Validity indicates that the study is measuring what it is supposed to. It is relevant to determine if the data evidence corresponds to the theories in the study and the research questions. Mostly, a measurement in a study is potentially valid when it can be reproduced and provide an accurate depiction of the data (Drost, 2011; Ravid, 2015).

Data Collection and Management

Data collection and management describes the justification of all data collection methods, tools, instruments, and procedures in the study. This section will also describe the process of the data collection, specifically, how, when, where, and by whom.

Participant Selection

The recruitment of participants involved engineering programs leaders, faculty, advisors, student affairs, academic affairs, and diversity/equity/inclusion offices at HEI. The identification steps for identifying potential participants are in the target population sections. Once all 94 institutions were selected, potential participants were identified based on the criteria indicated previously, and a recruitment email was created and distributed through Qualtrics online platform (https://Depaul.Qualtrics.com) which provided a brief introduction of the researcher and the study. It also provided a survey link for the participants to access the questionnaire online. There was a disclaimer that indicated participating in the study constitutes agreement of participation but also allowed opting out of participating.

Data Collection

Qualtrics online platform was utilized as the data collection instrument of participant responses. This process was active for approximately four months. The raw data for all survey groups were exported to Microsoft Excel files separately where the data was organized and cleaned-up. Data clean-up was the process of removing data fields that Qualtrics place in the spreadsheet such as dates, times, information sheet with informed consent, IP address, respondents name, and a host of other fields that were irrelevant for statistical analysis. The cleaned-up data was then imported to IBM SPSS Statistics 26 (SPSS) for statistical analysis. There were four reminder emails sent to each group separately to request participation in the online survey.

Data Analysis

The measurement of the data used ratio and frequency in determining the relationship between the variables. SPSS and Microsoft Excel provided the computational analysis of the data. The parametric statistical test included the simple t-test and Analysis of Variance (ANOVA) for analyzing the data. Ravid (2015) provided the distinction for using the Simple t-test in computational analysis to compare the means of the groups to test all the hypothesis in this study. The comparison of these means will unearth the differences, if any. Additionally, the three-way ANOVA statistical analysis allowed the comparison of the means to test for statistical significance. It tests to see if there is a relationship between the means of the groups or is the relationship relative to chance (Hoy & Adams, 2016). To determine this significance, the researcher must examine the F-ratio to see if the p-value is less than .10 ($p < .10$). The degree of freedom (*df*) estimates variability to define the t-distribution used in calculating the p-value (Ravid, 2015). In addition, frequency distribution was utilized on most questions where the participants were able to select more than one answer for the question and to address research question 3. Frequency distribution was also used in the demographic section related to ethnicity and age range and various other questions in each survey group. Using frequency distribution allowed a tally of the data to rank and categorize the data (Ravid, 2015). Three-way ANOVA was required based on the limitation of the t-test which only compares two groups. ANOVA can look at the variance of the groups' means, and three-way ANOVA can look at three independent variables (Abbott, 2011; Muijs, 2016). Three-way ANOVA statistical test was used to address the hypothesis for research question 2.

For the data analysis, the research raw data was entered in SPSS for statistical inquiry. After careful examination, it became apparent that data organization was required prior to the analysis. There were questions with multiple variables that a respondent could select all applicable choices. This required creating and defining a variable for each choice in a question, an example of this is ethnicity and assessment measures. This process is defined in SPSS as a multiple response set and the data is considered a dichotomy group tabulated at value 1. This means that the respondents were able to choose all applicable choices and the data selections coded either with a one or zero. A coding of one indicated a respondent's selection of that answer choice, thus, a zero is a non-selection by the respondent. There are numerous other questions within all four survey groups defined and analyzed in this manner which will be indicated in each table. Frequency analysis was used to analyze all the questions, but t-test and ANOVA was used to analyze the research questions and hypothesis statements.

Ravid (2015) indicated that in conducting statistical analysis, it requires identifying independent variables (represented by X, X_1, X_2, & X_3) used to predict the dependent variable (represented by Y). This process is known as multiple correlations. In this statistical test, the data is getting to the coefficient of determination (represented by R_2), which has a variation range of 0 to 1.00. "R_2 is greater when the predictor variables have a low correlation with each other than when the predictor variables correlate highly with each other" (Ravid, 2015, p. 127). The goal of the coefficient of determination is to determine the "proportion of the variation of the combined predictor variables" (Ravid, 2015, p. 127). This inferential statistical test allowed the researcher to assess the strength of the relationship between the continuous variables to make inferences and predictions about a population based on a smaller sample of data taken from the population of analysis. The statistical tests will also assist in determining whether the data obtained is significant enough to reject or fail to reject the null hypothesis. Correlation Coefficient explains the strength of the association between the measurements of two variables. The sign and the absolute value of a correlation coefficient describes the direction and the magnitude of the relationship between two variables. The findings of the statistical tests will be discussed further in Chapter 4: Research Findings.

Instruments

Survey instruments assisted the researcher in obtaining information from a targeted population relative to the topic of the research. The researcher then analyzed the data collected from the survey to conclude the findings of the issues (Ravid, 2015). The construction of the survey consisted of open and closed-end questions, discrete choices, continuum choices, descriptive items, and concept scale questions. These types of questions used demographic, multiple choice, drop-down, open and closed-end, and Likert scale. Discrete choices offer the participants selections such as yes/no or male/female, while continuum choices used a 5-point Likert scale and bracket questions.

Surveys

The survey instruments for this study were developed by the researcher to analyze four distinct groups of administrators and faculty at HEI: Deans/Directors of Student and Academic Affairs/Diversity offices/Inclusion, Deans of Engineering, Academic Advisors in the engineering programs, and Engineering Faculty Chairpersons. The questions for each of these four survey groups had to be tailored to their job functions and responsibilities of each group. The breakdown of the surveys are as follows: Advisors contained 17 questions, Faculty Chairs contained 22 questions, Deans of Engineering contained 23 questions, and Dean/Directors of Student Affairs, Academic Affairs & Diversity/Equity/Inclusion Office contained 23 questions. Fowler (2014) defined survey research as:

> An approach to producing statistics about a population by asking questions, usually, of a subset of those in the population. The accuracy of those statistics depends on how well the subset mirrors the characteristics of the whole population and how well the answers to the questions measure what the researcher wants to describe. (p. 660)

The survey questions used in this quantitative analysis were designed for statistical computations as a means of providing generalizations about the target population. This can be achieved by designing a questionnaire that describes the characteristics of the target population using numerical data which allows the researcher to make inferences (Creswell, 2014). Questionnaires also allowed the collection and statistical analysis of large data sets. The data-evidence from the analysis supported the researcher in either confirming or rejecting the proposed assumptions. Educational researchers use the different types of approaches – quantitative, qualitative, or mixed-method to analyze the ideas, attitudes, and trends of the sample population (Fowler, 2014). Additionally, educators use these data sets to explore polices, teaching practices and curriculums, student assessment and satisfaction levels, theories, programs, and educational settings. In essence, research methods are required to provide a synopsis as to the effectiveness of the examination in question. This is where reliability is called into question and can be addressed by designing instruments that are a representation of the population (Archary, 2010).

Secondary Data Analysis

Secondary data from the 2014 and 2018 NCES and IPEDS provided additional analysis in this study related to enrollment and attainment rates in engineering programs at HEI for African American female engineering students. Also, data extrapolated from IPEDS related to the number of African American female students who enrolled in the engineering programs in 2015. The attainment rate of these females provided the data evidence of how many of them persisted and graduated.

In constructing a viable survey, researchers are required to consider several elements prior to formulating and distributing to participants. As Ravid (2015) asserted that logistics is an important element to constructing a valid and reliable survey. The logistics involve a planning approach that identifies what population will be studied and how will the instrument be administered to the target group. Other questions such as does the survey include information of the participants' experiences and demographic while maintaining confidentiality and anonymity. The last steps prior to distributing the surveys are to organize the questions and use sections if necessary, review the survey again looking at clarity and the total number of questions, and determine how missing data will be treated (Ravid, 2015).

Assumptions

Although this researcher's interest stems from examining inequities in education for African American female students, the goal is to recognize that readers might perceive bias in this research based on the researcher's race and gender in connection to this subject matter. Based on this assumption, the researcher will continuously strive to present objective findings relative to the outcome of the data evidence and not based on subjectivity or bias of the researcher.

Limitations

Abbott (2011) indicated that one consistent limitation in any type of research study is the sample size of the targeted group. This is relevant as larger sample size is preferred to provide better generalizations. However, statistical significance is still determined by p-values that range from .01 to .10 to yield an effect on the sample size.

Chapter III Summary

This study used a synthesis of existing theories to examine the relationship between diversity policies and recruitment, along with academic initiatives and student retention, faculty and student interactions, and assessment of programs and student attainment rates. The study analyzed data collected from surveys distributed to various groups for which the findings are reported out based on each group from the sub-populations. Secondary data from the 2014 and 2018 NCES and IPEDS on engineering enrollment and attainment rate for African American females were analyzed using descriptive and inferential statistics. Also, the research looked at the diversity percentages of engineering students at these institutions.

The research methodology for this study assisted in analyzing if there is a relationship between institutional effectiveness and their established support mechanisms to assist their African American female engineering students toward attainment. Through this process, the survey instrument was developed as a means of collecting data to test the hypotheses to either reject or fail to reject the null hypothesis. The next chapter, Chapter four: Research Findings, will present the data outcome from each survey group along with the statistical analysis of the research questions and research hypotheses.

Chapter IV

Results of the Study

Overview

Conducting research in educational settings explores various phenomena. These phenomena cover many issues that besetting educational institutions’ pertaining to their students, faculty, staff, curriculum, practices, culture, systems, and any moving part of the organization. Researchers use either quantitative or qualitative research to explain a phenomenon or a combination of both, described as mixed-method research (Muijs, 2016). Additionally, Muijs (2016) provided information on examining phenomena through quantitative research methods to analyze numerical data statistically. The literature review for this research suggested the necessity to explore institutions' initiatives and assessment measures through a quantitative analysis. The outcome required determining how the institutions assess the effectiveness of their initiatives in assisting students in persisting and obtaining their degrees, especially African American female engineering students.

Quantitative research is a scientific tool used to analyze a large quantity of numeric data. It is well suited to examine the effectiveness of support systems within HEI by providing flexibility and a data structure that is conclusive and objective. The research instrument (questionnaires) provided further flexibility to examine four roles at HEI: the representing agents (Advisors, Faculty Chairs, Deans of Engineering in the Mechanical, Civil, and Chemical departments, and Directors of Student & Academic Affairs/Diversity/Equity/Inclusion). Using this process was an essential piece of the investigative process as the design of the instrument allowed the participants to answer various types of questions using rating tools such as the Likert scale, multiple-choice, open-ended, closed-ended, and multiple responses.

This chapter provided the significant findings of the statistical data analysis from the participants in each survey group. First, it provided the demographics for each participant group which included their role, gender, ethnicity, and age range. Second, it presented the research questions and the hypotheses analysis. Third, the findings for a few questions on the participants' questionnaire discussed how they informed the study—finally, the summary of the findings for all the participant groups.

This research analysis aimed to determine whether there is statistically significant difference between HEI in various regions that utilize an array of academic initiatives, support resources, and assessment measures to support the degree attainment for African American female engineering students. Additionally, this study aimed to determine if there were diversity levels at HEI within the four participant roles of Advisors, Faculty Chairs, Deans of Engineering, and Directors of Academic & Student Affairs/Diversity/Equity/Inclusion, representing agents for their institution.

Data collected from 63 higher educational institutions out of 94 selected for this study was classified as either Land-Grant or Predominantly White Institutions, and Carnegie classification 'Very high research activity'. Frequency distribution statistically analyzed the raw data of the questionnaires for each survey group based on the various response types and the hypotheses tested for all three research questions using two-way and three-way ANOVA. Additionally, the extrapolated secondary data from IPEDS analyzed the hypotheses testing.

The statistical results also included the demographic data for each survey group, the response rates of the participants, and secondary data analysis from the Integrated Postsecondary Education Data System (IPEDS) variables of 2014 enrollment numbers and 2018 attainment numbers for African American female engineering students. The disaggregated data of the

IPEDS variables provided the researcher with statistics on this population's enrollment and attainment rate. This data assisted in informing the researcher of the total number of these students entering HEI engineering programs and then how many graduated from the program. The statistical analysis for questions not presented in this section are presented in Appendices E, F, G, and H (Table 4.1). These questions informed the study by providing data on practical experiences for each survey group for which some questions and sub-sections were similar within the groups (i.e., assessment, funding, professional development, and suggestions for improvements). This information allowed data clustering to check for similarity in the answers within and between the groups. Table 4.1 provides a reference for each survey group's demographic questions, which the raw data is in the corresponding appendix.

Table 4.1

Reference Table for Demographic Data

Survey Group	Demographic Data	Appendix
Advisors	Table 4.3	E.1 – E.4
Faculty Chairs	Table 4.4	F.1 – F.4
Deans of Engineering	Table 4.5	G.1 – G.4
Directors of Student & Academic Affairs/Diversity/Equity/Inclusion	Table 4.6	H.1 – H.4

Note. A cross-reference guide for all survey questions for each participant group.

For the research hypotheses analysis, an acceptable Cronbach's alpha level of .10 determined statistically significant results to either reject or fail to reject the null hypotheses. The three hypotheses for the research questions were analyzed, and the results are in the corresponding table listed below.

Table 4.2

Reference Table for Demographic Data

Research/Hypothesis	Table
RQ1/H_a	Tables 4.8, 4.9, 4.10, and 4.11
RQ2/H_a	Tables 4.12, 4.13, 4.14, and 4.15
RQ3/H_a	Tables 4.16, 4.17, 4.18, and 4.19

Note. Reference table for this chapter for all demographic data for each participant group.

Findings

Participants Demographic Data

The breakdown of the demographic data for all four survey roles (Advisors, Faculty Chairs, Deans of Engineering, and Directors of Student & Academic Affairs/Diversity/Equity/Inclusion) are represented in Tables 4.3 through 4.6. The participant's demographic data relates to their ethnicity, gender, and age range. The survey questions for ethnicity and age range required defining the data as multiple response sets in SPSS, while the gender question was dichotomous.

Advisors

Table 4.3 provides the outcome of the descriptive covariates for Advisors. The ethnic variable was defined and analyzed in SPSS as a multiple response set. Analyzing in this manner produced output in percentages higher than 100% as it represents the frequency distribution of participants' selection choices, yielding 114.3% of cases for Advisors. The output of 114.3% is the result of participants having the option to choose more than one response to a question. Thus, allowing the compilation of the various ethnic groups for statistical purposes. The total respondents for the Advisors group were N = 36, with one respondent not answering at N = 1 or 2.8%. Thus, valid responses at N = 35 or 97.2%. The data outcome showed females at N = 29 or

80.6% and males at N = 4 or 11.1%. The total respondents were N = 36, with three respondents not indicating their gender at N = 3 or 8.3%. Thus, the total valid responses are N = 33 or 91.7%.

The age range distribution outcome for engineering advisors for the categories 25-34 and 55-64 was each N = 10 or 27.8%, followed closely by the 35-44 category at N = 9 or 25%. The data evidence of the last two categories showed 45-54 at N = 4 or 11.1% and 65-74 at N = 2 or 5.6%. There were no participants in the other two categories of 75-84 and 85 or older. The total respondents were N = 36 or 100%, with no missing responses.

Within this role, the data indicated a significantly higher level of dominance by ethnicity – white, gender – female, and age range – 25-34 and 55-64. Based on the significantly higher percentages of these categories, HEI needs to assess their advisor roles in engineering to ensure appropriate representation for all students attending these programs.

Table 4.3

Advisors Survey Group Demographics Breakdown

Advisors	Ethnicity	Percent	Gender	Percent	Age Range	Percent
Highest Group	White	65%	Female	80.6%	25-34 & 55-64	27.8%
Lowest Group	Asian/Native American	2.5%	Male	11.1%	65-74	5.6%

Note. N = 36. Percentages do not equal 100% because of missing cases.

Faculty Chairs

Table 4.4 shows the outcome of the descriptive covariates for the Faculty Chairs participants, which was also defined and analyzed in SPSS as a multiple response set. The total respondents for this group at N = 28, with two respondents not answering at N = 2 or 7.1% yielding valid responses at N = 26 or 92.9%, with a percent of cases at 107.7%. The demographic outcome for the ethnicity variable showed the White ethnicity at 85.7% as the majority for this role at HEI. In contrast, the other ethnicities ranged from 3.6% to 10.7%. The gender data distribution for Faculty Chairs showed the demographic of this role at HEI to be significantly higher for males at N = 20 or 71.4% and females represented at N = 5 or 17.9%. The total respondents were N = 28, with three respondents not answering N = 3 or 10.7%. Table 4.3 also shows the outcome of the age range distribution for Faculty Chairs (Chemical, Civil, and Mechanical) in engineering. In this role, the data also presented variances in the age range categories; 55-64 at N = 11 or 39.3%, followed closely by 45-54 at N = 9 or 32.1%. Additionally, categories 25-34, 35-44, and 65-74 were significantly lower at N = 1 or 3.6%, N = 2 at 7.1%, and N = 4 or 14.3%. All respondents provided their age at N = 28 or 100% on the survey. There was a vast difference between the majority and minority groups for this participant group, with White males significantly outnumbering the other groups. Griffin et al. (2010) study discussed the strategies and support that assist faculty of color in persisting in the STEM fields leading to representation in HEI for STEM students. The rationale is apparent for increasing the number of Black Female Faculty Chairs, which requires increasing the number of African American Female Engineers.

Table 4.4

Faculty Chairs Survey Group Demographics

Faculty Chairs	Ethnicity	Percent	Gender	Percent	Age Range	Percent
Highest Group	White	85.7%	Male	71.4%	55-64	39.3%
Lowest Group	Multi-Racial	3.6%	Female	17.9%	25-34	3.6%

Note. N = 28. Percentages do not equal 100% because of missing cases.

Deans of Engineering

Table 4.5 shows the outcome of the descriptive covariate for Deans of Engineering (Mechanical, Civil, and Chemical departments). As discussed in the previous two groups, the White ethnicity also had a higher percentile of 72% compared to the other ethnicities ranging from 8% to 12%. There were no respondents in the ethnic group categories of Other Pacific Islander, Asian, Native American, and American Indian. The total respondents for this group were N = 21 with no missing data. The percent of cases for this group is 119%. The analysis of the gender distribution for Deans of Engineering is an essential component for this role at HEI which indicated a significantly higher outcome for males at N = 13 or 61.9% and females represented at N = 7 or 33.3% (Table 4.4). The total respondents within the gender category were N = 21, with one respondent not answering at N = 1 or 4.8%. The data outcome provided total valid responses at 65% for males and 35% for females. The data variance in the age range distribution for the Deans of Engineering indicated N = 12 or 57.1% for the 55-64 age range category. All other age range categories were significantly lower, ranging from 19% to 9.5%. The total respondents for the age range category were N = 21 or 100%, with no missing responses. This participant group is similar to the outcome of the Faculty Chairs, where again, the majority group is the White Male Deans of Engineering. A lack of diversity requires assessment and strategies to increase representation for Black Female Deans of Engineering.

Table 4.5

Deans of Engineering Survey Group Demographics

Deans of Engineering	Ethnicity	Percent	Gender	Percent	Age Range	Percent
Highest Racial Group	White	72%	Male	61.9%	55-64	57.1%
Lowest Racial Group	Hispanic/Multi-Racial	8%	Female	33.3%	45-54	9.5%

Note. n = 21. Percentages do not equal 100% because of missing cases.

Directors of Student & Academic Affairs/Diversity/Equity/Inclusion

Table 4.6 shows the outcome of the descriptive covariate for Directors of Student & Academic Affairs/Diversity/Equity/Inclusion roles were also defined and analyzed in SPSS as a multiple response set. Following suit of the previous roles, this group had a majority ethnicity of White at 65%; however, the other races have a relatively low percentage ranging from 2.5% to 12.5%. The total respondents for this group were N = 36, with one respondent not answering at N = 1 or 2.8%. The results provided valid N = 35 or 97.2% responses, and the percent of cases at 114.3%. The gender demographic outcome for the Directors of Student & Academic Affairs/Diversity/Equity/Inclusion provided a viable component for this variable. The data indicated higher gender demographic for females in this role at a statistical level at N = 12 or 60% and males at N = 7 or 35%. The total respondents for the gender category were N = 20, with one missing respondent (N = 1 or 5%). The total valid responses resulted in 36.8% for males and 63.2% for women.

