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STEM Education and Retention for Black Women using High-Impact Practices: Historically Black Colleges and Universities vs. Predominantly White Liberal Arts Colleges

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STEM Education and Retention for Black Women using High-Impact Practices: Historically Black Colleges and Universities vs. Predominantly White Liberal Arts Colleges

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ABSTRACT

Black women are significantly underrepresented within the fields of science, technology, engineering, and mathematics (STEM). To address this, the Association of American Colleges & Universities crafted ten high-impact practices to increase student engagement and promote retention. This research paper examines how three specific high-impact practices (learning communities, mentoring, and undergraduate research experience) are utilized in STEM education.This research paper explores and compares the best high impact approaches that successfully teach and retain Black women within the various fields of STEM within the differing academic environments of historically Black colleges & universities (HBCUs) and predominantly white liberal art colleges (PWLACs). This paper concludes with recommendations for continuous research on Black women who pursue STEM in addition to institutional policies and practices that predominantly white liberal art colleges must do in order to contribute efforts in addressing the large disparity.

Dedication

To my beloved Grandma Julia, I miss you very much!

And to my younger self for never giving up (Thank you!)

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Introduction

Black women in the United States experience oppression on two different levels: race based and gender based discrimination. The discrimination that arises stems from stereotypes that society continues to perpetuate and uphold in order to manitain critical social order (McGee & Bentley 2017; Alfred et al. 2018). Historically, legislation has been written as a strategy to prohibit Black individuals from gaining access to education (Ricks 2014). Because of their intersecting identities, Black women are not seen as their own entity but rather associated with Black men or to the demographic women as a whole (Howard 2016). The lack of acknowledgement pressures Black women to select which identity is most salient to them. This leads to circumstances where Black women are misunderstood and thus inappropriately supported. For example, Black women are disproportionately underrepresented in STEM fields (Dickens et al. 2021). . According to the National Science Foundation, Black women earned only 2.9% of bachelor degrees across the multiple fields of science, technology, engineering, and mathematics (NSF 2019). One reason for this low representation is because society does not view Black women as adequately smart students unless they are silent and passive learners (Nguyen et al. 2021; Wade-Jaimes & Schwartz 2018). Such messaging discourages Black girls' and women's learning and their pursuit of STEM majors in college and STEM careers after college (Nguyen et al. 2021; Charleston et al. 2014; Wade-Jaimes & Schwartz 2018). Research statistics show that educational access for African Americans is low across all fields, not just STEM. Only 77% of African Americans graduate from high school compared to 82% of whites; only 35% of African Americans go on to college compared to 43% of whites (Kuh et al. 2006; Carter & Wilson 1997; Social Science Research Council Project 2005). Research about factors

that predict the persistence and success of undergraduate Black Women in education and particularly in STEM is growing and ongoing.

To explore the strategies that promote STEM retention, the American Association of Colleges and Universities identified what they called high impact practices (HIPs). These practices are ways that encourage active learning that further student engagement (Kuh 2008). Three high impact practices that I plan on analyzing as they relate to Black women persistence in STEM are: the creation of learning communities, mentoring, and undergraduate research experience. The following paper will outline how these three practices have contributed to Black women's overall success and retention within science, technology, engineering, and mathematics fields. I will examine how these specific practices have been implemented within the curriculum of Historically Black College and Universities (HBCUs) and Liberal Arts Colleges. Thus, I present a research paper that explores and compares the best high impact approaches to successfully teach and retain Black women in STEM, highlighting similarities and differences between HBCUs and liberal art colleges.

Chapter 2: Historical Representation in STEM

Section 2.1 : Women in STEM

The field of STEM has historically been dominated by males, specifically white males (Riegle-Crumb & King 2010; Kachchaf et al. 2015). Title IX was enacted in 1972. This important legislation secured the rights of women receive an education free from discrimination based on sex and gender. The goal was to craft a society where all would have similar educational access and opportunities for prosperity. However, the gender disparity continues to persist, particularly in STEM education and the STEM workforce.. The longstanding debate on

what humans categorize as “male’ and “female” is subjective and based-on the perspective of whoever is conducting the observations. Not surprisingly, research from a time when women were refused education resulted in a confluence of femininity and female, which created a representation that placed women inferior to the male as it relates to intellect, strength, and ability to be rational (Keller 1985). As a result, women lacked access to education, representation in various fields, and participation in leadership. This exclusion of women up until 1972 continues to harm the representation of women, as the long history of discrimination will take time to reverse.

