

## EXPECTATIONS VS. REALITY: REIMAGINING THE ENGINEERING AND COMPUTING DOCTORAL EXPERIENCE FOR BLACK WOMEN

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*The purpose of this qualitative research study is to examine the doctoral experiences of successful Black women enrolled in U.S. engineering and computing programs. Specifically, this manuscript analyzes Black women's perceived expectations regarding what they believed their doctoral programs would be like prior to their enrollment in graduate school versus their actual experiences as doctoral students (n = 37). Findings conclude that Black women expected their coursework would either be academically rigorous or not very difficult at all, and that their faculty advisors would provide them with tailored academic and social support. In addition, some of the Black women also expected that they would not have to deal with racism and sexism under the assumption that their respective departments were inclusive and equitable. Black women's actual experiences consisted of unsupportive faculty, surprising levels of racism and sexism, and an obligation to code-switch. This article also discusses the implications of the findings, and strategies for helping Black women succeed in engineering and computing doctoral programs are also discussed.*

**KEY WORDS:** *Black women, doctoral students, engineering and computing doctoral programs, code-switching, faculty advisement, discrimination*

### 1. INTRODUCTION

Black women enrolled in graduate school experience a host of academic and social challenges that impact their success (Lewis et al., 2016; Love, 2017). Black women enrolled in science, technology, engineering, and mathematics (STEM) graduate programs encounter racial stereotypes, severe isolation, and alienation, and have to prove their intellectual abilities (Alexander and Hermann, 2016; Borum and Walker, 2012; McGee and Bentley, 2017). However, specifically in the field of computing and engineering, there is limited research focusing on the doctoral level experiences of Black women. In an effort to address the insufficient representation of Black women enrolled in computing and engineering doctoral programs, we must place their educational experiences at the forefront in order to best address encountered barriers in the academy. To do this, it is important to first understand how Black women characterize and

comprehend their academic experiences while enrolled in computing and engineering doctoral programs.

Therefore, the purpose of this qualitative investigation is to examine and understand both Black women's perceived expectations regarding what graduate school would be like prior to beginning their doctoral programs, and their academic and social experiences after enrolling in their degree programs. This research study is guided by the following two questions: (1) What are the perceived expectations of Black women enrolled in computing and engineering doctoral programs, and (2) What are the perceived realities of Black women enrolled in computing and engineering doctoral programs? By qualitatively exploring their experiences, this research study will provide higher education researchers and administrators with additional tools and resources to provide improved educational spaces that help Black women thrive as engineers and computer scientists.

## **2. THE EDUCATIONAL EXPERIENCES OF BLACK WOMEN ENROLLED IN GRADUATE SCHOOL**

Navigating graduate school as a Black woman is a challenging endeavor given the academic and social difficulties they encounter in the ivory tower. Previous research indicates that Black female graduate students experience being the lone or token Black female student in their degree programs as well as encountering blatant forms of gender and racial discrimination (Apugo, 2017; Cartwright et al., 2021). These same issues are present for Black women who specifically pursue graduate programs in STEM academic disciplines (Alexander and Hermann, 2016; Artis et al., 2018). Black female scientists experience various forms of discrimination within their degree programs, which results in a lack of support from faculty, low self-confidence, loneliness, and stress due to needing to overcompensate and prove themselves (Alexander and Hermann, 2016; Joseph, 2012; McGee and Bentley, 2017). Black women's perceived expectations versus their perceived realities as graduate students differ quite considerably. For example, Black female graduate students are "expected to know things about the process and politics of the institution without being "mentored," "guided," or "coached" in order to meet their degree milestones (Love, 2017, p. 149). As such, Black women come to learn that their doctoral education is meant to be an independent process wherein they have to rely on the support of family members to "make sense of the hidden curriculum" (Patterson-Stephens et al., 2017, p. 20).