Additionally, Table 4.6 shows the age range data outcome for Directors of Student & Academic Affairs/Diversity/Equity/Inclusion. The age range of 55-64 was the highest at N = 8 or 40%, and the other categories ranged from 20% to 10%. The total respondents for the age range category were N = 20 or 100%, with no missing responses. This participant group was interesting as it also followed suit of the Advisors' group. However, there was a vast difference in the number of white females compared to the other ethnicities in this group. As indicated above, the outcome prompts a reason for assessment and transformation: the populous student consists of numerous ethnicities and gender. There must be a balance in demographics for these roles to encompass an array of representation for the students.

Table 4.6

Directors of Student & Academic Affairs/Diversity/Equity/Inclusion Survey Group Demographics

Directors of Student & Academic Affairs/Diversity/Equity/ Inclusion	Ethnicity	Percent	Gender	Percent	Age Range	Percent
Highest Ethnicity Group	White	65%	Female	60%	55-64	40%
Lowest Ethnicity Group	Asian/Native American	2.5%	Male	35%	65-74	10%

Note. N = 36. Percentages does not equal 100% because of missing cases.

Table 4.7 illustrates the totals and percentages for the two frameworks (Land-Grant Institutions and Carnegie Classification of ‘Very high research activity’) used in this study for HEI. Also, it provided the totals and percentages for the six accrediting organizations for HEI: Higher Learning Commission (HLC), Middle States Commission on Higher Education (MSCHE), New England Commission of Higher Education (NECHE), Northwest Commission on Colleges and Universities (NWCCU), and Southern Association of Colleges and Schools Commission on Colleges (SACSCOC). Appendix C provides a breakdown of the states in each accrediting organization. The regional accreditation organization consist of six regions within the U.S.: New England, Middle States, North Central, Southern, Western, and Northwest. These organizations are recognized by the Council for Higher Education Accreditation (CHEA) and responsible for the review of HEI within their region.

It is important to notate that Table 4.7 does not provide a breakdown relative to institution types such as predominantly white institution, historically black institution, private, public, or Ivy League. Additionally, the total and percentages does not equal 100% because forty of the institutions are categorized as both Land-Grant and ‘Very high research activity’. The institutions in this study are classified as predominantly white institutions in HEI, except for two of them. Within this study, it is important to notate that the total number of representative institutions was *N* = 63 out of the 94 selected institutions.

Table 4.7

Demographic of Higher Education Institutions

Type	Total	Percentage
Land-Grant Institutions	40	42.5%
Carnegie Classification 'Very high research activity'	85	90%
Accreditation Organizations		
HLC	25	26.6%
SACSCOC	26	27.7%
WSCUC	9	9.6%
MSCHE	16	17%
NECHE	11	11.7%
NWCCU	7	7.4%
Total	94	100%

Note. N = 94 for HEI for this study.

Research Questions and Hypotheses Analysis

There are three research questions in this study with each having one hypothesis. The primary goal is to analyze the variables using the statistical tests of two-way and three-way ANOVAs. The ANOVA statistical test was used to test the hypothesis by comparing the means between and with-in the four groups checking to see if there were statistically significant differences that are by chance, $p < 0.10$. The primary goal of running the ANOVA test was to determine whether there was an interaction between the independent variables on the dependent variable. The ANOVA testing was necessary in this research to examine if there was a statistically significant difference in the four groups mean. The t-test statistical analysis was used to inform the researcher and provide a comparison of two groups at a time, but not to determine statistically significance. The statistical software, Stata 17, was used to analyze the variables for each hypothesis. The parameters of Stata 17 allowed clustering variables to group the data on the questionnaire. For example, the data for the ethnicity variable was clustered to allow the combination of various ethnic groups. Additionally, the researcher used clustering of the data choices into one variable for analysis that was used in RQ1 and RQ3. This clustering of data points produced variables that were similar in their category which allowed an in-depth exploratory process of data interpretation. The groups were established based on the homogeneous of their academic roles, administrators or faculty.

The following table provides a listing of all variables used to analyze the three research questions:

Table 4.8

Dependent and Independent Variables

Dependent	Independent
African American Student Attainment Rate	HEI Regions Academic/Student Support Resources Assessment Indicators Gender Ethnicity Age Range

Note. All variables used in this study.

There were three research questions in this study that examined support/initiatives, diversity for faculty and administrators, and assessment indicators at HEI to progress the African American female engineering student's attainment rate. The outcome of the statistical analysis determined whether to reject or fail to reject the null hypotheses. Table 4.9 provides a point of reference for the survey questions in each survey group that was used to analyze the research questions.

Table 4.9

Statistical Analysis Guide

Group	Research Question #1	Research Question #2	Research Question #3
Advisors	Q8	Q2, Q3, & Q4	Q11 & Q13
Faculty Chairs	Q13	Q2, Q3, & Q4	Q17
Deans of Engineering	Q11 & Q15	Q2, Q3, & Q4	Q9
Directors of Student Affairs / Diversity / Inclusion	Q15, Q16, Q18, & Q19	Q2, Q3, & Q4	Q13

Note. A reference guide showing the questions used for each research question within each participant group.

Generally, in academic research the null hypothesis is formulated to indicate what is not occurring or neutrality of an issue. On the other hand, the research hypothesis indicates the assumption of the researcher to be either a negative or positive association between the dependent variables on the independent variable. In this study, each research question presented different perspectives such as RQ1 was formulated traditionally with the null hypothesis indicating neutrality and the alternate hypothesis indicating a positive association. RQ2 presented an opposing component with the null hypothesis taking a stance that there are diversity levels which positively impacts the student attainment rate while the research hypothesis indicates no diversity level which negatively impacts the student attainment rate. Finally, RQ3 followed suit of RQ2 with presenting the opposing component for the null hypothesis which indicated that the presence of assessment indicators positively impacts the student attainment rate and the research hypothesis indicated that the lack of assessment indicators negatively impacts the student attainment rate.

The three research questions along with each null hypothesis and research hypothesis are as follows:

RQ1: *Does the presence of support resources/academic initiatives increase the attainment rate for African American female engineering students within the HEI accrediting regions?*

- Null Hypothesis (H_0): There is no association between academic/support initiatives within HEI on the degree completion for African American female engineering students.
- Hypothesis (H_a): There is a positive association between academic/support initiatives within HEI that on the degree completion for African American female engineering students.

Tables 4.10, 4.11, 4.12, and 4.13 represents the two-way ANOVA statistical tests conducted separately for each participant group (Advisors, Faculty Chairs, Deans of Engineering, and Director of Student & Academic Affairs/Diversity/Equity/Inclusion. The study examined the effects of the independent variables of academic resources/initiatives and institutions region on the dependent variable student's attainment rate. Academic resources/initiatives included sub-categories of academic support/initiatives, diversity, engineering organizations, other support/student support, advising, mentoring, and tutoring. The variable institutions region included the sub-categories HLC, SACSCOC, WSCUC, MSCHE, NECHE, and NWCCU. These independent variables were statistically analyzed to determine their impact on the dependent variable, attainment rate, which included the African American female engineering students' attainment rate for the institutions included in this research.

The outcome of the statistical analysis showed no statistically significant effects for all participant groups for the categories of academic resources/initiatives and institutions regions on the student's attainment rate. The non-statistically significant results for Advisors at $F(4, 6)$ =

.45, $p = .77$ which indicated that within the Advisors group there was minimal variance between the independent and dependent variables.

Following suit of the Advisors group, Faculty Chairs, Deans of Engineering, and the Directors of Student & Academic Affairs/Diversity/Equity/Inclusion had non-statistically significant results. Deans of Engineering data analysis yielded $F(0)$ while the Directors of Student and Academic Affairs/Diversity/Equity/Inclusion yielded $F(2, 2) = 7.62$, $p = .11$. Although the Faculty Chairs group yielded statistically significant results for the variables separately, it did not yield statistically significant results for the two-way interaction at $F(0)$. The results of $F(0)$ indicates that the means in each group are equal. However, the findings must demonstrate variance across the board for all participant groups and a two-way interaction between the independent variables on the dependent variable to have statistically significant results for RQ1. Thus, the findings of the data analysis for RQ1 resulted in non-statistically significant data outcome for all four participant groups, thus failing to reject the null hypothesis. The results did not require conducting a post hoc test.

Table 4.10

Between Groups Effects for RQ1-Advisors

H_1 Variables	*df*	*F*	*P*
Attainment Rate			
Academic Resources	6	.13	.99
Region	4	.50	.74
Academic Resources X Region	4	.45	.77

Note. *df* represents the degree of freedom, *F* is the variation between the means, and *P* represents the p-value which is set at p < .10 and whether or not statistically significant outcome exist.

Table 4.11

Between Groups Effects for RQ1- Faculty Chairs

H_1 Variables	*df*	*F*	*P*
Attainment Rate			
Region	3	3.91	.03
Academic Resources	1	7.56	.01
Academic Resources X Region	0		

Note. *df* represents the degree of freedom, *F* is the variation between the means, and *P* represents the p-value which is set at $p < .10$ and whether or not statistically significant outcome exist.

Table 4.12

Between Groups Effects for RQ1- Deans of Engineering

H_1 Variables	*df*	*F*	*P*
Attainment Rate			
Region	3	1.72	.21
Academic Resources	1	.34	.57
Region X Academic Resources	0		

Note. *df* represents the degree of freedom, *F* is the variation between the means, and *P* represents the p-value which is set at $p < .10$ and whether or not statistically significant outcome exist.

Table 4.13

Between Groups Effects for RQ1- Directors of Student and Academic Affairs/Diversity/Equity/Inclusion

H_1 Variables	*df*	*F*	*P*
Attainment Rate			
Region	3	4.68	.18
Academic Resources	4	1.41	.45
Region X Academic Resources	2	7.62	.12

Note. *df* represents the degree of freedom, *F* is the variation between the means, and *P* represents the p-value which is set at $p < .10$ and whether or not statistically significant outcome exist.

RQ2**:** *Is the student attainment rate for African American female engineering student associated with the level of diversity for HEI administrators and the faculty roles?*

- Null Hypothesis (H_0): There is diversity in ethnicity, gender, and age range for the HEI administrators and the faculty roles that contribute to positive outcomes in the student attainment rate for African American female engineering students.
- Hypothesis (H_a): There is no diversity in ethnicity, gender, and age range for HEI administrators and the faculty roles that contribute to negative outcomes in the student attainment rate for African American female engineering students.

Tables 4.14, 4.15, 4.16, and 4.17 illustrates the data outcome for RQ2 to determine whether statistically significant data results existed to either reject or fail to reject the null hypothesis. The independent variables for this hypothesis analysis were gender, ethnicity, age range, and the dependent variable was attainment rate. The ethnicity variable was clustered as the participants were able to select multiple races, such as Black and White.

The data outcome in Table 4.14 for the Advisors role (HEI administrators) did not yield statistically significant results for either the HEI administrators or faculty roles thus eliminating the requirement of a post hoc test. The Advisors role had statistically significant difference in HEI regions with gender at $F(1, 26) = 4.25$, $p = .05$, and region with ethnicity at $F(4, 26) = 5.44$, $p = .01$. However, when gender and ethnicity were paired together on HEI regions, the outcome yielded statistically insignificant difference at $F(0)$. For the variables gender and age range on HEI regions, the results were also statistically insignificant difference at $F(2, 23) = .21$, $p = .81$. The last results pertain to ethnicity and age range on HEI regions yielded $F(3, 22) = 1.09$, $p = .37$.

Table 4.14

Diversity within the demographic variables/Results for Advisor Group

Variables	*df*	F	*P*
Gender X Ethnicity	0		
Gender X Age Range	2	.21	.81
Ethnicity X Age Range	3	1.09	.37
Gender X Ethnicity X Age Range	0		

Note. *df* represents the degree of freedom, *F* is the variation between the means, and *P* represents the p-value which is set at $p < .10$ and whether or not statistically significant outcome exist.

Table 4.15 shows the data results for the participant group Faculty Chairs which yielded statistically non-significant results for all the variables at *F*(0). The table also shows the pairing of the independent variables on HEI regions. The Faculty Chairs (faculty role) had statistically non-significant differences in HEI regions for all independent variables paired together at *F*(0).

Table 4.15

Diversity within the demographic variables/Results for Faculty Chairs Group

Variables	*df*	F	*P*
Gender X Ethnicity	0		
Gender X Age Range	2	1.54	.24
Ethnicity X Age Range	1	2.04	.17
Gender X Ethnicity X Age Range	0		

Note. *df* represents the degree of freedom, *F* is the variation between the means, and *P* represents the p-value which is set at $p < .10$ and whether or not statistically significant outcome exist.

Table 4.15 shows the data results for the participant group Deans of Engineering (faculty role) which also yielded statistically non-significant results for all the variables at *F*(0). The table also shows the data results of pairing the independent variables on HEI regions.

Table 4.16

Diversity within the demographic variables/Results for Deans of Engineering Group

Variables	*df*	F	*P*
Gender X Ethnicity	1	.02	.90
Gender X Age Range	2	.67	.53
Ethnicity X Age Range	1	.01	.91
Gender X Ethnicity X Age Range	0		

Note. *df* represents the degree of freedom, *F* is the variation between the means, and *P* represents the p-value which is set at $p < .10$ and whether or not statistically significant outcome exist.

The last group of Directors of Student & Academic Affairs/Diversity/Equity/Inclusion followed suit of the previous groups with statistically non-significant results for all variables at *F*(0). Table 4.16 illustrates the data outcome of the independent variables paired with each other on the dependent variable.

Table 4.17

Diversity within the demographic variables/Results for Directors of Student and Academic Affairs/Diversity/Equity/Inclusion Group

Variables	*df*	F	*P*
Gender X Ethnicity	1	1.21	.29
Gender X Age Range	1	2.67	.13
Ethnicity X Age Range	2	.05	.95
Gender X Ethnicity X Age Range	0		

Note. *df* represents the degree of freedom, *F* is the variation between the means, and *P* represents the p-value which is set at $p < .10$ and whether or not statistically significant outcome exist.

Thus, failing to reject the null hypothesis for this research question with post hoc test not conducted. These results indicated a minimal level of diversity within the Advisor participant group for gender and age range within the HEI regions. However, the other three groups did not have sufficient diversity levels for ethnicity, gender, and age range within the various regions in HEI.

RQ3: *Are there assessment indicators at HEI that progress the academic attainment rate for African American female engineering students?*

- Null Hypothesis (H_0): The presence of assessment indicators for academic support at universities has a positive impact on the attainment rate for African American female engineering students.
- Alternative Hypothesis (H_a): The non-presence of assessment indicators for academic support at universities negatively impact the attainment rate for African American female engineering students.

This research question was formulated to determine whether the assessment indicators (drop in grade point average, by student request, decline in grades, lack of attendance, program requirements, and other criteria) at HEI within the various regions either positively or negatively affect the attainment rate for African American female engineering students. Tables 4.18, 4.19, 4.20, and 4.21 provide the statistical analysis using a two-way ANOVA for each participant group. There were statistically insignificant results for the advisor group at $F(6, 13) = .32$, $p = .92$ and for the Directors of Academic and Student Affairs/Diversity/Equity/Inclusion at $F(1, 2) = 2.29$, $p = .27$. Alternatively, there was statistically significant results for the Faculty Chairs group at $F(4, 12) = 2.66$, $p = .08$ and for the Deans of Engineering group at $F(1, 3) = 30.37$, $p = .01$. Based on this data, the outcome indicated failing to reject the null hypothesis as the statistically significant results did not occur for all four participant groups. Again, eliminating the need to conduct a post hoc test.

Table 4.18

Student Assessment Indicators – Advisors Group

H_1 Variables	*df*	*F*	*P*
Attainment Rate			
Region	5	.87	.53
Assessment Indicators	3	.50	.69
Region X Assessment Indicators	6	.32	.92

Note. *df* represents the degree of freedom, *F* is the variation between the means, and *P* represents the p-value which is set at $p < .10$ and whether or not statistically significant outcome exist.

Table 4.19

Student Assessment Indicators – Faculty Chair Group

H_1 Variables	*df*	*F*	*P*
Attainment Rate			
Region	4	2.13	.14
Assessment Indicators	4	.60	.67
Region X Assessment Indicators	4	2.66	.08

Note. *df* represents the degree of freedom, *F* is the variation between the means, and *P* represents the p-value which is set at $p < .10$ and whether or not statistically significant outcome exist.

Table 4.20

Student Assessment Indicators – Deans of Engineering Group

H_1 Variables	*df*	*F*	*P*
Attainment Rate			
Region	3	281.58	.01
Assessment Indicators	3	142.13	.01
Region X Assessment Indicators	1	30.37	.01

Note. *df* represents the degree of freedom, *F* is the variation between the means, and *P* represents the p-value which is set at $p < .10$ and whether or not statistically significant outcome exist.

Table 4.21

Student Assessment Indicators – Directors of Student and Academic Affairs/Diversity/Equity/Inclusion Group

H_1 Variables	*df*	*F*	*P*
Attainment Rate			
Region	3	1.10	.51
Assessment Indicators	3	1.39	.44
Region X Assessment Indicators	1	2.29	.27

Note. *df* represents the degree of freedom, *F* is the variation between the means, and *P* represents the p-value which is set at $p < .10$ and whether or not statistically significant outcome exist.

Quantitative Data Analysis Summary

The data for each survey group (Advisors, Faculty Chairs, Deans of Engineering (Mechanical, Civil, and Chemical) was statistically analyzed separately to provide evidence to determine if a connection exist between the outcome of the data analysis and the conceptual framework of this study. It also assisted in informing the implications of future research and suggestions for institutions and policies, but this will be discussed further in Chapter 5.

The statistical results for each survey group were broken down by their respective group and presented by frequency distribution analysis. Frequency distribution analysis was selected to statistically analyze majority of the data due to the design of the survey questions. A good portion of the survey questions gave the participants the option to select all applicable answer choices. For these questions, some of the data was analyzed using frequency distribution, descriptive statistics, and one-way ANOVA. A comprehensive raw data analysis for all survey questions by group can be explored in Appendices E, F, G, and H.

Advisor Survey Group Analysis

The following analysis pertains to the practical experience of Advisors as their roles relate to African American female engineering students. Questions 14-17 covered suggestions to improve culture, recruitment and retention of African American female engineering students, recruitment and retention of African American female faculty and diversity. The clustering of these questions allowed grouping of the participants' answers. This method was intentionally chosen after the researcher started to see a trend in the participants' answers during the coding process for the open-ended questions. Frequency analysis had to be used to analyze the data again based on the design of the survey questions to which SPSS treats this data as a multiple response set.

Table 4.22 examined HEI assessment methods in determining whether a student requires academic intervention and the actual number and percentages of participants in this group broken down by how many answered the questions (valid) along with those who did not (cases missing). In this question, the number was higher at N = 91 because participants could choose all applicable choices, total cases are N = 36. There were missing participant responses at N = 9 or 25%. The data showed a somewhat even distribution of selection of choices with the highest category being 'student request appointment' (N = 23) and the lowest being 'lack of attending class' (N = 14). This was interesting to which Maton et al. (2012) confirmed this finding by indicating in their research that educational institutions need to establish an early warning detection system to identify students requiring academic assistance. Additionally, these researchers recommended that consistent monitoring along with advising provides support and guidance to reduce academic pitfalls for students. The findings of this question indicated that institutions rely on students to vocalize whether they need assistance. This is a reactive approach as students may not seek help or direction until their situation is dire, student request appointment at N = 23 or 25.3% and lack of attending class at N = 14 or 15.4%.

Table 4.22

Assessment Measures (perception of needs) for Advisors Survey Group

Q7: Assessment Measures	N	Percent	Percent of Cases
Student Request Appt. (highest)	23	25.3%	85.2%
Lack of attending class (lowest)	14	15.4%	51.9%
Total Valid	27	75%	
Missing	9	25%	
Total	36	100%	

Note. N = 36. Frequency distribution using multiple response set. Variables tabulated at value 1.

Table 4.23 indicates the usage of innovative advising practices to 'think outside the box' at HEI. This brings creativity to advising practices and promotes creativity to establish student outreach, connectivity, and support. The results of the data had an outstanding utilization rate at N = 23 or 63.9%. There were participants that did not answer this question at N = 9 or 25%.

Table 4.23

Innovative Advising Practices – Advisors Survey Group

Q13: Innovative Advising Practices	N	Percent	Valid Percent
Yes	23	63.9%	85.2%
No	4	11.1%	14.8%
Total	27	75%	100%
Missing	9	25%	
Total	36	100%	

Note. N = 36. Dichotomous variable.

The data evidence in this section provided information regarding the importance of establishing assessment measures and innovative advising practices of student's performance.

Institutions employing these practices create holistic processes to support the educational journey of students. The next section will examine the practical experiences of Engineering Faculty Chairs, specifically in the disciplines of Civil, Chemical, and Mechanical.