Separating children in educational environments starts early. When children first attend school, before they have developed social identities and academic habits, they are often segregated based on societal expectations placed on respective genders. Schools continue to use gender to categorize and compare children and assume particular abilities. Boys are encouraged to participate in more hands-on activities while girls are discouraged from even engaging in stimulating activities aside from the arts and humanities. At these ages, children become familiar with gender norms and expectations which cause them to formalize their own norms and stereotypes (Miller et al. 2009). These gender stereotypes are crucial when it comes to girls viewing their participation in STEM and affect who will actually persist in STEM and become successful. The gender gap within STEM begins early and slowly starts to become apparent. By middle school, more than twice as many boys than girls intend to work in science or engineering-related jobs (Charlesworth & Banaji 2019). This data demonstrates that the learning environments in which girls are placed are not conducive to their learning but also discourage them from pursuing ambitions with the various fields of STEM. These differences continue on throughout highschool, affecting who pursues STEM fields in college.

One significant barrier toward enhancing diversity in STEM is the use of tracking systems in high school. This tactic monitors students' academic performance in science and math courses and uses this data as a pipeline for enrollment in advanced STEM courses and future STEM college majors (Fuller 2008; Alfred et al. 2019). If women and people of color are not effectively supported in early math and science courses, this tracking system automatically excludes them from a future in STEM.

Another barrier for women in STEM is sexism. Male undergraduates are five times more likely to declare a major within the fields of engineering or computer science than women. These numbers are not as surprising when you account for the frequency with which female students are exposed to academic environments that are not supportive and leave them prone to experiencing sexism (Ramsey et al. 2013). Because of sexism, women are less likely to feel a sense of belonging, a necessity for a student's academic success (Charlesworth & Banaji 2019). This failed sense of belonging in conjunction with the competitiveness of STEM fields leaves women feeling inadequate and upholds negative perceptions of women's academic abilities. As a result, women pursuing stem in higher education experience woman-scientist identity interference (WSII). WSII is the experience of psychological and behavioral difficulty combining the specific identities of women and scientists (Settles 2004; Settles et al. 2009).

Currently, women only represent 38% of bachelor degrees within the traditional STEM fields (National Science Foundation 2018). Oddly enough, the representation for women with bachelor degrees in computer science has dropped 10% between the years of 2000 to 2015 (National Science Foundation 2018). In contrast, women are earning their masters and their doctorate degrees, 34% and 41% respectively (Table 2, National Science Foundation 2018). Among the traditional fields in STEM, women represent only a quarter of the workforce and

only 27% of either full-time or tenured professors. Additionally, the monetary compensation is nowhere near that of their male equivalents. Within the United States, women in the STEM workforce are generally compensated $20,000 less per year than their male counterparts (Bureau of Labor Statistics). In addition to being paid less, women still do >75% of childcare and household labor (Bianchi et al. 2000). Due to this low pay and need to do so much labor outside of their career women struggle to create a balance between their careers and their families. This often leaves women having to decide between the two. In addition, the United States still does not provide sufficient family leave and few companies (or academic institutions) provide support for working parents. An example of how parenting disproportionately affects women is the motherhood penalty (Correll et al. 2017; Bernard et al. 2008, as cited in Charlesworth & Banaji 2019). Research into this penalty shows that women with children are paid about $10,000 less than women without children. These same studies also indicated that men with children actually receive a pay increase of about 4% (Correll et al. 2017)

Section 2.2: Black Women in STEM

As stated at the outset of this thesis, Black women experience gender discrimination in addition to racial discrimination. The intersectionality of their two identities causes Black women to experience what has been called double jeopardy. As people, Black women face oppression from multiple systems based on the history and foundation of the United States. Within the United States education system, Black girls and women are criminalized at a higher rate than their white counterparts. In 2014, 12% of African American girls in public schools were suspended (Alfred et al. 2019). Moreover, Blacks girls face a high probability of being