Faculty Chairs (Civil, Chemical, & Mechanical) Survey Group Analysis

The following frequency distribution analysis pertains to the practical experience of Faculty Chairs as their role relate to African American female engineering students (Table 4.24). Questions 19-22 pertaining to suggestions to improve culture, recruitment and retention of African American female engineering students, recruitment and retention of African American female faculty, and diversity have been clustered to analyze the data (Appendix F). Additionally, clustered analysis was used for the survey questions related to the average number of students in each class, average number African American female engineering students in each class, teaching or lab assistant, hours per week advising students, hours each semester advising students, number of African American engineering students advised, and number of publications with students (Appendix F).

The data outcome of this survey group also indicated that HEI determine if students need assistance primarily through the students requesting assistance (N = 19 or 25.7%), but also if their grades start to decline (N = 18 or 24.3%). The other factors of drop in GPA, other school criteria, and lack of attending class were very close ranging from 16.2% to 17.6%.

Table 4.24

Identify Students - Faculty Chairs Survey Group

Q14: Identification	N	Valid Percent
By Student Request	19	25.7%
Other school criteria	12	16.2%
Lack of attending class	12	16.2%
Total	24	85.7%
Missing	4	14.3%
Total	28	100%

Note. N = 28. Frequency distribution using multiple response set. Variables tabulated at value 1.

As indicated above, the faculty chairs group were like the advisor's group with the highest answer selection being students requesting assistance. This is a concerning factor as the process needs to be comprehensive and the highest factor need not be at the student request to provide better student support. It is also important to note that the answer choices for these two groups were very close in the data outcome. The next group to be examined are the Deans of Engineering to evaluate the output in determining similarity in the results or vast differences.

Deans of Engineering Survey Group Analysis

The Deans of Engineering were the next group to be analyzed looking for similarities or differences in the data analysis outcome. Table 4.25 explores the types of freshman orientation that HEI offers to incoming students. The data evidence indicated that the topic addressed the most in freshmen orientation is 'academic support services' at N = 15 or 28.3% and 'discrimination' at N = 7 or 13.2%. This showed a significant disparity in higher education taking a proactive approach in presenting and having a conversation with new students on high level cultural topics that hinder welcoming environments at HEI. The presentation of cultural topics during freshman orientation introduces and confirms the quality of the institutions culture by presenting factors that impede a welcoming environment for all students. Table 4.26 indicated an even more disturbing result related to the frequency of yearly assessment of these topics. The analysis indicated that N = 10 at 47.67% of HEI do not offer yearly assessment and N = 5 or 23.8% of HEI do offer yearly assessment. This question had missing responses of respondents at N = 21 or 28.6%.

Table 4.25

Freshman Orientation - Deans of Engineering Survey Group

Q5: Freshman Orientation	N	Percent
Academic Support Svc	15	28.3%
Discrimination	7	13.2%
Total	16	76.2%
Missing	5	23.8%
Total	21	100%

Note. N = 21. Frequency distribution using multiple response set. Variables tabulated at value 1. **Table 4.26**

Yearly student assessment - Deans of Engineering Survey Group

Q6	N	Percent	Percent of Cases
Yes	5	23.8%	33.3%
No	10	47.6%	66.7%
Total	15	71.4%	
Missing	6	28.6%	
Total	21	100%	

Note. N = 21. Dichotomous variable.

Appendix G provides the cluster analysis of questions 20-23 related to suggestions to improve culture, recruitment and retention of African American female engineering students, recruitment and retention of African American female faculty and diversity. Additionally, clustered analysis can be found in Appendix G for the following questions: Q12 - number of African American female faculty mentored, Q14 - number of African American female engineering students mentored, Q15 - means of identifying students to be mentored, and Q17 - number of African American female faculty in engineering departments.

In response to Question 7 – Does your university have measures in place to assess the effectiveness of the items below? This question is essential in discussing that the university has assessment measures in place to analyze effectiveness. So, it is not enough to have processes in place but progressive to have both assessment measures and analysis of effectiveness. Table 4.27 statistical output revealed that HEI have a higher assessment of the culture of engineering programs and student performance at N = 15 or 31.9%, respectively. The least assessed component is faculty performance at N = 6 or 12.8%. All four of these factors are important and require a closer percentage of assessment to provide HEI with an overall dynamic of assessment. There were also five respondents that did not answer this question resulting in a 23.8% reduction of answers and valid responses at N = 16 or 76.2%.

Table 4.27

Measures of assessment related to effectiveness – (Multiple response set) for Deans of Engineering Survey Group (N = 21)

Q7:	N	Percent	Percent of Cases
Culture of Eng. Program	15	31.9%	93.8%
Student Performance	15	31.9%	93.8%
Faculty Performance	6	12.8%	37.5%
Total	16	76.2%	
Missing	5	23.8%	

Note. N = 21. Frequency distribution using multiple response set. Variables tabulated at value 1.

Question 13 – What measures does your institution use to strengthen faculty engagement in student achievement? There were no significant differences in the findings of this questions as the outcome of the participants choices were extremely close ranging from N = 3 to N = 1 (Table 4.28). Academic support had the highest result at N = 3 or 33.3%, while the other choices were close at N = 2 or 22.2% and N = 1 or 11.1%. There were considerably low responses for this question N = 7 at 33.3% with participants not answering at N = 14 or 66.7%. An assumption surfaced based on this output that the participants in this group did not know the answers for this question, yet this group hold an essential leadership role at their HEI.

Table 4.28

Strengthen Measures for faculty engagement - Deans of Engineering Survey Group

Q13:	N	Percent	Percent of Cases
Academic Support	3	33.3%	42.9%
Faculty Training	2	22.2%	28.6%
Faculty Hiring	2	22.2%	28.6%
Mentoring	1	11.1%	14.3%
Student Support/Train	1	11.1%	14.3%
Total	7	33.3%	
Missing	14	66.7%	
Total	21	100%	

Note. N = 21. Frequency distribution using multiple response set. Variables tabulated at value 1.

The findings in this section provided relevant information of assessment processes and measures at HEI. This evidence was crucial to identify whether essential components are in place and being monitored for effectiveness. In short, are the processes meeting or exceeding the goal of supporting the universities clients (the student populous). Although this output shows the existence of these processes, it also indicates that HEI could improve their assessment measures to enhance overall effectiveness at their institution. The next section examined the Directors of Student & Academic Affairs/Diversity/Equity/Inclusion survey group data analysis.

Directors of Student &Academic Affairs/Diversity/Equity and Inclusion Survey Analysis

The following analysis pertains to the practical experience of Directors of Student Affairs/Diversity/Equity/Inclusion as their roles relate to African American female engineering students. Some questions were analyzed as a dichotomy group which means there are multiple variables that can be selected (multiple response set or the variables have two choices and are tabulated at value 1 - yes/no selections). In Table 4.29, the data pertains to question 9 – Does your institution have professional development for deans, faculty, and/or advisors related to the items below: (check all that apply)? The participants response to this question had a variance in the data outcomes with academic support services having the highest percentage of 33.3% at N = 10 and implicit/explicit bias at 16.7% or N = 5. There were 7 participants that did not respond to this question at 35%.

Table 4.29

Freshman Orientation - Directors of Student & Academic Affairs/Diversity/Inclusion Survey Group

Q9: Freshman Orientation	N	Percent	Percent of Cases
Academic Support Services	10	33.3%	76.9%
Diversity	9	30%	69.2%
Cultural Awareness	6	20%	46.2%
Implicit/Explicit Bias	5	16.7%	38.5%
Total	13	65%	
Missing	7	35%	
Total	20	100%	

Note. N = 20. Frequency distribution using multiple response set. Variables tabulated at value 1.

Q20-23 was statistically analyzed using clustered analysis. These questions pertain to suggestions to improve culture, recruitment and retention of African American female engineering students, recruitment and retention of African American female faculty, and diversity (Appendix H).

The following Table 4.30 contains the statistical analysis for question 10 as it relates to the frequency of freshman orientation. The results indicated that the majority conduct training only once a year at N = 9 or 45%. The other two categories were tied at N = 2 or 10%. The remaining 35% was participants who did not respond to this question. This is an essential question that leaves the researcher pondering the reason for the lack of response.

Table 4.30

Frequency of orientation, Directors of Student & Academic Affairs/Diversity/Equity/Inclusion Survey Group

Q10: Frequency of Orientation		N	Percent	Valid Percent
Valid	Every semester/quarter	2	10%	15.4%
	Once a year	9	45%	69.2%
	Other	2	10%	15.4%
	Total Valid	13	65%	100%
	Missing	7	35%	
Total		20	100%	

Note. N = 20. Multiple choice selection, variables tabulated at value 1.

The statistical data outcome of Table 4.31 relates to HEI having assessment measures to analyze the various categories in question 11. Again, this was a vital question of assessment to which seven participants did not answer at 35%. The highest response to this question was student academic programs at 30% or N = 9 and the least selected answer was the culture of engineering programs at 6.7% or N = 2.

Table 4.31

Assessment measures - Directors of Student & Academic Affairs/Diversity/Inclusion Survey Group

Q11:	N	Percent	Percent of Cases
Student Academic Programs	9	30%	69.2%
Student Performance	8	26.7%	61.5%
Effectiveness of Initiatives	6	20%	46.2%
Advisors Effectiveness	5	16.7%	38.5%
Culture Engineering Programs	2	6.7%	15.4%
Total	30	100%	230.8%
Total Valid	13	65%	
Missing	7	35%	
Total	20	100%	

Note. N = 20. Frequency distribution using multiple response set. Variables tabulated at value 1.

The data outcome related to HEI tracking of racial groups in their assessment measures to provide insight to the university's leadership was analyzed in question 17 (Table 4.32): Q17 - If yes, does the data provide a comparison with other racial groups and gender? (Paired with Q16). The response for this question was significantly low with yes and no being tied at N = 2 or 10% each. There were 16 participants that did not answer this question. These responses indicated that assessment of HEI effectiveness of their programs/initiatives, student performance, student academic programs, advisors, and culture is vital in providing leadership with information on whether their practices are meeting their mission and goals for all students. The statistical mean for this question yielded 1.50 and the standard deviation at .577.

Table 4.32

Comparison of racial groups, Directors of Student & Academic Affairs/Diversity/ Inclusion Survey Group

Q17: Racial/Gender Comparison		N	Percent	Valid Percent
Valid	Yes	2	10%	50%
	No	2	10%	50%
	Total	4	20%	100%
	Missing	16	80%	
Total		20	100%	

Note. N = 20. Dichotomous variable.

The responses from the leadership role of the Directors of Student & Academic Affairs/Diversity/Equity/Inclusion were essential in providing information that this group should be privy to. The lack of responding to several questions indicated either the lack of knowledge or the absence of these components. Tracking data is a function of offices that these directors oversee, yet these participants answered some questions but not all within their survey group.

Chapter IV Summary

Although the findings from this research project of each participant groups did not explain the variances in the dependent variable, it did indicate variances for some groups in the analysis of the dependent and independent variables. This variance was apparent in each hypothesis for each research question where some groups had statistically significant results and others did not. However, the testing requirements was based on having statistically significant results across all four groups to reject the null hypotheses. This outcome suggested that a different quantitative approach could yield statistically significant results in the future, but this will be discussed in more detail in Chapter five.

The results from the factorial analyses indicated significant differences among institutions from different regions and within the four participant groups in examining support resources and students' attainment rate; thus, research question one failed to reject the null hypothesis. Next, research question two examined diversity levels of race, gender, and age range within the roles at HEI which indicated non-significant differences amongst the roles; thus, failing to reject the null hypothesis. Lastly, research question three also resulted in failing to reject the null hypothesis as there was non-statistically significant results for all four participant groups. However, Faculty Chairs and Deans of Engineering had statistically significant results while Advisors and Directors of Student Affairs/Diversity/Equity/Inclusion did not have statistically significant outcome. This suggests that there are differences in the means for Faculty Chairs and Deans of Engineering, but not the other two groups. Based on this outcome, the researcher of this study also examined differences related to grouping the participants into categories of HEI administrators (Advisors and Directors of Student & Academic Affairs/Diversity/Equity/Inclusion) and HEI faculty (Faculty Chairs and Deans of Engineering). By grouping the participants, the data outcome showed similarities within in the grouping that were opposite to the other grouping.

The latter observation informed the study by suggesting the need for additional research to determine why there is statistical difference when grouping the participants. There are assumptions that the representing agents for the 63 institutions either lacked the answers to some of the questions posed or their institution did not have the initiatives, programs, assessment measures, or policies described in this research study. This outcome is an important resource tool that could inform future research or provide other HEI with a direction for assessing its institution to enhance resources to assist the academic attainment for African American female engineering students. Again, even though the data analysis did not yield statistically significant results for all four survey groups, it did indicate which variables within each participant group had statistical significant outcome**.** The next chapter, Chapter five, provides a summary of the study to include implications, recommendations for future research, limitations, and a conclusion.

Chapter V

Discussion and Recommendations

The culture of engineering programs at HEI has been known for its complexity of its subject matter and the exclusivity of engagement with African American female engineering students. Exclusionary culture is one component for the lack of attrition for these students in the engineering discipline. Therefore, there were three aspects examined in this quantitative study to analyze whether these institutions have specific academic initiatives/support resources, diversity within the faculty and administrative roles, and assessment indicators for early detection of academic issues. These factors pertained to HEI contribution in assisting African American female engineering students in their degree attainment.

This chapter provides a summary of the study to include key findings summary, implications, recommendations, limitations, gaps in the research, and conclusion. The discussion will focus on academic initiatives and resources that assist the degree attainment for African American female engineering students at PWI. It will also conclude this chapter by highlighting future directions for HEI with an emphasis on those with a Carnegie Classification of 'Very high research activity'.

Key Findings Summary

As indicated in the literature review section there are studies that focus on the issues that lead to attrition for STEM female students of color. However, this researcher found a gap in the literature related to the lack of attrition for African American female engineering students and limited literature that examined academic initiatives/support resources to assist these students in completing their degree. The scholarship of Rice (2016) indicated this problem from a system level approach identified as the macrosystem (external environment) and the microsystem (internal environment). These two factors encompass a wide array of issues that inhibit the degree progression for African American female engineering students. The microsystem includes 1) determination & persistence, 2) racial identity, 3) racial micro-aggression, and 4) negative stereotypes. The macrosystem is related to 1) academic support resources, 2) early warning detection systems, 3) supportive & cooperative peer culture, 4) information sharing of students by faculty, and 5) supportive & encouraging faculty (Rice, 2016; Rice & Alfred, 2014). Other studies revealed similar findings but identified the issues on the sub-system level such as determination, persistence, negative stereotypes, lack of faculty support, academic preparation, financial, family assistance, and exclusion (Johnson, 2011; Lichtenstein et al., 2014; Ong et al., 2011; Perna et al., 2009; Perna et al., 2010; Riegle-Crumb & King, 2010).

Additionally, engineering programs were described as a meritocracy that identify with male and white affecting the culture of inclusion, recruitment and retention issues, and the ethnic and gender disparity in enrollment numbers in this program. These issues prompted a closer examination of these issues within my research. The researchers interest in the topic resulted from her 11-year-old niece, Nia, desire to become an engineer or a chemist. Her other niece, Kira, has a desire to become a dermatologist which prompts future research in STEM related programs.

In this section, there is an analytical comparison presentation of the demographic data and the significant data findings for all four survey groups in this analysis. In examining the findings associated with the targeted population, there were some unexpected data outcomes which did not coincide with the synthesis of the literature review. The outcome suggested that additional research is required in this subject area.

The purpose of this proposed quantitative study was to analyze the initiatives at HEI geared toward increasing diversity and retention in engineering programs for African American females. The aim of the research sought to identify methods for HEI to provide a supportive learning environment for these students. The methods are an important concept as African American females are underrepresented in the engineering student population, workforce, and in the faculty and administrative roles at HEI.

Research Questions/Hypotheses

There were three research questions that guided the focus of this project. Each research question has two hypotheses (null and research hypothesis) which determined whether to reject or fail to reject the null hypothesis. The context of the first research question examined sub-categories of support resources/academic initiatives at HEI such as diversity, advising, mentoring, engineering organizations, degree progression audit, academic support programs, other support resources, faculty support, tutoring, and student support. The attainment rate for African American female engineering students from HEI in this research was extrapolated and calculated based on their enrollment number in 2014 and their 2018-degree completion. The last step summed up the participants of this study for each accrediting region. The analytics of the hypothesis of this research question did not indicate significant effect of the variables on the attainment rate of the African American female engineering students. It is important to restate here that research question one was formulated traditionally by indicating a neutral position in the null hypothesis and positive position for the research hypothesis.

RQ1: *Does the presence of support resources/academic initiatives increase the attainment rate for African American female engineering students within the HEI accrediting regions?*

- Null Hypothesis (H_0): There is no association between academic/support initiatives within HEI on the degree completion for African American female engineering students.

- Hypothesis (H_a): There is a positive association between academic/support initiatives within HEI that on the degree completion for African American female engineering students.

Research question two was formulated to analyze the diversity level of HEI administrators (Advisors and Directors of Student & Academic Affairs/Diversity/Equity/Inclusion) and faculty roles (Faculty Chairs and Deans of Engineering). The independent variables for this research question were gender, ethnicity, age range, and region, and the hypothesis test examined the effects of these variables on the dependent variable, student attainment rate. Again, there was no significant data outcome as the means for the covariates were close which indicates there was not a vast difference established in the means for each of the categories of the participant answers. Research question two was designed differently than research question one whereas RQ2 indicated a positive position with the null hypothesis and a negative position for the research hypothesis.

RQ2**:** *Is the student attainment rate for African American female engineering students associated with the level of diversity for HEI administrators and the faculty roles?*

- Null Hypothesis (H_0): There is diversity in ethnicity, gender, and age range for the HEI administrators and the faculty roles that contribute to positive outcomes in the student attainment rate for African American female engineering students.
- Hypothesis (H_a): There is no diversity in ethnicity, gender, and age range for HEI administrators and the faculty roles that contribute to negative outcomes in the student attainment rate for African American female engineering students.

The last research question focused on key indicators of assessment to examine if these indicators progress the academic attainment rate for African American female engineering students. The critical indicators identified were declining grades, students requesting appointments, a drop in cumulative grade point average (GPA), other school criteria, and a lack of attending class. According to Maton et al. (2012), assessment indicators assist HEI in identifying academic issues for the students thus allowing early intervention. Identifying and intervening are crucial in assisting the persistence of these students. There are students who will ask for assistance and some that will not. It is important for HEI leadership to take a proactive position to nurture the growth of their students and accomplish the goal of attrition. Following suit of the other research questions/hypotheses, the data outcome yielded non-statistically significant results. Following suit of research question two, research question three held a positive position and the research hypothesis indicated a negative position.

RQ3: *Are there assessment indicators at HEI that progress the academic attainment rate for African American female engineering students?*

- Null Hypothesis (H_0): The presence of assessment indicators for academic support at universities has a positive impact on the attainment rate for African American female engineering students.
- Alternative Hypothesis (H_a): The non-presence of assessment indicators for academic support at universities negatively impact the attainment rate for African American female engineering students.

Postulation of the Findings

The purpose of this quantitative study was to analyze the initiatives at HEI geared toward increasing diversity and retention in engineering programs for African American females. Based on the review of the scholarly literature on the experiences of African American females pursuing studies in engineering, the various challenges for these students were documented, particularly in the context of PWIs and the impact the challenges present on degree attainment for African American females.

It also aims to understand how educational institutions can provide a supportive learning environment for African American female students in engineering programs. Although, the findings of this study did not yield statistically significant results as the researcher assumed would occur. However, the data outcome provided importance in analyzing the persistence of African American female engineering students at PWIs. It will add value to the scholarly body of this subject matter by shedding insights and informing future research to further clarify this complex issue. The motivation is to increase the representation of Black females in the engineering workforce and the direct path includes increasing enrollment at HEI, supporting these females in their quest, and ensuring attrition. These actions will begin the process of providing diversity in this 'male dominated' workforce. Again, the goal of this research presented an understanding of the requirements of HEI to close the diversity gap within their engineering programs. Through the correlation of the literature review and the data findings, researchers can utilize the information of this study to examine the factors further. When awareness of a problem is discussed, HEI can use this information to assess its programs and initiatives to improve the learning environment for African American female engineering students.

Although the data outcome did not reveal statistically significant results of the variance in the means for the research questions and hypotheses, it did indicate an association of the covariates – attainment rate, academic initiatives/support services, region, assessment indicators, gender, ethnicity, and age range. The outcome provided future focus in examining these covariates. This future focus will be discussed in the future research sub-section. The data interpretation was a key aspect to make recommendations of the factors to address for HEI and the improvements necessary to improve the culture of engineering programs. This outcome provided a guideline to determine the direction of future research to increase attrition. Females have been at a deficit in so many fields of study leading to underrepresentation. Reversing the dynamic of underrepresentation in engineering is important for not just diversifying the workforce but bringing creative aspects from different perspectives.