incarcerated during their time in high school. These examples exemplify stereotypes that ultimately undermine a Black woman's interest in and their ability to perform in STEM fields even if they have a positive attitude towards it (Shapiro and Williams 2011). Additionally, the tactic of tracking negatively affects the STEM pipeline for Black women based on environmental circumstance and educational accessibility. This strategy disregards life experiences making it extremely difficult for Black women to persist in the competitive and quantitative fields of science, technology, engineering, and mathematics. Academic tracking in primary and secondary institutions essentially widens the gap of academic accessibility. For example, African American students are the least represented in advanced placement courses. Once African American women are identified as low achievers, they are tracked from elementary school to high school and are placed in low-level courses that prevent academic growth. This form of institutional oppression upholds the system of white supremacy and contributes to a large percentage of Black girls being pushed out of school before they even graduate (Alfred et al. 2018). This results in Black women being restricted from entering STEM programs even before they go to college. As a result, African American women internalize learned helplessness, believing that failure to succeed at a task was beyond their control. These learned helplessness, defeatist behaviors and thoughts are developed in the classroom especially under the direction of ineffective teaching practices (Powell 1990; Abiola and Chance 2012).

These attitudes and practices are also observed in classrooms and campus settings at higher educational institutions. In higher education, Black women in STEM continue to endure discrimination in all aspects as it pertains to their three identities: being Black, being a woman, and being a scientist. The intersection of these identities often cause Black women to have to choose between them while sacrificing the others. This is known as the double bind experience, in which an individual is placed in a center of a psychological predicament of conflicting options

and must select one with no concrete solution (Dortch & Patel 2017). As a result, the intersection of these identities, particularly race and gender, negatively affect Black women's retention in the STEM field. In 2017-2018, Black women of African descent earned only 2.9% of bachelor degrees across science, technology, engineering, and mathematics (STEM) fields (National Science Foundation 2019). The lack of representation within the STEM creates a constant cycle of Black women who pursue any science or math related career out of pure interest, but then leave because they are the underrepresented. Being the only individual of your identity in the classroom or in the STEM workplace causes you to feel isolated, tokenized, and invisible. These feelings lead to Black women experiencing a lack of sense of belonging, a factor that causes Black female scientists to either leave their current positions or leave the field entirely (Alfred et al. 2018).

At predominantly white institutions (PWIs), Black women experience people viewing their intersecting identities as negative in all aspects including: physical, cultural, and intellectual (Jordan 1994). For example, Black women are trying to balance their identities within a culture that prioritizes competition. In STEM, the culture of 'survival of the fittest' is stronger than in many other fields making it particularly difficult for people with marginalized identities to navigate. This competitive culture assumes a meritocracy and fails to account for societal systems that oppress underrepresented and marginalized groups. This leads to implications that Black students are responsible for their lack of representation, resulting in learning spaces that are hostile toward Black women (McGee and Bentley 2017). In addition, within these environments, both racial and gender microaggressions reinforce feelings of isolation, especially in places where the presence of Black faculty and the population of Black students are rare. In addition to isolation, low representation leads to an additional burden., Being the only Black

person in their class or department creates a narrative that these individuals are acting and speaking on behalf of the entire Black community (Sanchez et al. 2019). With this hyper focused lens on Black women, there's a high level of internal pressure to be absolutely perfect. Black women also experience intentional exclusion from their male counterparts, known as the male huddle (McGee and Bentley 2017). These male "colleagues" not only exclude Black women from their learning communities, but they also assign stereotypical tropes to Black women. These include roles as mammy and jezebel, which are articulated through inappropriate sexist and racist remarks. Finally, Black women also suffer at the hands of faculty members and advisors who often dismiss them based on their own internalized biases. This leads to a lack of support for Black women from individuals who are supposed to guide and mentor them (McGee and Bentley 2017).

Section 2.3: Present Day

The various fields within science, technology, engineering, and mathematics inherently produces an environment that is full of bias, both explicit and implicit, towards Black women. The National Science Foundation reported that only 5% of all doctoral recipients in science and engineering were Black (2018). Additionally, only 2% of practicing scientists and engineers are Black women (National Science Foundation 2015). The low pursuit and retention percentages are heavily attributed to the lack of rigor and variety of STEM course offerings in low-income schools that students of color disproportionately attend (Ong et al. 2011). Additional factors are that, Black girls are hypersexualized and disciplined at a higher rate than their white counterparts and suspended at a rate of four times higher than white girls; this over-discipline creates a

narrative that Black girls and women are not viewed as smart students unless they are strictly passive learners (NWLC 2016; Wade-Jaimes & Schwartz, 2018). At the graduate level, Black women continue to feel isolated from the collective, are worried about financial stability, experience racialized and gendered barriers as it pertains to obtaining competitive fellowships, and struggle in cultivating supportive faculty relationships (Sanchez et al. 2019). At every turn, there is a barrier that Black women face in order to become successful in STEM fields and/or to acquire leadership positions. To move past these issues and increase participation of Black women in STEM, it's necessary to understand the importance of and develop a healthy support system. Intentionally supporting Black women in STEM, for example with great mentoring, results in a more positive outcome in a Black woman's relationship to her identity as a scientist but also encourages her to stay in the field. Because of the importance of representation in STEM, higher education institutions have adopted high-impact practices to encourage higher retention in areas that exhibit drastic disparities both racial and by gender.

Chapter 3 : High Impact Practices

Section 3.1: What are High Impact Practices (HIPs)?

High Impact Practices, also known as HIPs, are educational practices that involve active learning as a way to further promote student engagement (Kuh 2008). These practices meet the expectations set by George Kuh and the Association of American Colleges and universities (AAC&U) of achieving in depth learning, making significant engagement gains, and an overall positive impact on historically underserved student populations. From these standards, Kuh

identified ten high-impact practices that academic institutions should implement into their core curriculum. These ten specific practices are: first year seminars, learning communities, writing intensive courses, collaboratives assignment and projects, undergraduate research, study abroad, service learning, internships, and capstone or senior projects. Research has shown that implementing these practices has led to better outcomes for students and an overall positive experience in higher education. George Kuh & Ken O'Donnell (2013) highlighted key elements that were shared across all ten practices. Some of the elements include: significant investment of time and effort by both student and faculty over an extended period of time, experiences with diversity, opportunities to apply content to real-world situations, and a public demonstration of competence. To fully reap the benefits and witness first hand the impact, Kuh recommends that students actively engage and try to participate in at least two high-impact practices throughout their academic career. These practices are meant to decrease academic gaps between white students and those that are a part of minority communities. The formation of high-impact practices and the constant push to integrate them into academic curriculum is because they create events that help students to persist within their desired area of interest without feeling isolated or excluded. These practices increase student retention and graduation rates across diverse backgrounds. With that in mind, HIPs exist to make academic spaces more equitable.

Section 3.2: Learning Communities

One type of high impact practice is the creation of learning communities (LC). Learning communities are defined as a cohort of students who collectively share a common academic goal and work collaboratively alongside each other and professors. According to George Kuh, the

main objective for learning communities is to encourage integration of learning across various disciplines that lead to application within the real world (Kuh 2008). The practice of learning communities highlights the movement from individualism to community; they attempt to strike a holistic balance between individuality and social connectedness. Primarily in an educational setting, learning communities act as conduits to develop both a deeper meaning and accessible framework of predetermined curricular content. LCs combine multiple educational practices to help students who participate succeed. These practices range from intentional student-faculty contact to multi-level collaboration to supportive institutional environments (Shapiro 2008). Shapiro also writes that learning communities are strongly related to the five clusters of effective educational practices on the national survey for student engagement. The clusters are diversity experiences, self-reported gains for the students personal and social development, practical competence, general education, and overall satisfaction with the undergraduate experience. Students who opt in to be a member of a LC are simultaneously taking two or more courses that connect to each other in some capacity that allow for active and constant collaboration with their peers. Current research shows a positive correlation between students who participate in learning communities and their grade point averages (GPAs). As it pertains to this research, it is important to note that 29% of Black students participate in learning communities nationally (Halsell 2017). For learning communities, collective efforts highlight different perspectives that assist with crafting solutions to complex social problems. Learning communities are a pragmatic approach to deepening student's perception of the content they are learning in a way that fosters continuous thought that results in positive outcomes like grades and discipline retention.