Demographic Data

There were assumptions from reviewing the literature on this topic for the descriptive covariates ethnic, gender, and age range. However, the findings varied for each of the descriptive covariate and within each participant role. In comparing the statistical frequency results of each survey group, the data outcome indicated that the prevalent ethnicity across all four groups is White at 72%. This data indicated a high level of disparity in diversifying each position supporting the necessity for HEI to re-examine their hiring practices to promote diversity for their institution.

The analysis for all four survey groups yielded a close distribution amongst the gender roles, females at 47.8% and males at 45%. It also depended on the grouping of the participants with the females being the dominant group for the Advisors and the Directors of Student & Academic Affairs/Diversity/Equity/Inclusion with an average of 70% in comparison to males at 23%. Males dominated the Faculty Chairs and Deans of Engineering at 67% in comparison to females at 25.6%. The data indicated that when the roles are combined, HEI is progressing in providing gender equity within these four roles. However, the higher gender representation in the Directors of Student Affairs/Diversity/Equity & Inclusion depicts an inaccurate picture for incoming students of the representation of women in engineering disciplines at HEI.

For the age range, the assumption was that older individuals were extensively holding these positions. However, in this research the data outcome indicated otherwise which shows positivity of change toward establishing diversity, equity, and inclusion. This is in alignment with the article written by Ghaffarzadegan and Xu (2018) who indicated that in the past the older individuals mainly held leadership positions at HEI and was based on tenure. Even though Congress prohibited imposing mandatory retirement ages for employees in the U.S., this outcome represents advancement within HEI (Larson, et al., 2012). This is an important component to this research as the data demographics in this study supported that the HEI roles are moving toward a younger workforce.

The highest percentage for advisor's ethnicity was White at 65% while Black resulted in 12.5%. The other ethnicities had even lower results ranging from 7.5% to 2.5%. This data outcome suggested that leaders must examine this role and actively recruit other ethnicities to diversify the position. The significant finding of having younger individuals in the Advisor role possibly provided an ability to relate, communicate, and connect to student needs. The data outcome for advisors indicated that the demographic of this role at HEI in this study are significantly higher for females at N = 29 or 80.6% and males represented at N = 4 or 11.1%. The outcome of the age range distribution for Advisors in engineering was based on the variance of the factors. The first factor suggested that the 55-64 category is the dominant age group for all roles at an average of 41%. This was not the presumptive dominant age range for which the assumption was the 65-74 range indicating that the average age in education is reducing to younger age groups. It also important to mention that there were no respondents within all four survey groups for the age ranges of 75-84 and 85 or older. The age ranges for these roles were not significantly different in comparison. Surprisingly in the 25-34 category, there were N = 4 or 20% of this population holding leadership positions. This is significant in supporting that the age demographic for these roles in higher education are reducing to the younger age groups. As indicated previously, the raw data for the demographics for all four survey groups can be found in Appendices E, F, G, and H. Based on the findings in this study, further research is needed in this area.

This outcome suggested a lack of ethnic diversity in the advisor field in higher education. This also suggested a disparity in providing equitable gender advisory representation for students in engineering. However, this is a key factor of providing gender advisory support for females in engineering as advisors are sometimes faculty members at some institutions. As discussed by Chubin et al. (2005), HBCUs are vital in assisting African American students in obtaining their baccalaureate to doctoral degrees. HBCUs such as Howard, Spelman, MIT, Texas A&M, and North Carolina A&T are excellent examples of top producing institutions in engineering disciplines for these students.

This group did not represent numerous ethnicities for the Faculty Chair participants, suggesting a substantial lack of diversity at HEI. Again, the White ethnicity indicated a vast disparity at 85.7% while there were no Black faculty chairs. The other ethnicities were must lower at 10.7% to 0%. The gender disparity for Faculty Chairs was significant at valid percent of 80% for males and 20% for females. This suggested a lack of gender diversity within the Faculty Chair position at HEI. This is crucial data as Berry et al. (2014) provided the yearly growth for 2001, 2006, and 2012 of African American female engineering faculty in the biggest engineering disciplines such as mechanical, chemical, biomedical, civil, electrical, industrial, and computer.

Additionally, Roy (2019); NCES (2018); Yoder (2012) provided data of engineering undergraduate degrees and enrollment for 2014 and 2015 broken down by ethnicity, gender, and discipline. These researchers also provided the number of degrees awarded by institution, master's degrees awarded by ethnicity and gender, and doctoral degrees awarded by ethnicity and gender. This demographic data was essential information that provided which engineering disciplines African American female engineering students are likely to enter and graduate from. Thus, gender faculty diversity is essential in engineering disciplines proven by research that attract Black females. However, HEI must continue or consider having outreach to the K-12 public school system in their area to provide exposure and attract these students continuously. Change is often incremental and requires time to assess, plan, implement, obtain feedback, and continually assess. The data outcome in this role seems to be consistent with career advancement as there is a tenured time frame for faculty which increases the time required in this position prior to being promotable to the faculty chair position.

The Deans of Engineering role demonstrated a significant difference in ethnic comparison at HEI. So far, the evidence indicated a lack of ethnic diversity for this crucial role in higher education. The demographic of White was the prevalent ethnicity at 72% while Black yielded 12%. The other ethnicities range from 8% to 0%. Gender for this role followed suit of the faculty chair role whereas males are the dominate gender for the Deans of Engineering. The data outcome showed males at 61.9% and female at 33.3%. The output also warrants closer inquiry by HEI to determine the reasons for the lack of diversity in this leadership role in engineering and create an actionable plan of increasing diversity. In this role, the diversity in leadership is still predominantly high in the older age range of 55-64. Also, there were no respondents in the younger age category of 25-34, and the older categories of 75-84 or 85 and older.

The data outcome for Directors of Student & Academic Affairs/Diversity/Equity/Inclusion indicated a closing of the ethnicity gap for this role within higher education. Also, the outcome of the data suggested progress in gender equity within these leadership positions which is a valuable resource in developing recruitment and retention plans at HEI with males at 35% and females at 60%. The summary of the age range distribution indicated several factors. The first factor suggested that the 55-64 category is the dominant age group for all roles at an average of 41%. This was not the presumptive dominant age range for which the assumption was the 65-74 range indicating that the average age in education is reducing to younger age groups. Again, it also important to mention that there were no respondents within all four survey groups for the age ranges of 75-84 and 85 or older. The age ranges for these roles were not significantly different in comparison. Surprisingly in the 25-34 category, there were N = 4 or 20% of this population holding leadership positions. This is significant in supporting that the age demographic for these roles in higher education are also reducing to the younger age groups. As indicated previously, the raw data for the demographics for all four survey groups can be found in Appendices E, F, G, and H. Based on the findings in this study, further research is required in this area to provide awareness and examine what measures HEI can employ to support the degree attainment for African American female engineering students.

Implications

Implications for Theory

Although Senge (1990) created ‘Learning Organizations’ as a business model of implementing change, this model was applicable to higher educational institutions who desired a holistic approach of transformation. However, a theory specifically tailored for HEI model of change needs to be tailored to address the specific organizational structure of HEI. The model of change needs to encompass a holistic approach that includes diversifying leadership, diversifying faculty and support staff, diversifying the student body in all programs, and creating administrative committees to assess programs, initiatives, support resources, policies, and early warning detection system. Assessment is a very important aspect of the change model. Assessments must be conducted prior to implementing a change process, including feedback, and must be continuous to ensure the plan is working. If a plan fails to produce the desired outcome, a reassessment of the processes would be necessary to determine what is not working. One existing model of change for institutions to consider is the holistic approach used by University of Maryland Baltimore County (UMBC). HEI can use UMBC model and alter the model if necessary to fit the structure of its institution.

Implications for Policies

There are steps prior to beginning a transformative process. The institutions must first assess the entire structure of their organization to identify the “underlying patterns and how they can be changed. It is these patterns that are roadblocks to change, not specific people or events” (Isaacson & Bamburg, 1992, p.42). This statement by the authors is an impactful statement that applies to all organizations when taking on a change endeavor. It is essential to examine issues affecting the culture, hindering effective learning for students, lack of diversity, student retention and attainment, and past failed change initiatives. This process allows for a holistic approach that focuses on the issues not the people or events that change periodically and the problems continue to exist.

Senge (1990) identified five core disciplines (personal mastery, mental modes, shared vision, team learning, and systems thinking) that mold schools' transformation into learning organizations. These interrelated components produce a contextual landscape of an effective change initiative. However, the focus of this research looked at Senge's Fifth discipline, systems thinking, which Isaacson and Bamburg (1992) indicated as "the cornerstone of change" (p.42). Systems thinking is so relevant to institutional policies as leaders of HEI must take this approach which indicates using a holistic lens by identifying patterns. This holistic approach examines the connectivity of systems and how they relate to the larger entity, the entire university. It allows the leader to focus on the connecting systems rather than individual role or people.

Assessment committees must examine if the change initiative is effective, assess the practice of advisors, educators, departments, colleges, and implement and monitor professional development for administrators, educators, advisors, and other pertinent staff. Finally, employ policies geared toward actively increasing and sustaining the student populous and the faculty recruitment. Diversity of gender and ethnicity is the key to bridging the gap in the engineering field. Engineering educational practices must be modified to address the learning needs of every student.

Implication for Institutional Transformation

Institutional transformation is an important tool to assist leadership at HEI to create, assess, and establish systemic change. This systemic change process identifies all key areas that require either a modification or a total re-vamping of programs, initiatives, policies, and the culture. As discussed by Harper and Hurtado (2007); Quan et al. (2019, there are factors that leadership and its committees must examine to sustain the systemic change efforts which include the following:

- Campus/program/classroom climate
- Freshman and sophomore orientation
- Student assessment
- Early Warning and Detection systems as a tracking/sharing mechanism
- Mandatory student advising
- Mentorship (role models)
- Undergrad research programs
- Faculty and Administrators professional development (key focal areas are intersectionality and multiculturalism)
- Faculty support
- Institution's investment in recruiting, retaining, and mentoring future Black faculty
- Foster faculty engagement with students
- Partner with K-12 public school systems and college preparatory organizations to cultivate future minority talent in engineering
- Replicate a Meyerhoff Scholar's program as a change model

It is important to note that the factors listed above were identified for engineering programs at HEI to create and establish a positive change to recruit, retain, and assist Black engineering students to complete their program. However, as (Maton et al., 2012) indicated that UMBC initially examined only its engineering program and eventually assessed the entire university to make improvements for a holistic approach that benefits all students, faculty, administrators, and leadership. Also, these factors contribute to bridging the academic gap for minority students who aspire to become an engineer, but also establishes valuable sharing and tracking mechanisms, and partnerships that benefit all stakeholders. It will also bridge the diversity gap to increase representation of minorities as faculty and leaders at universities.

Recommendations

This section provides recommendations that resulted from the inferences of the research data. The data outcome of the research questions/hypotheses along with the survey questions from each participant group provided insight for future research. Future research requires using multiple frameworks, but the focus should continue examining PWIs with a Carnegie Classification of ‘Very High Research Activity’. Finally, this researcher suggests using various research designs (qualitative, quantitative, and mixed method) to further explore issues presented in this study, provide a robust analysis to enhance the culture at PWIs, and enhance the learning environment and experiences for African American female engineering students.

Recommendations for Future Research

After reviewing the recommendations of other scholars in the literature review and analyzing the outcome of the data analysis of this project, this researcher was able to surmise that future research could focus on HEI in-depth. This could entail examining and analyzing initiatives and programs utilizing a combination of approaches of collecting data. The data needs to include existing extrapolated data, document analysis of the institutions policies, in-depth interviews, case and longitudinal studies, and surveys. The interviews and surveys could be distributed to both administrators, faculty, and students, but my suggestion is to focus on one or two groups at a time. The goal is to be able to have robust data collection and in-depth analysis of the focal group. By using multiple layers of data, a researcher can also conduct a comparative analysis to determine just how effective each initiative assist African American female engineering students to degree attainment. Additionally, the research context can include comparative case studies between HBCUs and PWIs, or between PWIs. The longitudinal studies could analyze whether initiatives/programs improve the attainment rate of African American female engineering students.

Recommendations for Institutions

A suggestion is to examine other institutions transformational model for its programs and initiatives as a guideline to begin assessment and implementation of organizational change. This process will provide the institutions leaders with a direction for systemic change to bring diversity, equity, and inclusion to all its process and to its stakeholders. Having a direction serves as a best practice of what elements are successful. However, it is vital for leaders to thoroughly assess their institutions' culture, programs, and initiatives because adjusting the chosen model might be required as each institution is different. The leader initially implemented successful models of change in the engineering programs and then extended them ot other disciplines, successful models such as the University of Maryland Baltimore County (UMBC).

Another recommendation pertains to establishing academic initiatives and support resources to assist with the degree attainment for African American female engineering students. In addition to each universities current initiatives and resources there are additional ones to add such as learning communities, undergraduate research projects, service-learning, and student orientation for freshmen and sophomores. Learning communities provide a collaborative educational environment for students to engage in coursework, but also to interact with one another on a social level. Undergraduate research projects can be utilized in conjunction with service-learning to provide interaction between faculty and students. Service-learning is a valuable learning tool for students to participate in experiential learning which provides real life job experience. Service-learning helps students to make a connection between their coursework and career. This is essential as it adds an aspect of the practicality of learning the coursework. In essence, service learning combines academic work, experiential learning, and civic engagement to prepare students for their future career. Finally, institutions must consider providing student orientation for incoming freshmen and again in their sophomore year. Student orientation provides students with important university information and resources that are available to assist them in their academic journey. Having it again in the sophomore year reconfirms the valuableness of the resources for the students. The goal is to adopt a holistic transformative approach that assesses every aspect of the institution to determine what components require change and to ensure accountability of the implemented plan.

Recommendations for Practice

Professional development is an additional tool for universities and its' staff that assist with preparation and strategizing in the tools of their trade. It is a means for faculty and administrators to share information, learn new skills, and discuss ways to improve student learning. Professional development conferences are also a source to introduce cultural awareness and multiculturalism to the faculty and staff. Professional development aims to provide a platform to share best-practices and introduce new concepts that improve the students' learning environment.

Another recommendation is having faculty-student collaborative research which can go in conjunction with service-learning projects. Students are afforded the opportunity to conduct research under the direction of a faculty member and engage critically to solve a real-world problem. This component serves multiple levels of engagement by which faculty get the opportunity to teach their trade in a control environment and provide mentorship to students.

These recommendations can be necessary in many disciplines but are crucial to the engineering discipline where the complexity of concepts can be overwhelming for students and the necessity to provide a professional connection between faculty and students. On the other hand, faculty members benefit from this engagement through a rich interaction of teaching and learning that extends outside of the classroom.

Limitations of the Study

As this study evolved, there were limitations of this research project that arose relative to participant follow-up, qualification of the participant, and Covid-19 restrictions. The researcher did not view these limitations as negative factors but provided enlightenment on how to engage future projects on this subject matter. The challenges of research projects provide a corrective path to dive deeper and present robust analyses of plausible solutions continuously.

The first limitation was the inability to follow up with participants. Quantitative analysis utilizing survey questions research does not allow the researcher to probe participants if an answer is unclear or left blank. The second limitation is a valid assumption that the study participants held various roles within their HEI and were eligible to act as the representing agent for their institution. After reviewing some of the participant answers of the participants, the only logical assumption was that some participants did not have complete knowledge of the services and programs offered at their institution or were new to their position. Finally, toward the end of the data collection of this research project, a horrific pandemic Covid-19, created a global shutdown of all higher educational institutions. This pandemic caused a moment of uncertainty as to 'what next'. HEI shut down its campuses and moved to online learning. All processes were conducted electronically, creating challenges in obtaining a robust participant response rate resulting in the lack of collecting an abundance of viable information.

Several challenges that presented themselves during this research project; the first is related to the scarcity of the response rate from institutions resulting in the lack of collecting an abundance of information; secondly, this researcher realizes the importance of keeping the research instrument concise. So, future research utilizing a shorter questionnaire could indicate if there is just a lack of response from agents at HEI or if the questionnaires were too long, resulting in a lower response rate.

Several individuals responded by email indicating a relatively short time in their position, thereby not qualified to provide viable feedback. The researcher would then request the information of an alternate who was qualified to participate in the research. Some of the alternates participated, and some did not. Some participants were either not qualified or had moved to a different position and did not respond. These factors, along with a lack of an abundance of returned questionnaires, often yield a lower response rate. Although researchers desired a higher participant response rate, this research study's response rate was feasible at 18.5%, which was relatively high considering the setback of the Covid-19 pandemic.

Another major challenge that presented itself as the research project was underway was related to the development of the questionnaires. The original questionnaires were broken down into the following groups:

- Advisors contained 46 questions
- Faculty Chairs contained 60 questions
- Dean of Engineering contained 96 questions
- Dean/Directors of Student Affairs & Diversity/Equity/Inclusion contained 105 questions.

These questionnaires were distributed to the groups at 30 HEI, and the researcher received limited responses. Although an initial recruitment email and two reminder emails were sent, there were a total of 23 responses from all four groups. In addition, the researcher observed that all participants were partially completing the surveys. A choice was made to either scrap the initial research and start over or devise an alternative solution to move forward with the research project. An alternative approach was devised to increase the target population from 30 to 94

HEI. This approach resulted in a total sampling of 713 participants yielding 105 responses for this study. This alternative approach was a simple fix to the issue, and fortunately, the researcher had identified 22 additional standby institutions. The decision was also made to identify and include 23 more institutions bringing the total number of HEI in this study to 94. The procedural change was necessary for the study to provide robust data analysis and statistical findings that represent the target population.

Another limitation of the study is the ability to discuss the association between the data based on the number of participant responses to the survey questions and the statistical analysis used. The limited data collected for the various support/initiatives categories reduced the ability to determine statistical inferences. It became apparent that future research would benefit from a mixed-method approach which would afford a robust analysis to provide an association analysis of the data outcome.

Gaps in the Research

As a future researcher, discoveries were found related to limited studies focusing explicitly on the issues that plague African American female engineering students. A vast majority of the research study included women of all races, women of color (which include minority females from other countries), Black males and females, or all STEM fields in one study. This study did not examine all women and minorities; instead, the focus was narrowed to African American women majoring in engineering who attend PWIs. The gap in the research relates to addressing specific educational needs for African American women majoring in engineering programs, assessment of the institutions' support services, and initiatives evaluation to determine how support is allocated, who needs the services, and how it is utilized.

HEI must proactively examine its culture through audits to determine the climate of its campus, programs, and classrooms. Toxic learning environments are not conducive for African American female engineering students to persist and obtain their degrees. The goal is to establish a culture rich in diversity and inclusion. This type of culture benefits all individuals in the campus environment, as Kezar and Eckel (2002a). The audit would provide a report for review by the leaders to decide what structures require change.

Conclusion

As we strive toward enhancing higher educational institutions' organizational cultures, leaders must assess their systems to determine the underlying issues hindering the degree progression for African American female engineering students. The critical component is to look at the structural dynamics and not at the individuals within the system. People do not stay the same; presidents of universities change, faculty change, students change, and everyone eventually move on. However, the systems remain intact, and when transformed, can address the needs of all the stakeholders involved, and future change would only occur if there were an overhaul to a policy or an event that impacts the structure, such as Covid-19. Covid-19 impacted the entire structure of HEI and was unforeseeable. During this pandemic, some institutions were able to make teaching and learning transition more manageable, while some probably found the adjustment difficult. Therefore, continual assessment of the structure is necessary to reduce the chance of a build-up of issues to address.

The conversation and action plans regarding retention and attainment for African American female engineering students at PWIs need to be changed to include the examining these institutions and how they can better support their diverse student populous. Too much emphasis has been given to what these students need to acquire (resilience) to navigate engineering programs at PWIs effectively.

This research perspective aims to shift the future institutional focus from the lack of student resilience to educational policies that promote diversity, inclusion, and campus climate change. Opportunities in education are not equal for everyone in society, leading to different life trajectories. There has always been important to address the role that universities play in actively assisting all students in the progression of their educational attainment. However, there must be active participation, not just documentation of HEI requirements or the resilience level that minority students must achieve to overcome the barriers of attending a PWI. Leaders and their staff at HEI must take an aggressive approach to remove a pervasive climate in engineering programs and the campus environment. Another thought is ensuring that the time and effort spent formulating assessments must move toward implementing institutional transformation for the emergence of positive change.

Another goal of this crucial and unique research is to provide alternative constructs for educational institutions to enhance their institutional culture and to provide a diverse learning environment. The exploration of the literature review suggests that educational institutions must implement support resources to provide a diverse and inclusive culture for all students. Additionally, institutions need to make changes to their academic support services to assist African American women in their educational pursuits in engineering fields. These changes are often necessary based on the differences in instructional practices at predominantly White and Black schools. Today, there is still a gap in education between White students in contrast to Black students in America, especially in urban cities. The construct is not completely overt in presentation; instead, there are subtleties in the miseducation of the Black population. These subtleties preclude providing an enriched curriculum in predominantly Black schools. At the elementary and secondary school levels in the U.S., research has shown that Black children struggle with mathematical and scientific concepts. In addition, these subtle differences in education dictate the academic preparation and engagement of African American students compared to White students.

An additional aim is to enlighten administrators at HEI within the U.S. that African American female engineering students might require additional guidance to assist them with completing their engineering program degrees. An analysis could then be conducted to determine how many African American women have benefited from support and retention programs based on their increased college graduation rate, increased school enrollment, inclusive learning environments, increased workforce hiring, and diversity training for faculty and students. Additionally, there must be an assessment system to evaluate support services by re-allocating support services staff or hiring additional staff to ensure ample coverage for analyzing students' academic performance. This concept offers PWIs a resource tool to examine their retention and support methods to determine if changing the culture is necessary to reduce stereotypes regarding gender and race.

Another goal of this examination was to include or change the type of academic support services offered at PWIs in areas such as their living-learning communities and assessments. Living-learning communities would provide an inclusive learning culture while promoting social relationships between students and the academic environment with faculty, administration, and mentors. The assessment would monitor the program's effectiveness and identify students who benefited from its use and provide outreach efforts to get these students involved in the services. The involvement would aid and guide successful retention and graduation rates. Current literature suggests that Black females with a strong sense of belonging and academic identity have a better coping mechanism and manage the barriers encountered within their engineering programs. Self-confidence is a significant factor for Black females in navigating their engineering studies, which assists them with dealing with perceived racism, a lack of support systems, stereotypes, isolation, and having a different cultural background (Tate & Linn, 2005).

The assumption prior to conducting research is that institutions with learning communities and academic support programs have a higher degree attainment rate for their African American female engineering students. Unfortunately, this research was unable to either confirm or reject this assumption. This proposed research project considers the findings of these scholars. However, it offers an alternative means of addressing the issue by examining the institutions to identify the requirement of changes on the systemic level.

The importance of this research project was to dive deep into the institutional culture of engineering programs at PWIs to make recommendations for improvement to enhance the mechanisms of support for African American female engineering students. By examining prior research, the narratives of educational inequities for African American female engineering students provided a platform that institutional practices and policies require changes. These changes represent the first steps toward obtaining inclusion and equity within engineering programs.

Although the data outcome of this study suggests additional research is required, this study starts the process by contributing to the existing body of scholarly literature related to African American female engineering students at HEI. This study was inconclusive; thus, additional research is required to determine the effect of support services/initiatives, assessment indicators, and faculty/administrators on the attainment of African American female engineering students. Despite the limitation of the research design, the data outcome has value to guide future research for replication purpose and shed light on the future direction for this researcher.

Finally, the result of a holistic, transformative approach should establish an inclusive culture that makes all students feel a part of the campus environment. This literature review described an inclusive environment as a ‘welcoming environment’ that does not exclude individuals based on their ethnicity, gender, age, sexual orientation, physical disability, and religious affiliation.

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APPENDICES

Appendix A

Informed Consent, Invitations, and Follow-up Emails

INFORMATION SHEET FOR PARTICIPATION IN RESEARCH STUDY

Institutional Effectiveness on Student Retention and Diversification for African-American Female Engineering Students at Predominantly White Institutions

Principal Investigator: Robbin R. Parker (Graduate Student), DePaul University/College of Education

Institution: DePaul University, USA

Faculty Advisor: Leodis Scott, EdD, Leadership, Language and Curriculum, Doctoral Program

I am conducting a research study because I am trying to learn more about initiatives at Predominantly White Institutions that are geared toward increasing diversity and retention in engineering programs for African American females. Through scholarly literature pertaining to the experiences of African American females pursuing studies in engineering, the various challenges for these students were documented, particularly in the context of Predominantly White Institutions and the impact the challenges present on degree attainment for African American females. The aim is to determine what initiatives does each university have and how do they assess the effectiveness of these initiatives. The goal of the research is to provide recommendations of change to build communities of learning to foster positive learning environments for African-American female engineering students at Predominantly White Institutions.

I am asking you to be in the research because of your role at the university (Dean of Engineering, Dean of Student Affairs/Diversity Office, Advisor, or Faculty member in the engineering programs) qualifies participation in this study.

Your participation in this study will involve answering a simple survey pertaining to diversity, recruitment, and retention. If you agree to be in this study, you will be asked to fill out and submit an online survey. The survey will include questions about diversity, recruitment, and retention at your university. I will also collect demographic information such as sex, race, age, employment status, institution name, city and state of institution, position, and degree type. Research activity will be completed online through a software application, Qualtrics. If there is a question you do not want to answer, you may skip it. The study should take about 20 minutes to complete.

Research data collected from you will be collected in an identifiable way and then be de-identified later.

When you first give me your information it will be linked to you with a code number and I will have a key that tells me who that code number belongs to. So, for a period of time, it is possible to link this information to you. However, I have put some protections in place, such as storing the information in a secured computer under password protection and with encrypted files. After the study is completed in about 6 months, I will remove all the identifiers and make the data de-identified. The data will be kept for an undetermined period of time in the de-identified way, since there should be no risk to you should someone gain access to the data.

Your participation is voluntary, which means you can choose not to participate. There will be no negative consequences if you decide not to participate or change your mind later after you begin the study.
You can withdraw your participation at any time, by contacting me via email or by phone (Robbin R. Parker, rparke12@mail.depaul.edu or 773-551-7177). Since the information you gave me is still identifiable and linked to your name (or other direct identifier), I can remove your data from the research at any time.

If you have questions, concerns, or complaints about this study or you want to get additional information or provide input about this research, please contact the researcher (Robbin R. Parker, rparke12@mail.depaul.edu, ph# 773-551-7177) or my faculty sponsor (Leodis Scott, Assistant Professor at DePaul University, Leodis.Scott@depaul.edu, ph# 773-325-4526).

Invitation

DATE:

My name is Robbin R. Parker and I am doctoral student at DePaul University in the College of Education. I am conducting research of the assessment of programs/initiatives at predominantly white institutions for diversity, recruitment, and retention of African-American female engineering students. This research is crucial to continuing the advancement of a diverse student population in the field of engineering.

I am emailing to ask for your participation in this study and to fill out an approximate 20 minutes online survey. Your participation is voluntary and your answers will be confidential in the study.

If you agree to participate in this study, more information about the study will be included in the information sheet, which can be found as the first page of the Qualtrics survey. Filling out and completing the survey constitutes agreement in this study.

Follow this link to the Survey:
${l://SurveyLink?d=Take the Survey}

Or copy and paste the URL below into your internet browser:
${l://SurveyURL}

Follow the link to opt out of future emails:
${l://OptOutLink?d=Click here to unsubscribe}

If you have any questions, please contact me at rparke12@mail.depaul.edu

Thank you for your time and consideration. Having support from administrators/educators, such as yourself, assist with the successful advancement of policies in higher education.

Sincerely,

Robbin R. Parker
Doctoral Candidate
Educational Leadership
773-551-7177
Rparke12@mail.depaul.edu

Second Follow-up Email

DATE:

About nine days ago, I sent a reminder asking for your participation in my research study at DePaul University. Although we are currently in a precarious time, I am writing again to indicate how important your questionnaire results will be in getting accurate information. Your knowledge and responses will be valuable to the educational community.

The selected institutions are higher educational institutions in the United States within the six accreditation regions: New England, Middle States, North Central, Southern, Western, and Northwest. Additionally, the selected institutions have **either** Carnegie classification of "Very high research activity", Land-Grant institution, **OR** Predominantly White Institution, **and** have African American female engineering students. For clarification of institution type, your university may not be a Predominantly White Institution but is a Land-Grant institution and have African American female engineering students or could have a Carnegie Classification of "Very high research activity" with African American female engineering students. This would qualify your institutions to participate in this research. I pre-selected your university based on classification.

The goal of this research is to get results that are truly representative of higher educational institutions. If you previously indicated non-participation or not the right person for the role, please disregard this email.

If you agree to participate in this study, more information about the study will be included in the information sheet, which can be found as the first page of the Qualtrics survey. Filling out and completing the survey constitutes an agreement in this study.

Follow this link to the Survey:
${l://SurveyLink?d=Take the Survey}

Or copy and paste the URL below into your internet browser:
${l://SurveyURL}

Follow the link to opt out of future emails:
${l://OptOutLink?d=Click here to unsubscribe}

I would deeply appreciate your participation. Thank you for your time and consideration.

Sincerely,

Robbin R. Parker
Doctoral Candidate
DePaul University
Educational Leadership
773-551-7177
Rparke12@mail.depaul.edu

Third Follow-up Email

DATE:

Approximately 3 weeks ago, I sent a questionnaire asking for your participation in my research study at DePaul University. Your knowledge and responses will be valuable to the educational community. I am writing again, because of how important your questionnaire results will be in getting accurate information.

The selected institutions are higher educational institutions in the United States within the six accreditation regions: New England, Middle States, North Central, Southern, Western, and Northwest. Additionally, the selected institutions have **either** Carnegie classification of "Very high research activity", Land-Grant institution, **OR** Predominantly White Institution, **and** have African American female engineering students. For clarification of institution type, your university may not be a Predominantly White Institution but is a Land-Grant institution and have African American female engineering students or could have a Carnegie Classification of "Very high research activity" with African American female engineering students. This would qualify your institutions participation in this research. I pre-selected your university based on classification.

The goal of this research is to get results that are truly representative of higher educational institutions. If you are no longer in your position or have moved to a different department, please let me know so that I can remove your information.

If you agree to participate in this study, more information about the study will be included in the information sheet, which can be found as the first page of the Qualtrics survey. Filling out and completing the survey constitutes agreement in this study.

Follow this link to the Survey:
${l://SurveyLink?d=Take the Survey}

Or copy and paste the URL below into your internet browser:
${l://SurveyURL}

Follow the link to opt out of future emails:
${l://OptOutLink?d=Click here to unsubscribe}

I would deeply appreciate your participation. If you have already completed the questionnaire, please disregard this email. Thank you for your time and consideration.

Sincerely,

Robbin R. Parker
Doctoral Candidate
DePaul University
Educational Leadership
773-551-7177
Rparke12@mail.depaul.edu

Final Correspondence

DATE:

We are currently experiencing an unprecedented circumstance in our world with this Coronavirus pandemic. This virus has caused a plethora of turmoil in our daily lives from grief to anxiety. It has caused us to adapt within every aspect of our lives such as teleworking, online schooling, or still working despite the danger. As a doctoral student and a first responder, I am continuing to persist despite the challenges. With that said, I am sending this last correspondence to get the final push for participants. I am very close to meeting my response rate and would deeply appreciate you taking a moment out of your trying schedule to participate. The survey will be open for an additional 2 weeks.

You were selected to participate in this research based on your role – Dean of Engineering, Faculty Chair in an engineering program, Academic Advisor, Director of Academic/Student Affairs, or Director of Diversity/Inclusion/Equity office. Additionally, your institution was selected because of the following criteria: in the United States within the six accreditation regions - New England, Middle States, North Central, Southern, Western, and Northwest; have **either** Carnegie classification of "Very high research activity", Land-Grant institution, **OR** Predominantly White Institution, **and** have African American female engineering students.

If you agree to participate in this study, more information about the study will be included in the information sheet, which can be found as the first page of the Qualtrics survey. Filling out and completing the survey constitutes an agreement in this study.

Follow this link to the Survey:

If you agree to assist me in finalizing my research, words can't express my gratitude. If you have already completed the questionnaire or do not wish to participate, please disregard this email. Thank you for your time and consideration. Be well and be safe!

Sincerely,

Robbin R. Parker
Doctoral Candidate
DePaul University
Educational Leadership
773-551-7177
Rparke12@mail.depaul.edu

Appendix B

Survey Instruments

Advisors Survey

Start of Block: Demographics

Q2: What is your sex?

○ Male (1)

○ Female (2)

Q3: What is your race? (If multi-racial, please check all that applies)

▢ Black or African-American (1)

▢ White (2)

▢ Hispanic (3)

▢ Asian (4)

▢ Native American (5)

▢ American Indian (6)

▢ Alaska Native (7)

▢ Native Hawaiian (8)

▢ Other Pacific Islander (9)

Q4: What is your age?

○ 25 - 34 (3)

○ 35 - 44 (4)

○ 45 - 54 (5)

○ 55 - 64 (6)

○ 65 - 74 (7)

○ 75 - 84 (8)

○ 85 or older (9)

End of Block: Demographics

Start of Block: Advising/Assessment

Q5: How many African American female engineering students do you advise per week?

○ 1-5 (4)

○ 6-10 (5)

○ 11 or more (6)

○ Other (7)

○ None (8)

Q6: How many African American female engineering students do you mentor?

- ○ 1-5 (4)
- ○ 6-10 (5)
- ○ 11 or more (6)
- ○ Other (7)
- ○ None (8)

Q7: How do you identify students who need academic advising? (Check all that applies)

- ☐ Declining grades (4)
- ☐ Students requesting appointment (5)
- ☐ A drop in cumulative GPA (6)
- ☐ Other school criteria (7)
- ☐ Lack of attending class (8)

Q8: What support resources are in place to encourage degree completion for African American female engineering students?

____

____

____

____

Q9: When providing advising to students, do you utilize any of the following (check all that applies):

- ☐ Online platform (1)
- ☐ Video conferencing (2)
- ☐ Phone calls (3)
- ☐ In-person (4)
- ☐ Email (5)
- ☐ Text (6)

End of Block: Advising/Assessment

Start of Block: Professional Development

Q10: Level of satisfaction with the availability of resources in your department for students?

- ○ Extremely satisfied (1)
- ○ Moderately satisfied (2)
- ○ Slightly satisfied (3)
- ○ Neither satisfied nor dissatisfied (4)
- ○ Slightly dissatisfied (5)
- ○ Moderately dissatisfied (6)
- ○ Extremely dissatisfied (7)

End of Block: Funding

Start of Block: Professional Development

Q11: Is there professional development for advisors related to the following? (Check all that apply)

- ▢ Institutional policies (23)
- ▢ Advising practices (24)
- ▢ Managing implicit/explicit bias (25)
- ▢ Cultural Awareness (26)
- ▢ Gender/race bias in engineering (27)
- ▢ Diversity (28)

Q12: If yes, how often do you receive training?

- ○ Once a semester/quarter (4)
- ○ Once every year (5)
- ○ Other (6)

Q13: Does your institution encourage innovative advising practices?

- ○ Yes (28)
- ○ No (29)

End of Block: Professional Development

Start of Block: Suggestions for Improvement

Q14: Please provide suggestion(s) of improvement to improve the culture of engineering programs. (List at least one)

____

Q15: Please provide suggestion(s) of recruitment and retention for African American female engineering students. (List at least one)

____

Q16: Please provide suggestion(s) of recruitment and retention for African American female engineering faculty. (List at least one)

____

Q17: Please provide suggestion(s) to improve diversity in engineering programs. (List at least one)

____

End of Block: Suggestions for Improvement

Faculty Chairs Survey

Start of Block: Demographics

Q2: What is your sex?

○ Male (1)

○ Female (2)

Q3: What is your race? (If multi-racial, please check all that applies)

☐ Black or African-American (1)

☐ White (2)

☐ Hispanic (3)

☐ Asian (4)

☐ Native American (5)

☐ American Indian (6)

☐ Alaska Native (7)

☐ Native Hawaiian (8)

☐ Other Pacific Islander (9)

Q4: What is your age?

- ○ 25 - 34 (1)
- ○ 35 - 44 (2)
- ○ 45 - 54 (3)
- ○ 55 - 64 (4)
- ○ 65 - 74 (5)
- ○ 75 - 84 (6)
- ○ 85 or older (7)

End of Block: Demographics

Start of Block: Teaching/Advising Practices

Q5: On average, how many students are enrolled in your engineering program(s)?

○ 1-20 (4)

○ 21-30 (5)

○ 31-40 (6)

○ 41-50 (7)

○ 51-60 (8)

○ 61-70 (9)

○ 71-80 (10)

○ 81-90 (11)

○ 91-100 (12)

○ 101 or more (13)

○ None (14)

○ Not Applicable (15)

Q6: On average, how many African American female engineering students are in courses you teach?

○ 1-5 (4)

○ 6-10 (5)

○ 11-15 (6)

○ Other number (7)

○ None (8)

Q7: Do you have a teaching or lab assistant, reader, or grader assigned to each class?

○ Yes (1)

○ No (2)

Q8: In the courses you teach, do you utilize any of the following for instruction and/or advising? (Check all applicable choices)

▢ Online platform (1)

▢ Video conferencing (2)

▢ Service Learning (3)

▢ Other hands-on research projects (4)

▢ Texting (5)

▢ Email (6)

Q9: How many hours per week do you spend advising African American female engineering students in regularly scheduled office hours in person or online? Give your best estimate.

○ 1-5 (4)

○ 6-10 (5)

○ 11-15 (6)

○ None (7)

End of Block: Teaching/Advising Practices

Start of Block: Instructional responsibilities and workload

Q10: How many hours each semester do you work on research with African American female engineering students?

○ 1-5 (4)

○ 6-10 (5)

○ 11-15 (6)

○ Other (7)

○ None (8)

Q11: How many African American female engineering students do you mentor?

○ 1-5 (4)

○ 6-10 (5)

○ 11-15 (6)

○ Other (7)

○ None (8)

Q12: How do you identify the students to be mentored? (Check all that applies)

▢ Assigned by Department Head (4)

▢ By Student Request (5)

▢ Other Measure(s) (8)

Q13: Does your institution utilize any of the following initiatives? (Check all that apply)

- ☐ Retention (4)
- ☐ Recruitment (5)
- ☐ Diversity (6)
- ☐ Equity and Inclusion (7)
- ☐ Living-learning communities (8)
- ☐ Service-learning (9)
- ☐ Collaborative research programs between faculty and students (10)

Q14: How do you identify students who need academic assistance? (Check all that apply)

- ☐ Declining grades (4)
- ☐ By student request (5)
- ☐ A drop in cumulative GPA (6)
- ☐ Other school criteria (7)
- ☐ Lack of attending class (8)

End of Block: Instructional responsibilities and workload

Start of Block: Funding

Q15: Level of satisfaction with the availability of resources in your department for students?

- Extremely satisfied (1)
- Moderately satisfied (2)
- Slightly satisfied (3)
- Neither satisfied nor dissatisfied (4)
- Slightly dissatisfied (5)
- Moderately dissatisfied (6)
- Extremely dissatisfied (7)

End of Block: Funding

Start of Block: Scholarly Activity

Q16: How many publications/presentations have you collaborated with students?

- None (1)
- 1 to 5 (2)
- 6 to 10 (3)
- 11 or more (4)

End of Block: Scholarly Activity

Start of Block: Professional Development

Q17: Do you have professional development for faculty related to the following? (Check all that apply)

- ▢ Managing implicit/explicit bias (1)
- ▢ Gender/Race bias in engineering (2)
- ▢ Cultural awareness (3)
- ▢ Teaching practices and curriculum (5)
- ▢ Various institutional policies (6)
- ▢ Faculty development plan (7)
- ▢ Diversity (8)

Q18: If yes, how often is the training?

- ○ Once a semester/quarter (1)
- ○ Once every year (2)
- ○ Other (3)

End of Block: Professional Development

Start of Block: Suggestions for Improvement

Q19: Please provide suggestion(s) to improve the culture of engineering programs. (List at least one)

____

Q20: Please provide suggestion(s) to improve the recruitment and retention of African American female engineering students. (List at least one)

____

Q21: Please provide suggestion(s) to improve the recruitment and retention of African American female engineering faculty. (List at least one)

____

Q22: Please provide suggestion(s) to improve diversity in engineering programs. (List at least one)

____

End of Block: Suggestions for Improvement

Deans of Engineering Survey

Start of Block: Demographics

Q2: What is your sex? (If multi-racial, please check all that applies)

- ○ Male (1)
- ○ Female (2)

Q3: What is your race?

- ▢ Choose from drop-down list (1)
- ▢ White (2)
- ▢ Hispanic (3)
- ▢ Asian (4)
- ▢ Native American (5)
- ▢ American Indian (6)
- ▢ Alaska Native (7)
- ▢ Native Hawaiian (8)
- ▢ Other Pacific Islander (9)
- ▢ Black or African-American (10)

Q4: What is your age?