Section 3.3: Mentoring

Mentoring is defined as a developmental relationship between an individual who is experienced and an individual who lacks that experience. The relationship encompasses guidance in regards to the areas of academic, social, professional, and personal. The concept of mentoring dates back to Greek and Roman education; in the 1900s a cultural shift occurred that redirected mentoring from social environments to academic cultures (Colley 2002; Osipov et al. 2019; Roberts 2000). According to the Boyer Commission, mentorship needs to be long-term, exist beyond the traditional expectations, and require both patience and commitment from faculty members (1998). Past research has shown that same race and gender based mentoring assists in the success and retention of students, especially Black women in the field of STEM (Dickens et al. 2021). For the purpose of this research, it's important to highlight that previous research has concluded that mentoring Black women in STEM leads to success and persistence when it comes to Black women receiving STEM degrees (Palmer & Gasman, 2008; Dickens et al. 2021) Similar to learning communities, students who have access to mentoring are more likely to see an increase in the grades, GPA, and persistence to want to continue on the designated STEM track (Anderson et al. 1995; Campbell & Campbell 1997, as cited in Wilson et al. 2011). Practicing and executing a successful mentoring program requires a holistic approach that places student's intersecting identities and experiences at the forefront. Good mentoring often creates a pipeline of students who feel equipped and prepared, which encourages them to stay and further explore within their respective field of choice.

Section 3.4: Undergraduate Research

A more common high impact practice that is implemented in higher education, especially within the various fields of science, technology, engineering, and mathematics (STEM) is undergraduate research experience (UREs). Undergraduate research experience is the opportunity for students to conduct research independently under supervision of a faculty member. Until recently, undergraduate research was only being done in STEM departments. Now, undergraduate research is being implemented across different academic disciplines from the sciences, to humanities and even to the arts (Kuh 2008). Depending on the speciality, most experiences are funded by either governmental organizations or companies. For example, the National Science Foundation funds research experiences for undergraduates in any area relating to any of the four fields in STEM (National Science Foundation 2022). The main purpose of UREs is to expose college students to forming arguable, solid research questions that places them at the forefront in navigating a scientific and systematic investigation, particularly one in which they hope to possess concrete deliverables. Undergraduate research experiences help students become fully immersed in the research process, enabling students to recognize what they are learning in a real world context. Students that participate in hands-on research projects during the undergraduate experience are more likely to continue doing research and retain in their respective discipline (Boyer Commission Report 1998). Additionally, URE participants demonstrate improvements to their fundamental critical thinking skills when compared to their peers (Chamely-Wiik et al. 2021; Hunter et al. 2007; Kardash, 2000; Lopatto, 2007). The implementation of research opportunities at the undergraduate level cultivates the space for the students to apply what they have learned to real world situations. Several studies have shown a

strong correlation between students that engage in research and an increase in GPAs and graduation rates (Gregerman et al, 1998; Davis, 2009; Espinosa, 2011; Hu et al, 2008; Johnson, 2011; Schultz et al, 2011, as cited in Baron et al. 2020).

Chapter 4: Historically Black Colleges & Universities

Section 4.1: The History of HBCUs and Their Role in Black Education

Historically Black colleges and Universities (HBCU) are institutions of higher education in the United States that were created with the purpose of providing African-American and Black students access to education. HBCUs came into existence prior to the Civil Rights Act of 1964, however, its classification was established in 1965 by the Higher Education Act as a way to expand federal funding for these colleges and universities. The first few colleges and universities were built with the intention of educating the children of formerly enslaved individuals and preparing them in a way that allowed them to pay it forward and teach other Black people. According to the Hunt Institute, there were about 121 historically Black colleges and universities during their peak in the 1930s; today there are 101 accredited HBCUs that currently serve approximately 228,000 students (2021). Despite being prominent institutions for higher education, HBCUs have had to get creative and innovative in the ways they serve their students due to decades of underfunding. Even with low amounts of federal funding, HBCUs award one-third of STEM degrees earned by Black students and one-fourth of all bachelor degrees obtained by Black students. Importantly, these numbers come with HBCUs only representing 3% of all post-secondary institutions. Because their primary audience is Black students, HBCUs focus

primarily on creating intentional, interpersonal relationships between students, faculty, and staff. As institutions of higher education, HBCUs have been a dominant force in creating an educational environment that produces Black scholars.