- ○ 25 - 34 (1)
- ○ 35 - 44 (2)
- ○ 45 - 54 (3)
- ○ 55 - 64 (4)
- ○ 65 - 74 (5)
- ○ 75 - 84 (6)
- ○ 85 or older (7)

End of Block: Demographics

Start of Block: Assessment

Q5: Are there freshman orientation related to the following? (Check all that apply)

- ▢ Diversity (1)
- ▢ Cultural Awareness (2)
- ▢ Discrimination (3)
- ▢ Gender/Race bias (4)
- ▢ Academic Support Services (5)

Q6: Are there yearly student assessment for items in the above question?

- ○ Yes (1)
- ○ No (2)

Q7: Does your university have measures in place to assess the effectiveness of the items below? (Check all that applies)

- ▢ Culture of Engineering Programs (4)
- ▢ Faculty Performance (5)
- ▢ Each Engineering Program (6)
- ▢ Student Performance (7)

Q8: If so, are any of the following used as part of institution/department policy in assessing the performance of faculty/advisors/staff at your institution? (Check all that apply)

- ▢ Student evaluations (1)
- ▢ Student test scores (2)
- ▢ Student career placement (3)
- ▢ Other measures of student performance (4)
- ▢ Department chair evaluation (5)
- ▢ Peer evaluations (6)
- ▢ Self-evaluation (7)

End of Block: Assessment

Start of Block: Professional Development

Q9: Does your institution have professional development for deans, faculty, and/or advisors related to: (Check all that apply)?

- ☐ Managing explicit/implicit bias (1)
- ☐ Gender/race bias in engineering (2)
- ☐ Institutional policies (4)
- ☐ Teaching practices and curriculum (5)
- ☐ Faculty development plan (6)
- ☐ Cultural awareness (7)
- ☐ Diversity (8)

Q10: If so, how often are the training?

- ○ Once a semester/quarter (1)
- ○ Once every year (2)
- ○ Other (3)

Q11: Does your engineering programs have any of the following initiatives for students? (Check all that apply)

- ☐ Service-learning (1)
- ☐ Living-learning communities (2)
- ☐ Community-based research projects (3)
- ☐ Collaborative research projects between faculty and students (5)
- ☐ Retention (6)
- ☐ Recruitment (7)
- ☐ Diversity (8)
- ☐ Equity and Inclusion (9)

End of Block: Professional Development

Start of Block: Advising/Mentoring

Q12: How many African American female faculty members do you mentor?

- ○ 1-5 (4)
- ○ 6-10 (5)
- ○ 11 or more (6)
- ○ None (7)

Q13: What measures does your institution use to strengthen faculty engagement in student achievement? (Please list at least one method)

____

____

____

____

____

Q14: How many African American female engineering students do you mentor?

- 1-5 (1)
- 6-10 (2)
- 11 or more (3)
- None (4)

Q15: How do you identify the students to be mentored? (Check all that apply)

- Assigned by department head (1)
- By student request (2)
- Other measure(s) (3)
- Lack of attending class (4)
- Declining grades (5)
- Program requirement (6)

Q16: How do you provide support for these students to persist in their engineering discipline? Please name at least one.

____

End of Block: Advising/Mentoring

Start of Block: Diversity

Q17: How many African American female faculty member(s) are in your engineering departments?

○ 1-5 (4)

○ 6-10 (5)

○ 11 or more (6)

○ None (7)

Q18: Does your institution have a policy for diversifying faculty members and the student body?

○ Yes (23)

○ No (24)

End of Block: Diversity

Start of Block: Funding

Q19: Level of satisfaction with the availability of resources in your department for students?

○ Extremely satisfied (1)

○ Moderately satisfied (2)

○ Slightly satisfied (3)

○ Neither satisfied nor dissatisfied (4)

○ Slightly dissatisfied (5)

○ Moderately dissatisfied (6)

○ Extremely dissatisfied (7)

End of Block: Funding

Start of Block: Suggestions for improvement

Q20: Please describe suggestion(s) to improve the culture of engineering programs. (List at least one)

____

Q21: Please describe suggestion(s) to improve recruitment and retention of African American female engineering students. (List at least one)

____

Q22: Please briefly describe any suggestions to improve recruitment and retention of African American female engineering faculty. (List at least one)

____

____

____

____

____

Q23: Please briefly describe any suggestions to improve diversity in engineering programs. (List at least one)

____

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____

End of Block: Suggestions for improvement

Directors of Academic & Student Affairs/Diversity/Equity/Inclusion

Start of Block: Demographics

Q2: What is your sex?

○ Male (1)

○ Female (2)

Q3: What is your race? (If multi-racial, please check all that applies)

▢ White (2)

▢ Hispanic (3)

▢ Asian (4)

▢ Native American (5)

▢ American Indian (6)

▢ Alaska Native (7)

▢ Native Hawaiian (8)

▢ Other Pacific Islander (9)

▢ Black or African-American (10)

Q4: What is your age?

- ○ 25 - 34 (3)
- ○ 35 - 44 (4)
- ○ 45 - 54 (5)
- ○ 55 - 64 (6)
- ○ 65 - 74 (7)
- ○ 75-84 (11)
- ○ 85 or Older (12)

End of Block: Demographics

Start of Block: Academic and Professional Background

Q5: Please select all of the departments that you oversee? (Check all departments at your institution)

- ▢ Living Learning Communities (2)
- ▢ Diversity Office (4)
- ▢ New student orientation (5)
- ▢ Financial aid (6)
- ▢ Counseling centers (7)
- ▢ Advising centers (8)
- ▢ Leadership development (9)
- ▢ Student activities (11)
- ▢ Community service (13)
- ▢ Service learning (14)
- ▢ Career planning and placement (15)
- ▢ Alumni relations and development (17)
- ▢ Advocacy and support programs (20)
- ▢ Admissions (21)

Q6: Please select all the functions that your offices perform? (Check all applicable choices)

▢ Program development (2)

▢ Planning (3)

▢ Counseling (4)

▢ Training (5)

▢ Mentoring (6)

▢ Assessment and evaluation (7)

▢ Individual and group advising (10)

▢ Outcomes assessment (11)

▢ Cultural assessment (12)

▢ Funding sources identification (13)

▢ Grant writing (14)

End of Block: Academic and Professional Background

Start of Block: Funding

Q7: Level of satisfaction with the availability of resources in your department for students?

- Extremely satisfied (1)
- Moderately satisfied (2)
- Slightly satisfied (3)
- Neither satisfied nor dissatisfied (4)
- Slightly dissatisfied (5)
- Moderately dissatisfied (6)
- Extremely dissatisfied (7)

Q8: Has your institution identified funding sources to sustain assessment of diversity and retention policies?

- Yes (1)
- No (2)

End of Block: Funding

Start of Block: Assessment

Q9: Are there freshman orientation related to the following? (Check all that apply)

- Diversity (1)
- Cultural Awareness (2)
- Implicit/Explicit Bias (5)
- Academic Support Services (6)

Q10: If yes, how often?

- ○ Every semester/quarter (1)
- ○ Once a year (2)
- ○ Other (3)

Q11: Do you have assessment measures for the following? (Please check all that apply)

- ☐ Student Performance (1)
- ☐ Student's academic progress (2)
- ☐ Culture of engineering programs/institutions (3)
- ☐ Advisors effectiveness (4)
- ☐ Effectiveness of initiatives/programs, such living-learning communities, mentoring programs, service-learning, etc. (5)

Q12: Are any of the following used as part of institution/department policy in assessing the teaching performance of faculty/advisors/staff at your institution? (Check all that apply)

- [ ] Student evaluations (1)
- [ ] Student test scores (2)
- [ ] Student career placement (3)
- [ ] Other measures of student performance (4)
- [ ] Department chair evaluation (5)
- [ ] Peer evaluations (6)
- [ ] Self-evaluation (7)

End of Block: Assessment

Start of Block: Professional Development

Q13: Do you have professional development for faculty, deans, and advisors relative to the following: (Check all that apply)

- [ ] Managing implicit/explicit bias (1)
- [ ] Indicators of gender/race bias (2)
- [ ] Discrimination (3)
- [ ] Teaching practices/curriculum (4)
- [ ] Faculty development (5)
- [ ] Institution policies (6)
- [ ] Cultural Awareness (7)

Q14: If yes, how often are the training?

- ○ Once a semester/quarter (1)
- ○ Once every year (2)
- ○ Other (3)

End of Block: Professional Development

Start of Block: Monitoring

Q15: How does your institution identify minority/female students who need academic assistance? (Check all that apply)

- ☐ Declining grades (3)
- ☐ By student request (4)
- ☐ A drop in cumulative GPA (5)
- ☐ Lack of attending class (6)
- ☐ Other school criteria (7)

Q16: Does your office track the data for African American female engineering students usage of support services beyond their freshman year?

- ○ Yes (1)
- ○ No (2)

Q17: If yes, does the data provide a comparison with other racial groups and gender?

- ○ Yes (1)
- ○ No (2)

End of Block: Monitoring

Start of Block: Services

Q18: Are there initiative(s) in engineering programs for the following? (Please check all that apply)

- ☐ Retention (4)
- ☐ Recruitment (5)
- ☐ Diversity (6)
- ☐ Equity and Inclusion (7)
- ☐ Living-learning communities (8)
- ☐ Service-learning (9)
- ☐ Collaborated research programs between faculty and students (10)

Q19: What type of living-learning communities (LLCs) do you have for female students in engineering? (Check all that apply)

- ☐ Women in science, technology, engineering, and mathematics (1)
- ☐ Race, gender, and cultural relations (2)
- ☐ Other LLCs (3)

End of Block: Services

Start of Block: Suggestions for improvement

Q20: Please briefly describe any suggestions to improve the culture of engineering programs. (List at least one)

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____

Q21: Please briefly describe any suggestions to improve recruitment and retention of African American female engineering students. (List at least one)

____

____

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____

Q22: Please briefly describe any suggestions to improve recruitment and retention of African American female engineering faculty. (List at least one)

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____

Q23: Please briefly describe any suggestions to improve diversity in engineering programs. (List at least one)

____

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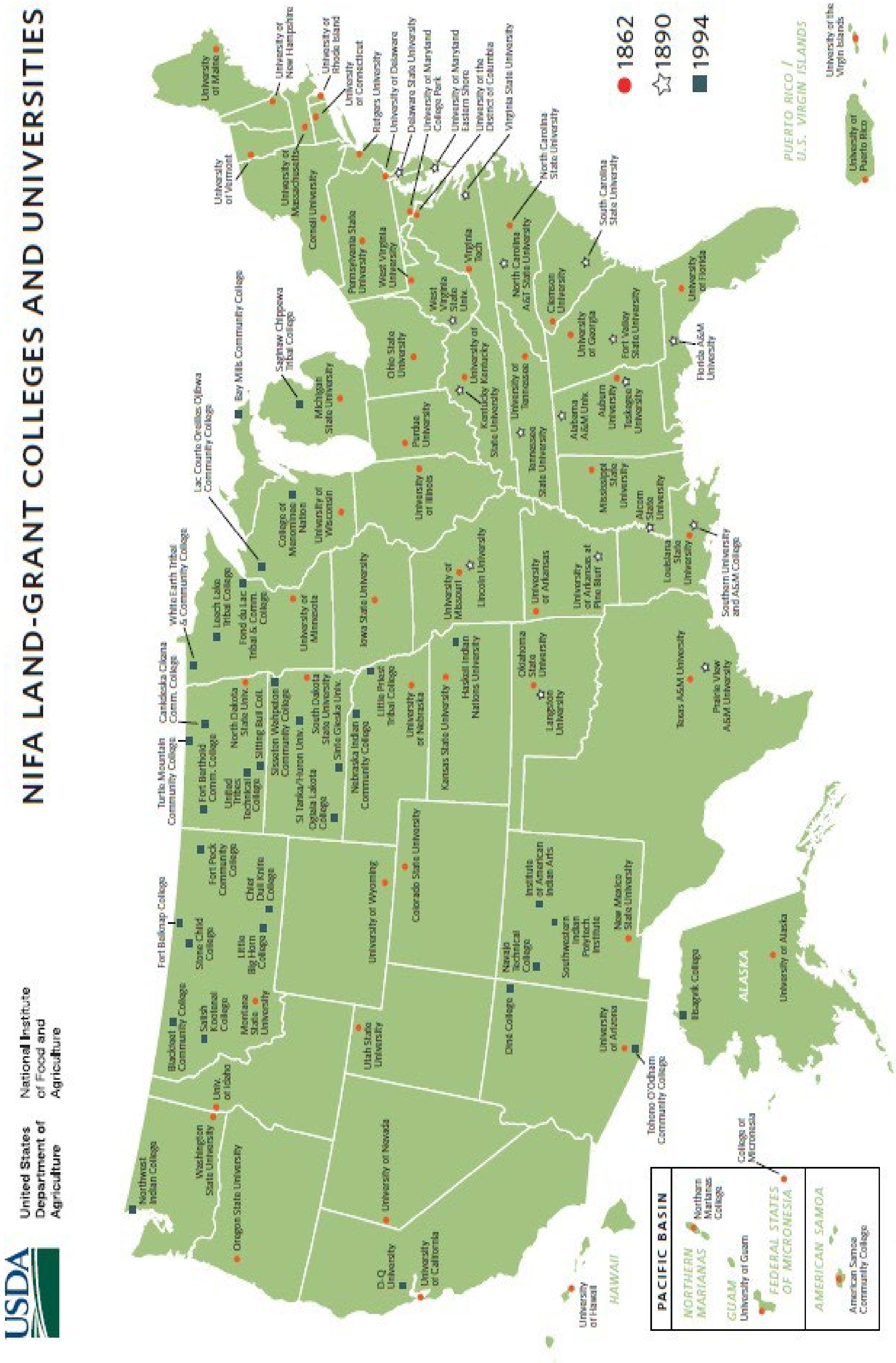
____

End of Block: Suggestions for improvement

Appendix C

Land-Grant Institutions Map and Listings


USDA
United States Department of Agriculture
National Institute of Food and Agriculture
NIFA LAND-GRANT COLLEGES AND UNIVERSITIES
1862
1890
1994
Northwest Indian College
Washington State University
Oregon State University
Univ. of Idaho
Blackfeet Community College
Salish Kootenai College
Montana State University
Fort Belknap College
Stone Child College
Little Big Horn College
Fort Peck Community College
Chief Dull Knife College
University of Nevada
D-Q University
University of California
Utah State University
University of Wyoming
Colorado State University
Diné College
Navajo Technical College
Southwestern Indian Polytech. Institute
Institute of American Indian Arts
New Mexico State University
University of Arizona
Tohono O'Odham Community College
Turtle Mountain Community College
Cankdeska Cikana Comm. College
Fort Berthold Comm. College
United Tribes Technical College
North Dakota State Univ.
Sitting Bull Col.
Sisseton Wahpeton Community College
Si Tanka/Huron Univ.
Oglala Lakota College
South Dakota State University
Sinte Gleska Univ.
Nebraska Indian Community College
Little Priest Tribal College
University of Nebraska
Kansas State University
Haskell Indian Nations University
Oklahoma State University
Langston University
Texas A&M University
Prairie View A&M University
White Earth Tribal & Community College
Leech Lake Tribal College
Fond du Lac Tribal & Comm. College
University of Minnesota
Iowa State University
University of Missouri
Lincoln University
University of Arkansas
University of Arkansas at Pine Bluff
Louisiana State University
Southern University and A&M College
Lac Courte Oreilles Ojibwa Community College
College of Menominee Nation
University of Wisconsin
University of Illinois
Bay Mills Community College
Saginaw Chippewa Tribal College
Michigan State University
Purdue University
Ohio State University
Kentucky State University
University of Kentucky
University of Tennessee
Tennessee State University
Mississippi State University
Alcorn State University
Alabama A&M Univ.
Auburn University
Tuskegee University
University of Georgia
Fort Valley State University
Florida A&M University
University of Florida
Clemson University
South Carolina State University
North Carolina A&T State University
North Carolina State University
Virginia Tech
Virginia State University
West Virginia State Univ.
West Virginia University
Pennsylvania State University
Cornell University
University of Vermont
University of Maine
University of New Hampshire
University of Massachusetts
University of Rhode Island
University of Connecticut
Rutgers University
University of Delaware
Delaware State University
University of Maryland College Park
University of Maryland Eastern Shore
University of the District of Columbia
ALASKA
Ilisagvik College
University of Alaska
HAWAII
University of Hawaii
PACIFIC BASIN
NORTHERN MARIANAS
Northern Marianas College
GUAM
University of Guam
FEDERAL STATES OF MICRONESIA
College of Micronesia
AMERICAN SAMOA
American Samoa Community College
PUERTO RICO / U.S. VIRGIN ISLANDS
University of Puerto Rico
University of the Virgin Islands

NIFA LAND-GRANT COLLEGES AND UNIVERSITIES (1862, 1890, AND 1994)

ALABAMA
Alabama A&M University, *Normal*
Auburn University, *Auburn*
Tuskegee University, *Tuskegee*

ALASKA
Ilisagvik College, *Barrow*
University of Alaska, *Fairbanks*

AMERICAN SAMOA
American Samoa Community College, *Pago Pago*

ARIZONA
Diné College, *Tsaile*
University of Arizona, *Tucson*
Tohono O'Odham Community College, *Sells*

ARKANSAS
University of Arkansas, *Fayetteville*
University of Arkansas at Pine Bluff, *Pine Bluff*

CALIFORNIA
D-Q University, *(Davis vicinity)*
University of California System-Oakland as Headquarters, *Oakland*

COLORADO
Colorado State University, *Fort Collins*

CONNECTICUT
University of Connecticut, *Storrs*

DELAWARE
Delaware State University, *Dover*
University of Delaware, *Newark*

DISTRICT OF COLUMBIA
University of the District of Columbia, *Washington*

FLORIDA
Florida A&M University, *Tallahassee*
University of Florida, *Gainesville*

GEORGIA
Fort Valley State University, *Fort Valley*
University of Georgia, *Athens*

GUAM
University of Guam, *Mangilao*

HAWAII
University of Hawaii, *Honolulu*

IDAHO
University of Idaho, *Moscow*

ILLINOIS
University of Illinois, *Urbana*

INDIANA
Purdue University, *West Lafayette*

IOWA
Iowa State University, *Ames*

KANSAS
Haskell Indian Nations University, *Lawrence*
Kansas State University, *Manhattan*

KENTUCKY
Kentucky State University, *Frankfort*
University of Kentucky, *Lexington*

LOUISIANA
Louisiana State University, *Baton Rouge*
Southern University and A&M College, *Baton Rouge*

MAINE
University of Maine, *Orono*

MARYLAND
University of Maryland, *College Park*
University of Maryland Eastern Shore, *Princess Anne*

MASSACHUSETTS
University of Massachusetts, *Amherst*

MICHIGAN
Bay Mills Community College, *Brimely*
Michigan State University, *East Lansing*
Saginaw Chippewa Tribal College, *Mount Pleasant*

MICRONESIA
College of Micronesia, *Kolonia, Pohnpei*

MINNESOTA
Fond du Lac Tribal & Community College, *Cloquet*
Leech Lake Tribal College, *Cass Lake*
University of Minnesota, *St. Paul*
White Earth Tribal and Community College, *Mahnomen*

MISSISSIPPI
Alcorn State University, *Lorman*
Mississippi State University, *Starkville*

MISSOURI
Lincoln University, *Jefferson City*
University of Missouri, *Columbia*

MONTANA
Blackfeet Community College, *Browning*
Chief Dull Knife College, *Lame Deer*
Fort Belknap College, *Harlem*
Fort Peck Community College, *Poplar*
Little Big Horn College, *Crow Agency*
Montana State University, *Bozeman*
Salish Kootenai College, *Pablo*
Stone Child College, *Box Elder*

NEBRASKA
Little Priest Tribal College, *Winnebago*
Nebraska Indian Community College, *Winnebago*
University of Nebraska, *Lincoln*

NEVADA
University of Nevada, *Reno*

NEW HAMPSHIRE
University of New Hampshire, *Durham*

NEW JERSEY
Rutgers University, *New Brunswick*

NEW MEXICO
Navajo Technical College, *Crownpoint*
Institute of American Indian Arts, *Sante Fe*
New Mexico State University, *Las Cruces*
Southwestern Indian Polytechnic Institute, *Albuquerque*

NEW YORK
Cornell University, *Ithaca*

NORTH CAROLINA
North Carolina A&T State University, *Greensboro*
North Carolina State University, *Raleigh*

NORTH DAKOTA
Fort Berthold Community College, *New Town*
Cankdeska Cikana Community College, *Fort Totten*
North Dakota State University, *Fargo*
Sitting Bull College, *Fort Yates*
Turtle Mountain Community College, *Belcourt*
United Tribes Technical College, *Bismarck*

NORTHERN MARIANAS
Northern Marianas College, *Saipan, CM*

OHIO
Ohio State University, *Columbus*

OKLAHOMA
Langston University, *Langston*
Oklahoma State University, *Stillwater*

OREGON
Oregon State University, *Corvallis*

PENNSYLVANIA
Pennsylvania State University, *University Park*

PUERTO RICO
University of Puerto Rico, *Mayaguez*

RHODE ISLAND
University of Rhode Island, *Kingston*

SOUTH CAROLINA
Clemson University, *Clemson*
South Carolina State University, *Orangeburg*

SOUTH DAKOTA
Oglala Lakota College, *Kyle*
Si Tanka/Huron University, *Eagle Butte*
Sinte Gleska University, *Rosebud*
Sisseton Wahpeton Community College, *Sisseton*
South Dakota State University, *Brookings*

TENNESSEE
Tennessee State University, *Nashville*
University of Tennessee, *Knoxville*

TEXAS
Prairie View A&M University, *Prairie View*
Texas A&M University, *College Station*

UTAH
Utah State University, *Logan*

VERMONT
University of Vermont, *Burlington*

VIRGIN ISLANDS
University of the Virgin Islands, *St. Croix*

VIRGINIA
Virginia Tech, *Blacksburg*
Virginia State University, *Petersburg*

WASHINGTON
Northwest Indian College, *Bellingham*
Washington State University, *Pullman*

WEST VIRGINIA
West Virginia State University, *Institute*
West Virginia University, *Morgantown*

WISCONSIN
College of Menominee Nation, *Keshena*
Lac Courte Oreilles Ojibwa, Community College, *Hayward*
University of Wisconsin, *Madison*

WYOMING
University of Wyoming *Laramie, WY*

Appendix D

Accreditation Regions

HLC	MSCHE	NECHE	NWCCU	SACSCOC	WSCUC
Arizona	Delaware	Connecticut	Alaska	Alabama	California
Arkansas	D.C.	Maine	Idaho	Florida	Hawaii
Colorado	Maryland	Massachusetts	Montana	Georgia	
Illinois	New Jersey	New Hampshire	Nevada	Kentucky	
Indiana	New York	Rhode Island	Oregon	Louisiana	
Iowa	Pennsylvania	Vermont	Utah	Mississippi	
Kansas	Puerto Rico		Washington	North Carolina	
Michigan	Virgin Islands			South Carolina	
Minnesota				Tennessee	
Missouri				Texas	
Nebraska				Virginia	
New Mexico					
North Dakota					
Ohio					
Oklahoma					
South Dakota					
West Virginia					
Wisconsin					
Wyoming					

Appendix E

Advisors Statistical Data Analysis

Section: Demographics

Table E.1

Gender Distribution for Advisors Survey Group (n = 36)

Q2: Gender	Frequency	Percent	Valid Percent
Male	4	11.1%	12.1%
Female	29	80.6%	87.9%
Total	33	91.7 %	100%
Missing	3	8.3%	
Total	36	100%	

Table E.2

Ethnicity Distribution for Advisors Survey Group (N= 36) – Multiple Response Set

Q3: Ethnicity	N	Percent	Percent of Cases
White	26	65.0%	74.3%
Black or African American	5	12.5%	14.3%
Hispanic	3	7.5%	8.6%
Asian	1	2.5%	2.9%
Native American	1	2.5%	2.9%
American Indian	2	5.0%	5.7%
Alaska Native	0	0%	0%
Native Hawaiian	0	0%	0%
Other Pacific Islander	0	0%	0%
Total	40	100%	114.3%
Valid Total	35	97.2%	
Missing	1	2.8%	
Total	36	100%	

Table E.3

Age Range Distribution for Advisors Survey Group (N = 36)

Q4: Age Range	N	Percent	Cumulative Percent
Valid			
25-34	9	25%	26.5%
35-44	9	25%	52.9%
45-54	4	11.1%	64.7%
55-64	10	27.8%	94.1%
65-74	2	5.6%	100%
75-84	0	0%	0%
85 or older	0	0%	0%
Total	34	94.4%	
Missing	2	5.6%	
Total	36	100%	

Section: Advising/Assessment

Table E.4

AA Students advise per week - Frequency Distribution Statistics for Advisors Survey Group (N = 36)

Q5: How many AA Female engineering students do you advise per week?

Valid	N	Percent	Cumulative Percent
1-5	18	50%	66.7%
6-10	2	5.6%	74.1%
Other	5	13.9%	92.6%
None	2	5.6%	100%
Total	27	75%	
Missing	9	25%	
Total	36	100%	

Table E.5

Question #5 Descriptive Statistics for Advisors Survey Group (N = 36)

Q5: How many AA Female engineering students do you advise per week?		
N	Valid	27
	Missing	9
Mean		1.93
Standard Deviation		1.466

Table E.6

AA students mentored - Frequency Distribution Statistics for Advisors Survey Group (N = 36)

Q6: Mentoring AA Female engineering students

Valid		N	Percent	Cumulative Percent
	1-5	13	36.1%	48.1%
	6-10	5	13.9%	66.7%
	Other	9	25%	100%
Total		27	75%	
Missing		9	25%	
Total		36	100%	

Table E.7

AA students mentored - Descriptive Statistics for Advisors Survey Group (N = 36)

Q6: How many AA Female engineering students do you advise per week?		
N	Valid	27
	Missing	9
Mean		2.1852
Standard Deviation		1.35978

Table E.8

Assessment Measures (perception of needs) – Frequency Distribution (multiple response set: N = 36) for Advisors Survey Group (selected responses)

Q7: Assessment Measures	N	Percent	Percent of Cases
Student Request Appt.	23	25.3%	85.2%
Declining grades	20	22%	74.1%
A drop in cumulative GPA	18	19.8%	66.7%
Other school criteria	16	17.6%	59.3%
Lack of attending class	14	15.4%	51.9%
Total	91	100%	337%

Table E.9

Assessment Measures Distribution Case Summary for Advisors Survey Group (N = 36)

Q7:	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	Percent
	27	75%	9	25%	36	100%

Table E.10

Support resources for degree completion – Advisor Survey Group - Frequency (multiple set) N = 36

Q8: Support Resources	N	Percent	Percent of Cases
Eng. Organizations	12	25%	57.1%
Advising	7	14.6%	33.3%
Academic Support	6	12.5%	28.6%
Tutoring	6	12.5%	28.6%
Diversity	5	10.4%	23.8%
Other Support	4	8.3%	19%
Mentoring	4	8.3%	19%
Student Support	4	8.3%	19%
Total	48	100%	228.6%

Table E.11

Support resources Distribution Case Summary for Advisors survey group (N = 36)

Q8:	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	Percent
	21	58.3%	15	41.7%	36	100%

Table E.12

Advising Students - *Descriptive Statistics for Advisors Survey Group (N = 36)*

Q9: When providing advising to students, do you utilize any of the following? (Check all that applies)

		Frequency	Percent	Valid Percent
In-person	Selected	27	75%	100%
	Not Selected	0	0%	0%
Email	Selected	23	63.9%	85.2%
	Not Selected	4	11.1%	14.8%
Phone Calls	Selected	13	36.1%	48.1%
	Not Selected	14	38.9%	51.9%
Online Platform	Selected	7	19.4%	25.9%
	Not Selected	20	55.6%	74.1%
Video Conferencing	Selected	5	19.4%	25.9%
	Not Selected	22	61.1%	81.5%
Text	Selected	5	13.9%	18.5%
	Not Selected	20	58.3%	77.8%

Section: Funding

Table E.13

Satisfaction of Resources in department - Descriptive Statistics for Advisors Survey Group (N = 36)

Q10: Level of satisfaction with the availability of resources in your department for students. (7 pt. Likert scale)

N	Valid	26
	Missing	10
Mean		2.42
Standard Deviation		1.332

Section: Professional Development

Table E.14

Professional Development – Advisors Survey Group (N= 36) Multiple response set

Q11:	N	Percent	Percent of Cases
Institutional Policies	22	19.3%	78.6%
Diversity	22	19.3%	78.6%
Advising Practices	20	17.5%	71.4%
Cultural Awareness	20	17.5%	71.4%
Managing Bias	17	14.9%	60.7%
Gender/Race Bias	13	11.4%	46.4%
Total	114	100%	407.1%

Table E.15

Professional Development Distribution Case Summary for Advisors survey group (N = 36)

	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	Percent
Q11	28	77.8%	8	22.2%	36	100%

Table E.16

Frequency of Professional Development Training – Advisors Survey Group (N= 36) Multiple response set

Q12: If yes, how often do you Receive training?	N	Percent	Percent of Cases
Once a semester/quarter	9	25%	34.6%
Once every year	7	19.4%	61.5%
Other	10	27.8%	100%
Total	26	72.2%	
Missing	10	27.8%	
Total	36	100%	

Table E.17

Question #12 Descriptive Statistics for Advisors Survey Group (N = 36)

Q12: If yes, how often do you receive training?		
N	Valid	26
	Missing	10
Mean		2.04
Standard Deviation		.871

Table E.18

Innovative Advising Practices – Frequency Distribution for Advisors Survey Group (N = 36)

Q13: Does your institution encourage innovative advising practices?

	N	Percent	Valid Percent
Yes	23	63.9%	85.2%
No	4	11.1%	14.8%
Total	27	75%	100%
Missing	9	25%	
Total	36	100%	

Section: Suggestions for Improvement

Table E.19

Cluster Analysis for Advisors Survey Group (N = 36): Q14 – culture of engineering programs, Q15 - retention and recruitment for African American female engineering students, Q16 - and retention and recruitment for African American female engineering faculty, &Q17 – improve diversity

Cluster Analysis	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	Percent
Q14-17 (Faculty Hiring)	11	22.2%	25	69.4%	36	100%
Q14-17 (Mentoring)	8	22.2%	28	77.8%	36	100%
Q14-17 (Acad. Support)	7	19.4%	29	80.6%	36	100%
Q14-17 (Recruitment)	7	19.4%	29	80.6%	36	100%
Q14-17 (Diversity)	6	16.7%	30	83.3%	36	100%
Q14-17 (Stud Supp Training)	6	16.7%	30	83.3%	36	100%
Q14-17 (Other)	6	16.7%	30	83.3%	36	100%
Q14-17 (STEM Pipeline)	6	16.7%	30	83.3%	36	100%
Q14-17 (Faculty Support)	5	13.8%	31	86.1%	36	100%
Q14-17 (Advising)	4	11.1%	32	88.9%	36	100%
Q14-17 (Retention)	3	8.3%	33	91.7%	36	100%
Q14-17 (Stud Mon Incent)	2	5.6%	34	94.4%	36	100%
Q14-17 (Faculty Training)	1	2.8%	35	97.2%	36	100%
Q14-17 (Culture)	1	2.8%	35	97.2%	36	100%
Q14-17 (Eng. Organization)	0	0%	36	100%	36	100%
Total	73	194.4%				

Appendix F

Faculty Chairs Statistical Data Analysis

Section: Demographics

Table F.1

Gender Distribution for Faculty Chairs Survey Group (N = 28)

Q2: Gender	Frequency	Percent	Valid Percent
Male	20	71.4%	80%
Female	5	17.9%	20%
Total	25	89.3%	100%
Missing	3	10.7%	
Total	28	100%	

Table F.2

Ethnicity Distribution for Faculty Chairs Survey Group (N= 28): Multiple Response Set

Q3: Ethnicity	N	Percent	Percent of Cases
White	24	85.7%	92.3%
Hispanic	3	10.7%	11.5%
Multi-Racial	1	3.6%	3.8%
Total	28	100%	107.7%

Table F.3

Ethnicity Distribution Case Summary for Faculty Chairs Survey Group (N = 28)

Q3: Ethnicity	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	Percent
	26	92.9%	2	7.1%	28	100%

Table F.4

Age Range Distribution for Faculty Chairs Survey Group (N = 28)

Q4: Age Range	N	Percent	Cumulative Percent
25-34	1	3.6%	3.6%
35-44	2	7.1%	10.7%
45-54	9	32.1%	14.3%
55-64	11	39.3%	46.4%
65-74	4	14.3%	85.7%
Total	28	100%	100%

Section: Teaching/Advising Practices

Table F.5

Students Enrolled in Engineering Programs for Faculty Chairs Survey Group (N = 28)

Q5: Students Enrolled	N	Percent	Cumulative Percent
1-20	1	3.6%	4%
21-30	1	3.6%	8%
31-40	1	3.6%	12%
41-50	0	0%	0%
51-60	2	7.1%	20%
61-70	0	0%	0%
71-80	0	0%	0%
81-90	2	7.1%	28%
91-100	1	3.6%	32%
101 or more	17	60.7%	100%
Total	25	89.3%	
Missing	3	10.7%	
Total	28	100%	

Table F.6

Question #5 Descriptive Statistics for Faculty Chairs Survey Group (N = 28)

Q5: On average, how many students are enrolled in your engineering program(s)?

N	Valid	25
	Missing	3
Mean		8.44
Standard Deviation		2.830

Table F.7

Question #6 Descriptive Statistics for Faculty Chairs Survey Group (N = 28)

Q6: On average, how many African American female engineering students are in courses you teach?

N	Valid	25
	Missing	3
Mean		1.8
Standard Deviation		1.5

Table F.8

Question #7 Descriptive Statistics for Faculty Chairs Survey Group (N = 28)

Q7: Do you have a teaching or lab assistant, reader, or grader assigned to each class?

N	Valid	24
	Missing	4
Mean		1.54
Standard Deviation		.509

Table F.9

Teaching or Lab assistant – Frequency Distribution (Multiple response set) for Faculty Chairs Survey Group (N = 28)

Q7:	N	Percent	Percent of Cases
Yes	11	39.3%	45.8%
No	13	46.4%	54.2%

Valid		Cases Missing		Total	
N	Percent	N	Percent	N	Percent
24	85.7%	4	14.3%	28	100%

Table F.10

Question #8 - Frequency Analysis Distribution Summary for Faculty Chairs Survey Group (N = 28)

Q8: In the courses you teach, do you utilize any of the following for instruction and/or advising? (Check all applicable choices)

Choices	N	Percent
Online platform	18	35.3%
Video conferencing	3	5.9%
Service learning	2	3.9%
Other hands-on research projects	12	23.5%
Texting	0	0%
Email	16	31.4%
Total	51	100%

Table F.11

Question #9 - Descriptive Statistics for Faculty Chairs Survey Group (N = 28)

Q9: How many hours per week do you spend advising African American female engineering students in regularly scheduled office hours in person or online? Give your best estimate.

N	Valid	25
	Missing	3
Mean		2.08
Standard Deviation		1.47

Section: Instructional responsibilities and workload

Table F.12

Question #10 – Descriptive Statistics for Faculty Chairs Survey Group (N = 28)

Q10: How many hours each semester do you work on research with African American female engineering students?

N	Valid	24
	Missing	4
Mean		4.21
Standard Deviation		1.474

Table F.13

Question #11 – Descriptive Statistics for Faculty Chairs Survey Group (N = 28)

Q11: How many African American female engineering students do you mentor?

N	Valid	23
	Missing	5
Mean		2.91
Standard Deviation		2.043

Table F.14

Q#12 – Identify students to be mentored for Faculty Chairs Survey Group (N = 28)

Q12:	N	Percent	Percent of Cases
Assign by dept. head	8	25.8%	36.4%
By student request	15	48.4%	68.2%
Other	8	25.8%	36.4%
Total	31	100%	140.9%

Valid		Cases Missing		Total	
N	Percent	N	Percent	N	Percent
22	78.6%	6	21.4%	28	100%

Table F.15

Q13 – Student Initiatives for Faculty Chairs Survey Group

Q13:	N	Percent	Percent of Cases
Svc Learning	12	10.3%	60%
LLCs	11	9.4%	55%
Collab Research Project	17	14.5%	85%
Retention	19	16.2%	95%
Recruitment	19	16.2%	95%
Diversity	20	17.1%	100%
Equity/Inclusion	19	16.2%	95%
Total	117	100%	585%

Valid		Cases Missing		Total	
N	Percent	N	Percent	N	Percent
20	71.4%	8	28.6%	28	100%

Table F.16

Identification of student who need assistance – Frequency Distribution (Multiple response set – N = 28)

Q14: Identification	N	Percent	Percent of Cases
By Student Request	19	25.7%	79.2%
Declining Grades	18	24.3%	75%
A drop in GPA	13	17.6%	54.2%
Other school criteria	12	16.2%	50%
Lack of attending class	12	16.2%	50%
Total	74	100%	308.3%

Table F.17

Identification of students who need assistance Distribution Case Summary (N = 28)

	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	Percent
Q14:	24	85.7%	4	14.3%	28	100%

Section: Funding

Table F.18

Question #15 – Descriptive Statistics (N = 28)

Q15: Level of satisfaction with the availability of resources in your department for students)		
N	Valid	23
	Missing	5
Mean		2.0
Standard Deviation		.739

Section: Scholarly Activity

Table F.19

Question #16 – Descriptive Statistics (N = 28)

Q16: How many publications/presentations have you collaborated with students?		
N	Valid	23
	Missing	5
Mean		2.91
Standard Deviation		.288

Section: Professional development

Table F.20

Question #17- Faculty Professional Development for Faculty Chairs Survey Group (N = 28)

Q17:	N	Percent	Percent of Cases
Manage Bias	20	16.5%	87%
Gender/Race Bias	17	14%	73.9%
Cultural Awareness	14	11.6%	60.9%
Teaching Practices	20	16.5%	87%
Various Instit. Policies	19	15.7%	82.6%
Faculty Development Plan	15	12.4%	65.2%
Service Learning	1	0.8%	4.3%
Diversity	15	12.4%	65.2%
Total	121	100%	526.1%

Valid		Cases Missing		Total	
N	Percent	N	Percent	N	Percent
23	82.1%	5	17.9%	28	100%

Table F.21

Question #18 – Descriptive Statistics (N = 28)

Q18: If yes, how often is the training?		
N	Valid	23
	Missing	5
Mean		2.17
Standard Deviation		.576

Section: Suggestions for Improvement

Table F.22

Clustered Analysis: Questions 19, Question 20, Question 21, & Question 22: Engineering programs – culture and diversity, retention and recruitment for African American female engineering students, and retention and recruitment for African American female engineering faculty Cluster Analysis (N = 28)

Cluster Analysis	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	Percent
Q19-22 (Mentoring)	3	10.7%	25	89.3%	28	100%
Q19-22 (Diversity)	8	28.6%	20	71.4%	28	100%
Q19-22 (Faculty Hiring)	7	25%	21	75%	28	100%
Q19-22 (Faculty Training)	1	3.6 %	27	96.4%	28	100%
Q19-22 (Advising)	1	3.6%	27	96.4%	28	100%
Q19-22 (Stud Supp Training)	3	10.7%	25	89%	28	100%
Q19-22 (Retention)	6	21%	22	78.6%	28	100%
Q19-22 (Stud Mon Incent)	0	0%	28	100%	28	100%
Q19-22 (Acad. Support)	3	10.7%	25	89.3%	28	100%
Q19-22 (Culture)	6	21%	22	78.6%	28	100%
Q19-22 (Other)	11	39%	17	60.7%	28	100%
Q19-22 (Recruitment)	10	35.7%	18	64%	28	100%
Q19-22 (STEM Pipeline)	9	32%	19	67.8%	28	100%
Q19-22 (Eng. Organization)	0	0%	28	100%	28	100%
Q19-22 (Faculty Support)	0	0%	28	100%	28	100%
Total	68	241.6%				

Appendix G

Deans of Engineering Statistical Data Analysis

Section: Demographics

Table G.1

Gender Distribution for Deans of Engineering Survey Group (N = 21)

Q2: Gender	Frequency	Percent	Valid Percent
Male	13	61.9%	65%
Female	7	33.3%	35%
Total	20	95.2%	100%
Missing	1	4.8%	
Total	21	100%	

Table G.2

Ethnicity Distribution for Deans of Engineering Survey Group (N = 21) Multiple Response Set

Q3: Ethnicity Multiple Set	N	Percent	Percent of Cases
White	18	72%	85.7%
Black or African American	3	12%	14.3%
Hispanic	2	8%	9.5%
Multi-Racial	2	8%	9.5%
Total	25	100%	119%

Table G.3

Ethnicity Distribution Case Summary for Deans of Engineering Survey Group (N = 21)

	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	Percent
Q3: Ethnicity	21	100%	0	0%	21	100%

Table G.4

Age Range Distribution for Deans of Engineering Survey Group (N = 21)

Q4: Age Range	N	Percent	Cumulative Percent
35-44	4	19%	19%
45-54	2	9.5%	28.6%
55-64	12	57.1%	85.7%
65-74	3	14.3%	100%
Total	21	100%	