Section 4.2: Pedagogical Approaches

The foundation of STEM curricula throughout HBCUs is grounded in two pedagogical frameworks. The first being Black Feminist Thought (BFT) and the second being Critical Race Theory (CRT) in conjunction with its sister theory of Critical Race Feminism (CRF). Black Feminist thought was first introduced in the 1990s by Patricia Hill Collins. Collins defines BFT as a field of knowledge that focuses on the experiences and intersecting identities of Black women (Collins 1990). Black Feminist Thought is crucial in the social context in regards to Black women redefining their identities and positions within the unjust and oppressive systems imbedded within the United States. Collins discusses how the practice of BFT consists of implementing three core themes. The first theme being the structure of the framework that is produced by the experiences Black women have encountered in their lives. The goal is to explore and deconstruct just how others' perception of Black women is rooted in stereotypes and used as a technique to control the behavior of Black women. In return, the process is meant to shift perspective and show Black women just how to prioritize self-valuation, self-definition, and to altogether replace harmful and negative ideas brought about by society. The second theme focuses on the interpersonal experiences that occur among Black women, and the third highlights the diversity regarding other identity markers of Black that provide different contexts in which their experiences can be shown and understood. The purpose of these themes is to create a space

for Black women to actively develop and explain their own stories as it pertains to aspects of Black women's culture (Collins 1992, 2002).

Critical Race Theory and Critical Race Feminism work in tandem to analyze and critique the proponent endemic that is racism and the important role that intersecting identities play within that experience. More specifically, CRF places women of color at the focal point, while examining the various ways they face discrimination based on their race, class, and gender and how they play into upholding the patriarchy and white supremacy (Hilal 1998). These theories focused heavily on generating liberating and transformative experiences based on the exploration of multicultural, multipersonal stories. CRT implements a structural framework that consistently acknowledges racism within America's everyday life, and expresses skepticism towards the dominant proclamation of color blindness, objectivity, and meritocracy. In addition, it challenges ahistoricism and insists on breaking down the historical context behind institutional practices, is interdisciplinary and crosses epistemological and methodological boundaries, and finally works towards eliminating racial oppression (Villalpando and Bernal, 2002, p. 245). The practice of CRT and CRF is seen through the use of counterstories whether that be in discussions, historical archives, or through personal testimonies. The goal of counter storytelling is to create a feeling of doubt among existing ideas and stereotypes that are being upheld and perpetuated by the dominant group, in this case white people and men.

Throughout institutional culture and curriculum, HBCUs are known for centering the Black experience. Specifically for Black women, faculty and administrators intentionally provide course material and programming that is relevant to African American women (Perna et al. 2009). HBCUs typically offer inclusive curricula that highlight the contributions of prominent Black women in the STEM fields. Research shows that Black women and other racial and ethnic

minorities respond positively to curricula in which they feel represented (Busch-Vishniac & Jarosz, 2004). By doing this, faculty members are creating opportunities for Black women to craft their own counterstories and build community within and among each other. At the same time, Black women are given the needed flexibility and freedom to locate themselves within the lense that the material is explored and analyzed. For this reason, Black women have been able to survive and thrive at institutions of higher education because of a community that supports them and makes the effort to make Black women a priority within the curriculum.

Section 4.3: STEM Education & Black Women Retention

Historically Black Colleges and Universities, as a collective, have made it their mission to provide and increase educational opportunities for underrepresented, underserved communities. Because of this institutional dedication, HBCUs have been placed in a unique position to increase the pipeline of Black students who stay in their respective discipline and continue to pursue either advanced degrees or careers in STEM (Perna et al. 2009). HBCUs are an even more important source of STEM degrees for Black women than they are for Black men; 33% and 26% respectively in STEM field bachelor degrees. According to Fiegener and Proudfoot, HBCUs are among the nations top undergraduate institutions that provide a significant proportion of African American doctoral recipients in the fields of science and engineering (S&E) (2013). Three years prior, the National Research Council acknowledged just how effective HBCUs were in increasing student success and participation within the STEM fields, which was supported by their graduation numbers of African Americans compared to