Section: Assessment

Table G.5

Freshman Orientation – Frequency Distribution (multiple response set) for Deans of Engineering Survey Group (N = 21)

Q5: Freshman Orientation	N	Percent	Percent of Cases
Diversity	11	20.8%	68.8%
Cultural Awareness	11	20.8%	68.8%
Discrimination	7	13.2%	43.8%
Gender/Race Bias	9	17%	56.3%
Academic Supp Svc	15	28.3%	93.8%
Total	53	100%	331.3%

Table G.6

Freshman Orientation Distribution Case Summary for Deans of Engineering Survey Group (N = 21)

Q5:	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	Percent
	16	76.2%	5	23.8%	21	100%

Table G.7

Yearly student assessment for orientation choices (Dichotomous) for Deans of Engineering Survey Group (N = 21)

Q6:	N	Percent	Percent of Cases
Yes	5	23.8%	33.3%
No	10	47.6%	66.7%
Total	15	71.4%	100%

Valid		Cases Missing		Total	
N	Percent	N	Percent	N	Percent
15	71.4%	6	28.6%	21	100%

Table G.8

Assessment Measures for Effectiveness – Frequency Distribution (multiple response set) for Deans of Engineering Survey Group (N = 21)

Q7: Assessment Measures	N	Percent	Percent of Cases
Culture of Eng Programs	15	31.9%	93.8%
Faculty Performance	6	12.8%	37.5%
Each Eng. Program	11	23.4%	68.8%
Student Performance	15	31.9%	93.8%
Total	47	100%	293.8%

Valid		Cases Missing		Total	
N	Percent	N	Percent	N	Percent
16	76.2%	5	23.8%	21	100%

Table G.9

Assessment of faculty/advisors – Descriptive Statistics for Deans of Engineering Survey Group (N = 21)

Q8: If so, are any of the following used as part of the institution/department policing in assessing the performance of faculty/advisors/staff at your institution? (Check all that apply)

Responses	N	Percent	Percent of Cases
Student Evaluations	15	21.1%	88.2%
Student Test Scores	6	8.5%	35.3%
Stud Career Placement	10	14.1%	58.8%
Other Measures of Stud Perf	7	9.9%	41.2%
Dept Chair Evaluations	11	15.5%	64.7%
Peer Evaluations	10	14.1%	58.8%
Self-Evaluations	12	16.9%	70.6%
Total	71	100%	417.6%

Valid		Cases Missing		Total	
N	Percent	N	Percent	N	Percent
17	81%	4	19%	21	100%

Section: Professional Development

Table G.10

Professional Development – Descriptive Statistics for Deans of Engineering Survey Group (N = 21)

Q9: Professional Development			
Responses	N	Percent	Percent of Cases
Teaching Practices/Curric	14	18.2%	93.3%
Institutional Policies	13	16.9%	86.7%
Manage Impl. /Expl. Bias	12	15.6%	80%
Cultural Awareness	9	11.7%	60%
Diversity	12	15.6%	80%
Faculty Develop Plan	11	14.3%	73.3%
Gender/Race Bias	6	7.8%	40%
Total	77	100%	513.3%

Valid		Cases Missing		Total	
N	Percent	N	Percent	N	Percent
15	71.4%	6	28.6%	21	100%

Table G.11

Question #10 – Descriptive Statistics for Deans of Engineering Survey Group (N = 21)

Q10: Frequency of Professional Development training?		
N	Valid	15
	Missing	6
Mean		2.27
Standard Deviation		.594
Variance		.352

Table G.12

Question #10 – Frequency of Professional Development training, Frequency Distribution Statistics for Deans of Engineering Survey Group (N = 21)

Q10: Frequency of training	N	Percent	Percent of Cases
Once a semester/quarter	1	4.8%	6.7%
Once every year	9	42.9%	66.7%
Other	5	23.8%	33.3%
Total	117	100%	688.2%

Valid		Cases Missing		Total	
N	Percent	N	Percent	N	Percent
15	71.4%	6	28.6%	21	100%

Table G.13

Student Initiatives (Multiple Response Set) N = 21 Deans of Engineering

Q11: Student Initiatives	N	Percent	Percent of Cases
Diversity	16	13.7%	94.1%
Service Learning	15	12.8%	88.2%
LLCs	15	12.8%	88.2%
Collab Research Projects	14	13.7%	94.1%
Retention	15	12.8%	88.2%
Recruitment	14	12%	82.4%
Equity & Inclusion	12	10.3%	70.6%
Comm Based Research	14	12%	82.4%
Total	117	100%	688.2%

Table G.14

Student Initiatives Distribution Case Summary for Deans of Engineering survey group (N = 21)

	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	Percent
Q11:	17	81%	4	19%	21	100%

Section: Advising/Mentoring

Table G.15

Descriptive Statistics for Deans of Engineering Survey Group (N = 21)

Q12: How many African American female faculty do you mentor?		
N	Valid	16
	Missing	5
Mean		2.75
Standard Deviation		1.483
Variance		2.200

Table G.16

Measure to strengthen faculty engagement for Deans of Engineering Survey Group (N = 21)

Q13: Faculty Engagement	N	Percent	Percent of Cases
Faculty Training	2	22.2%	28.6%
Academic Support	3	33.3%	42.9%
Stud Supp/Training	1	11.1%	14.3%
Faculty Hiring	2	22.2%	28.6%
Mentoring	1	11.1%	14.3%
Total	9	100%	128.6%

Valid		Cases Missing		Total	
N	Percent	N	Percent	N	Percent
7	33.3%	14	66.7%	21	100%

Table G.17

Descriptive Statistics for Deans of Engineering Survey Group (N = 21)

Q14: AA Students Mentored		
N	Valid	15
	Missing	6
Mean		2.67
Standard Deviation		1.447
Variance		2.095

Table G.18

Identify students to mentor – Deans of Engineering (Multiple Response Set) N = 21

Q15:	N	Percent	Percent of Cases
Assn by dept head	4	14.8%	36.4%
By student request	7	25.9%	63.6%
Other measure(s)	5	18.5%	45.5%
Lack of attending class	3	11.1%	27.3%
Declining Grades	5	18.5%	45.5%
Program Requirement	3	11.1%	27.3%
Total	27	100%	245.5%

Table G.19

Distribution Case Summary for Deans of Engineering survey group (N =21)

Q15:	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	Percent
	11	52.4%	10	47.6%	21	100%

Table G.20

Descriptive Statistics for Deans of Engineering Survey Group (N = 21)

Q16: Support Persistence	N	Percent	Percent of Cases
Diversity	1	5%	10%
Eng. Organizations	3	15%	30%
Mentoring	5	25%	50%
Academic Support	1	5%	10%
Student Support/Training	7	35%	70%
Tutoring	1	5%	10%
Advising	2	10%	20%
Total	20	100%	200%

Table G.21

Descriptive Statistics for Deans of Engineering Survey / Means of providing support for student persistence Distribution Case Summary for Deans of Engineering Survey group (N = 21)

	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	Percent
Q16:	10	47.6%	11	52.4%	21	100%

Section: Diversity

Table G.22

Descriptive Statistics for Deans of Engineering Survey Group (N = 21)

Q17: How many African American female faculty member(s) are in your engineering departments?

N	Valid	16
	Missing	5
Mean		2.19
Standard Deviation		1.471
Variance		2.163

Table G.23

Descriptive Statistics for Deans of Engineering Survey Group (N = 21)

Q18: Does your institution have a policy for diversifying faculty members and the student body?

N	Valid	16
	Missing	5
Mean		1.25
Standard Deviation		.447
Variance		.200

Section: Funding

Table G.24

Descriptive Statistics for Deans of Engineering Survey Group (N = 21)

Q19: Level of satisfaction with the availability of resources in your department for students?

N	Valid	16
	Missing	5
Mean		2.44
Standard Deviation		.814
Variance		.663

Section: Suggestions for Improvement

Table G.25

Suggestions for Improvement Clustered Question Analysis – Frequency Distribution Summary for Deans of Engineering Survey Group (N = 21)

Questions 20, Question 21, Question 22, & Question 23: Engineering programs – culture and diversity, retention and recruitment for African American female engineering students, and retention and recruitment for African American female engineering faculty

Cluster Analysis	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	Percent
Q20-23 (Mentoring)		%		%	21	100%
Q20-23 (Diversity)		%		%	21	100%
Q20-23 (Faculty Hiring)		%		%	21	100%
Q20-23 (Faculty Training)		%		%	21	100%
Q20-23 (Advising)		%		%	21	100%
Q20-23 (Stud Supp Training)		%		%	21	100%
Q20-23 (Retention)		%		%	21	100%
Q20-23 (Stud Mon Incent)		%		%	21	100%
Q20-23 (Acad. Support)		%		%	21	100%
Q20-23 (Culture)		%		%	21	100%
Q20-23 (Other)		%		%	21	100%
Q20-23 (Recruitment)		%		%	21	100%
Q20-23 (STEM Pipeline)		%		%	21	100%
Q20-23 (Eng. Organization)		%		%	21	100%
Q20-23 (Faculty Support)		%		%	21	100%
Total						

Appendix H

Directors of Student & Academic Affairs/Diversity/Equity & Inclusion Statistical Data Analysis

Table H.1

Gender Distribution for Directors of Student Affairs/Diversity/Equity & Inclusion Offices Survey Group (N = 20)

Q2: Gender	Frequency	Percent	Valid Percent
Male	7	35%	36.8%
Female	12	60%	63.2%
Total	19	95%	100%
Missing	1	5%	
Total	20	100%	

Table H.2

Ethnicity Distribution for Directors of Student Affairs/Diversity/Equity &Inclusion Offices Survey Group (N = 36) – Multiple Response Set

Q3: Ethnicity Multiple Set	N	Percent	Percent of Cases
White	26	65%	74.3%
Black or African American	5	12.5%	14.3%
Hispanic	3	7.5%	8.6%
Asian	1	2.5%	2.9%
Native American	1	2.5%	2.9%
American Indian	2	5%	5.7%
Multi-Racial	2	5%	5.7%
Total	40	100%	114.3%

Valid 35 Missing 1 2.8% Total 36 100%

Table H.3

Age Range Distribution for Directors of Student Affairs/Diversity/Equity & Inclusion Offices Survey Group (N = 20)

Q4: Age Range	N	Percent	Cumulative Percent
25-34	4	20%	20%
35-44	3	15%	35%
45-54	3	15%	50%
55-64	8	40%	90%
65-74	2	10%	100%
Total	20	100%	

Section: Academic and professional background

Table H.4

Descriptive Statistics for Directors of Student Affairs/Diversity/Inclusion Survey Group (N = 20)

Q5: Please select all of the departments that you oversee? (Check all departments at your institution)		
N	Valid	
	Missing	
Mean		
Standard Deviation		

Table H.5

Descriptive Statistics for Directors of Student Affairs/Diversity/Inclusion Survey Group (N = 20)

Q6: Please select all of the functions that your offices perform? (Check all applicable choices)		
N	Valid	
	Missing	
Mean		
Standard Deviation		

Section: Funding

Table H.6

Descriptive Statistics for Directors of Student Affairs/Diversity/Inclusion Survey Group (N = 20)

Q7: Level of satisfaction with the availability of resources in your department for students?	
N	Valid
	Missing
Mean	
Standard Deviation	

Table H.7

Descriptive Statistics for Directors of Student Affairs/Diversity/Inclusion Survey Group (N = 20)

Q8:	
N	Valid
	Missing
Mean	
Standard Deviation	

Section: Assessment

Table H.8

Freshman Orientation – Frequency Distribution (Multiple response set) for Directors of Student Affairs/Diversity/Inclusion Survey Group (N = 20)

Q9: Freshman orientation	N	Percent	Percent of Cases
Implicit/explicit bias	5	16.7%	38.5%
Diversity	9	30%	69.2%
Academic Support Services	10	33.3%	76.9%
Cultural Awareness	6	20%	46.2%
Total	30	100%	230.8%

Table H.9

Freshman Orientation Distribution Case Summary for Director of Student Affairs/Diversity/Equity & Inclusion Survey Group (N = 20)

Q9:	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	Percent
	13	65%	7	35%	20	100%

Table H.10

Frequency of orientation for Directors of Student Affairs/Diversity/Inclusion Survey Group (N = 20)

Q10: Frequency of Orientation		N	Percent	Valid Percent
Valid	Once a semester/quarter	2	10%	15.4%
	Once a year	9	45%	69.2%
	Other	2	10%	15.4%
	Total		65%	100%
	Missing	7	35%	
Total		20	100%	

Table H.11

Freshman Orientation Descriptive Statistics for Directors of Student Affairs/Diversity/Inclusion Survey Group (N = 20)

Q10: If yes, how often?		
N	Valid	13
	Missing	7
Mean		2.00
Standard Deviation		.577

Table H.12

Assessment measures Frequency Distribution – Multiple response set for Directors of Student Affairs/Diversity/Inclusion Survey Group (N = 20)

Q11:	N	Percent	Percent of Cases
Student Performance	8	26.7%	61.5%
Stud Academic Programs	9	30%	69.2%
Culture Eng. Programs	2	6.7%	15.4%
Advisors Effectiveness	5	16.7%	38.5%
Effect of Initiative Programs	6	20%	46.2%
Total	30	100%	230.8%

Table H.13

Assessment Measures Distribution Case Summary for Director of Student Affairs/Diversity/Equity & Inclusion Survey Group (N = 20)

Q11:	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	Percent
	13	65%	7	35%	20	100%

Table H.14

Question #12 – Frequency Distribution Summary for Directors of Student Affairs/Diversity/Inclusion Survey Group (N = 20)

Q12: Assess Teaching Performance	N	Percent	Percent of Cases
Student Evaluation	10	28.6%	83.3%
Student Test Scores	2	5.7%	16.7%
Student Career Placement	1	2.9%	8.3%
Other Measures	3	8.6%	25%
Dept Chair Evaluation	8	22.9%	66.7%
Self-Evaluation	1	2.9%	8.3%
Peer Evaluation	10	28.6%	83.3%
Total	35	100%	291.7%

Table H.15

Methods used to assess teaching performance Distribution Case Summary for Director of Student Affairs/Diversity/Equity & Inclusion survey group (N = 20)

Q12:	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	Percent
	12	60%	8	40%	20	100%

Section: Professional development

Table H.17

Descriptive Statistics for Directors of Student Affairs/Diversity/Inclusion Survey Group (N = 20)

Q14: If yes, how often are the training?	
N	Valid
	Missing
Mean	
Standard Deviation	

Section: Monitoring

Table H.18

Identification of AA female students requiring assistance Directors of Student Affairs/Diversity/Equity & Inclusion Survey Group (N = 20)

Q15: Assess Teaching Performance	N	Percent	Percent of Cases
Declining Grades	6	21.4%	60%
By Student Request	8	28.6%	80%
A drop in cumulative GPA	3	10.7%	30%
Lack of Attendance	6	21.4%	60%
Other School Criteria	5	17.9%	50%
Total	28	100%	280%

Table H.19

Identify students needing assessment Distribution Case Summary for Director of Student Affairs/Diversity/Equity & Inclusion survey group (N = 20)

Q15:	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	Percent
	10	50%	10	50%	20	100%

Table H.20

Support Student Persistence Directors of Student Affairs/Diversity/Equity & Inclusion survey group (N= 21) Multiple response set

Q16: Supp Stud Persistence	N	Percent	Percent of Cases
Diversity	1	5%	10%
Mentoring	5	25%	50%
Eng. Organizations	3	15%	30%
Academic Support	1	5%	10%
Tutoring	1	5%	10%
Stud Supp/Training	7	35%	70%
Advising	2	10%	20%
Total	20	100%	200%

Table H.21

Support students with persistence Distribution Case Summary for Directors of Student Affairs/Diversity/Equity & Inclusion survey group (N = 21)

Q16:	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	Percent
	10	47.6%	11	52.4%	21	100%

Table H.22

Tracking comparison by racial groups for Directors of Student Affairs/Diversity/Inclusion Survey Group (N = 20)

Q17: If yes, does the data provide a comparison with other racial groups and gender? (Paired with Q16)

N	Valid	4
	Missing	16
Mean		1.50
Standard Deviation		.577

Table H.23

Tracking comparison by racial groups for Directors of Student Affairs/Diversity/Inclusion Survey Group (N = 20)

Q17: Racial/Gender Comparison		N	Percent	Valid Percent
Valid	Yes	2	10%	50%
	No	2	10%	50%
	Total	4	20%	100%
	Missing	16	80%	
Total		20	100%	

Section: Services

Table H.24

Types of Initiatives in Engineering (Multiple Response Set) - Directors of Student Affairs/Diversity/Equity & Inclusion survey group (N = 21)

Q18: Types of Initiatives in Eng.	N	Percent	Percent of Cases
Retention	6	14.6%	50%
Recruitment	7	17.1%	58.3%
Diversity	7	17.1%	58.3%
Equity/Inclusion	6	14.6%	50%
LLCs	6	14.6%	50%
Service Learning	4	9.8%	33.3%
Collaborative Research Program	5	12.2%	41.7%
Total	41	100%	341.7%

Table H.25

Identify students needing assessment – Distribution Case Summary for Directors of Student Affairs/Diversity/Equity & Inclusion survey group (N=20)

Q18:	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	
	12	60%	8	40%	20	100%

Table H.26

Types of Living-Learning Communities (LLCs) Frequency Distribution (Multiple Response set) for Directors of Student Affairs/Diversity/Equity & Inclusion survey group N = 20

Q19: Types of LLCs	N	Percent	Percent of Cases
Women in STEM	4	36.4%	44.4%
Race/Gender/Cultural Relations	3	27.3%	33.3%
Other LLCs	4	36.4%	44.4%
Total	11	100%	122.2%

Table H.27

Types of Living-Learning Communities (LLCs) Distribution Case Summary for Director of Student Affairs/Diversity/Equity & Inclusion survey group (N = 20)

Q19:	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	Percent
	9	45%	11	55%	20	100%

Section: Suggestions for Improvement

Tables H.28

Clustered Analysis **-** *Questions 20, Question 21, Question 22, & Question 23: Engineering programs – culture and diversity, retention and recruitment for African American female engineering students, and retention and recruitment for African American female engineering faculty (N = 20)*

Cluster Analysis	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	Percent
Q19-22 (Mentoring)	4	20%	16	80%	20	100%
Q19-22 (Diversity)	1	5%	19	95%	20	100%
Q19-22 (Faculty Hiring)	4	20%	16	80%	20	100%
Q19-22 (Faculty Training)	1	5%	19	95%	20	100%
Q19-22 (Advising)	0	0%	20	100%	20	100%
Q19-22 (Stud Supp Train)	4	20%	16	80%	20	100%
Q19-22 (Retention)	3	15%	17	85%	20	100%
Q19-22 (Stud Mon Incent)	1	5%	19	95%	20	100%
Q19-22 (Acad. Support)	3	15%	17	85%	20	100%
Q19-22 (Culture)	3	15%	17	85%	20	100%
Q19-22 (Other)	0	0%	20	100%	20	100%
Q19-22 (Recruitment)	3	15%	17	85%	20	100%
Q19-22 (STEM Pipeline)	2	10%	18	90%	20	100%
Q19-22 (Eng. Organization)	0	0%	20	100%	20	100%
Q19-22 (Faculty Support)	0	0%	20	100%	20	100%

Appendix I

Analysis of Accreditation Regions

Analysis of HLC Region (N = 25)

Year	Enrollment Rate	Retention Rate	Completion Rate
2014	.73%	----------	----------
2016	.72%	1.03% (103%)	----------
2018	.50%	-----------	.175% (17.5%)

Analysis of SACSCOC Region (N = 26)

Year	Enrollment Rate	Retention Rate	Attainment Rate
2014	1.78%	---------	---------
2016	2.19%	1.27% (127%)	---------
2018	1.50%	---------	20%

Analysis of WSCUC Region (N = 9)

Year	Enrollment Rate	Retention Rate	Attainment Rate
2014	.35%	--------	--------
2016	.49%	1.42% (142%)	--------
2018	.43%	--------	.304% (30.4%)

Analysis of NWCCU Region (N = 7)

Year	Enrollment Rate	Retention Rate	Attainment Rate
2014	.36%	---------	--------
2016	1.62%	1.13% (113%)	--------
2018	.28%	--------	.175% (17.5%)

Analysis of MSCHE Region (N = 16)

Year	Enrollment Rate	Retention Rate	Attainment Rate
2014	1.25%	--------	--------
2016	1.27%	1.07% (107%)	--------
2018	.28%	--------	.175% (17.5%)

Analysis of NECHE Region (N = 11)

Year	Enrollment Rate	Retention Rate	Attainment Rate
2014	.72%	--------	--------
2015	.98%	1.46% (146%)	--------
2016	.78%	--------	.292% (29.2%)