African Americans who attended predominantly white institutions (National Research Council 2010). Similarly, HBCUs represent 21 of the 50 top institutions without a Carnegie classification. They have collectively produced 1,819 Black graduates who have pursued and earned doctorate degrees in the fields of science and/or engineering between the years of 1995 and 2004. HBCUs also make up 46% of the STEM degrees earned by Black women (Harper 2018). Multiple research studies suggest that the success behind HBCUs STEM education among Black students is because of the connection made through institutional and curriculum practices in regards to racial identity, critical race theory, and Black student achievement. When it comes to teaching Black women in STEM and ensuring they retain within their disciplines, HBCUs make an effort to ensure that Black women feel supported both academically and institutionally. For instance, Black women often leave the STEM field due to lack of representation, support, and negative self-perception brought on by societal stereotypes and tropes. To combat this, HBCUs highlight and support same race-gender mentoring for Black women pursuing STEM degrees. According to Cheatham & Phelps (1995), mentors provided students [Black women] with many mechanisms for coping with racism and sexism within the STEM field. They describe how positive and effective mentoring instills self-confidence and increases Black women's desire to pursue advanced degrees in STEM (Cheatham & Phelps, 1995). At Spelman College, an HBCU dedicated to educating Black women, each student has multiple mentors, including other students and people working in their STEM field (Perna et al. 2009). The relationships formed between a mentor and mentee are usually positively correlated with retention for areas of interest, and this is particularly true for Black women who continue to pursue STEM. HBCUs commitment to providing mentors for Black women led to a conscious effort to have a diverse range of faculty that both respect of Black women's learning process

while valuing their contributions to STEM. The institutional implementation of mentoring, specifically same race-gender mentoring, highlights one way HBCUs adopt the high impact strategy of mentoring and successfully applied it to the retention of Black women in the fields of STEM.

Participating in research as an undergraduate is another of the notable ways that increased STEM retention. For HBCUs, undergraduate research experience is crucial to promoting and encouraging STEM retention. A 2009 study that focused on Spelman College described how undergraduate research opportunities are offered through structured initiatives that serve to develop students' research interest and promote confidence with participating in STEM related research (Perna et al. 2009). Some of these initiatives include faculty sponsored research, a school-wide research day, and various summer research opportunities. Research day, a concept created by Spelman faculty years ago, provides students with a chance to present their own individualized research to the greater Spelman community. This opportunity allows students to see research from across various disciplines and inspires proactivity in students to continue to engage in research. Similarly, Spelman STEM students are known to engage and participate in summer research experiences during their undergraduate years. The students who participated in summer research have shared that their experience allowed them to cultivate a genuine interest in research as well as develop a passion for a specific field within science, technology, engineering, and mathematics (Perna et al. 2009). The study clearly showcases how HBCUs are using the high impact strategy of undergraduate research to their advantage in ensuring and promoting that Black women retain and are indeed successful within the field of STEM and among the STEM pipeline.

Chapter 5: Predominantly White Liberal Arts Colleges

Chapter 5.1: The History of Predominantly White Liberal Arts Colleges and Their Role in Black Education

Predominantly White Liberal Arts Colleges (PWLAC) are institutions of higher education that fall under the umbrella of predominantly white institutions (PWI). PWIs are described as institutions of higher learning where 50% of the student enrollment identifies as white (Lomotey 2010).These colleges, such as Harvard and other Ivies, mimic their approach to higher education from Cambridge University which was founded during the colonial period and became the standard model for other colleges. The purpose of colleges was to train young white men and provide access to education to upper class members of society (Lomotey 2010). This held true until Black students were fully allowed to integrate into these institutions after the Supreme Court decision of *Brown vs. Board of Education of Topeka.* This decision ruled that segregated schools were not in fact equal and were unconstitutional. After this decision, Black enrollment increased significantly at predominantly white colleges and universities (Allen 1987). However, this newfound opportunity introduced challenges to Black students longing for education. Black students on white campuses reported difficulties adjusting to a culturally different and socially-alienating academic environment (Allen 1987). White students, faculty, and administrators were harassing Black students, and ultimately created hostile learning environments. The hostility at these PWLACs and PWIs lead to high attrition rates and low retention rates for Black students (Morton and Parsons 2017; Allen 1987). The history and culture of predominantly white colleges and universities forced Black students to adopt a survivorship mentality that still lingers today. Despite this damning history, these institutions

continue to promote selectivity in higher education by attracting students who are highly achieving based solely on GPAs and standardized test scores (Brubacher 1997; Lomotey 2010).

Chapter 5.2: STEM Education and Black Women Retention

A comprehensive analysis of STEM education and retention of Black women at predominantly white liberal arts colleges is absent; Primarily because there is an overall lack of research being conducted on the experiences and persistence of Black women that pursue STEM degrees at predominantly white institutions (Blackwell 2020). Ebony Blackwell describes how Black women experience a diminished sense of self-confidence at these institutions where white people are the majority. This observation supports previous ideas by Carlone and Johnson (2007), who alongside others, suggested that Black women do not feel seen or valued as members of the STEM community (Carlone & Johnson, 2007; Ong et al. 2011). In addition, higher education environments where diverse representation is lacking in social environments as well as in STEM degree programs, make it challenging for minority students, such as Black women, to develop a sense of belonging and community, especially true in places where sexism and microaggressions are common (Linder et al. 2019). At predominantly white colleges and universities, the attrition rate for Black students was five to eight times higher than white students who attend those same institutions (McCauley, 1998). A main contributing factor is the behavior and beliefs adopted by professors. For example, faculty at PWIs may intentionally discourage Black women from participating in STEM because they are perceived to be inadequate in comparison to the standard (McCoy et al. 2017). At these institutions where the standard is white, middle class males, faculty harbor implicit biases against students who do not

represent the majority (Russell and Russell 2015). When faculty at these predominantly white colleges and universities approach Black female students in STEM disciplines with bias, they are promoting the tactic of weeding out based on a combination of their own and societal ideas of academic excellence (McCoy et al 2017). McCoy, Luedke, and Winkle-Wagner (2017) further discuss how this behavior demonstrated by faculty at PWI and PWLAC translates into them being gatekeepers of opportunities, such as undergraduate research experience. As previous literature suggests, undergraduate research experience is a high impact practice that is known to promote retention in STEM, specifically for minorities including Black women. The lack of access to opportunities, institutional support, and a community are factors that cause Black women to change majors and not retain their discipline within the field of STEM (McCoy et al 2017; Bourdieu 1979/1984; Russell and Russell 2015)

Blackwell's (2020) study supports previous literature that Black women in STEM retain and are more successful in STEM pursuits when they have access to research opportunities, have great mentors, and develop a genuine sense of belonging. More research is needed to further examine institutional factors that are preventing African American from being successful in STEM. Most importantly, predominantly white institutions and its subcategory of predominantly white liberal arts colleges need to create and develop initiatives that encourage Black women to pursue STEM instead of turning them away (Russell and Russell 2015).

Chapter 6: Discussion and Conclusion

Section 6.1: Discussion

The research presented in this paper showcases a positive correlation between overall student engagement and academic retention. This engagement must be intentionally developed through the use of high impact practices (HIPs). The success of HIPs in increasing student engagement and success has been particularly evident in STEM courses. Historically Black colleges and universities (HBCUs) have been successful in adopting and implementing HIPs and because of that are responsible for 25% of STEM bachelor degrees conferred for Black students. Producing one-fourth of degrees within a specific field is highly impressive given HBCUs only represent 3% of all post secondary institutions (Hunt Institute 2021). Research also demonstrates a lack of data about the success of Black women in STEM at predominantly white liberal arts colleges (PWLACs). This lack of data suggests a lack of commitment to the success and retention of Black women in PWLACs. This speaks to the original intent of this thesis, to analyze how high impact practice practices operate at both HBCUs and PWLACs in teaching STEM to Black women and how these practices affect their retention in STEM. Considering that the United States needs to increase diversity and skills within the STEM industry to compete with other countries on a global scale, scientists and researchers must explore the classroom structures and strategies at all types of colleges and universities to enhance the number of Black women that graduate with a STEM degree and continue to pursue STEM. It is imperative that this data be collected at PWLACs institutions, who have increased their enrollments of Black women over the past 20 years, in order to learn what works and implement institutional policies and practices that promote higher perusal of STEM by Black women.

Section 6.2: Conclusion

In conclusion, Black women are significantly underrepresented within the fields of science, technology, engineering, and mathematics. However, historically Black colleges and universities recognize the representation gap and have dedicated significant efforts to implement institutional policies and support that encourage Black women to pursue STEM and ultimately retain within their discipline. HBCUs use high impact practices to create an environment where Black women in STEM are supported and encouraged to continue to provide an excellent model for other types of colleges and universities.

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