In addition, pursuing a graduate degree is a difficult endeavor for Black women because of the lack of support they receive and the hostile environments they regularly encounter. Previous scholarship found that Black women pursuing graduate degrees in STEM disciplines do not expect to encounter barriers to building a strong rapport with their faculty advisors or connecting positively with their peers (Joseph, 2012). However, many Black women experience negative interactions with their faculty advisors and peer groups due to a chilly campus climate (Joseph, 2012). Black women also do not expect they will encounter the racial prejudice and blatant disrespect they do, which, in

turn, compels them to identify support systems (Bailey-Iddrisu, 2010). As a way to resist the unjust treatment they experience in the academy, Black female graduate students utilize their voices to challenge discrimination, take part in radical coping strategies, and seek affirmative support from their peers and allies (Apugo, 2019; Minnett et al., 2019; Robinson, 2013). However, the consequences of resisting and speaking out in the academy include Black women being wrongfully depicted as angry or combative when they speak on the issues that continue to hinder or discourage their academic success and overall well-being (Robinson, 2013). These stereotypes also cause Black women to code-switch, which we define for the purposes of this study as consciously or unconsciously modifying the way an individual behaves in mostly White environments to dissociate oneself from negative stereotypes held against Black women. Hall and colleagues (2012) purport that Black women in the workplace may alter the way they dress or speak because of the stereotypical beliefs held about them by their colleagues.

The racial exclusion, the unsupportive faculty advisors, and the lack of adequate mentorship that Black women experience hampers their academic success at the doctoral level. Overall, Black women enrolled in graduate degree programs strongly value formal or informal academic mentors who share their same social identities because they want to be better understood and have access to psychological support (Cook and Williams, 2015; Rasheem et al., 2018). Research indicates that Black female mentors help Black female graduate students succeed because they provide emotional and academic support, teach them how to navigate academia, and serve as invaluable role models (Grant and Simmons, 2008; Rasheem et al., 2018). Other forms of support that Black female graduate students typically rely on include seeking advice from the Black graduate students in their programs who inform them on how to enroll in and take required coursework, how to seek graduate assistantships, improve upon their time management, or check in with one another to keep everyone accountable to their goals (Johnson-Bailey, 2007; Minnett et al., 2019). Faculty who advise Black women must become familiar with their educational experiences as graduate students in order to develop a culturally responsive approach to academic advising and mentorship (Jones et al., 2013).

Overall, Black female graduate students encounter an array of academic and social problems that impede their success and it is important to address these concerns to improve their retention and graduation rates. There is very limited research exploring the doctoral experiences of Black women enrolled in computing and engineering programs. Previous scholarship that analyzes Black female computing and engineering doctoral students' expectations of graduate school versus their actual experiences is also absent from the literature. The purpose of this study is to highlight the experiences of 37 Black female doctoral students enrolled in computing and engineering programs to understand how they explain their academic and social experiences.

### **3. INTERSECTIONALITY THEORY**

The utilization of Intersectionality Theory to understand Black women's social identities across gender and race is critical to understanding the associative tensions for being

both a woman and Black, and the complex interplay between both. The term “intersectionality” was coined and developed to delineate the intricate ways in which gender and race contextualize Black women’s lived experiences at the margins due to the numerous, interlocking systems of oppression that they repeatedly encounter (Crenshaw, 1989). This analytical framework is a useful model that challenges “many of the oppressive structures confronted by black women” (Jordan-Zachery, 2007, p. 255). As such, Intersectionality Theory operates as a tool to both emancipate and elevate Black women (Jordan-Zachery, 2007; Walby et al., 2012). The conceptualization of Intersectionality Theory also applies to Black women’s experiences while enrolled in their graduate programs (Alexander and Bodenhorst, 2015; Ireland et al., 2018; Mwangi et al., 2018; Robinson, 2013).

Intersectionality theory operates from a particular lens that “requires researchers to look at the ways in which these interlocking systems of oppression function within black women’s experiences as blacks, as women, and as having a particular class location with higher education” wherein their “intersecting identities such as race, class, gender, sexuality, and ability, among others, are relational rather than isolated from each other” (Walkington, 2017, p. 51). At the intersectionality of their gender and race, Black female scientists are subjected to racism and sexism while pursuing their graduate education (Alexander and Hermann, 2016; Borum and Walker, 2012; Ireland et al., 2018; Joseph, 2012). Utilizing Intersectionality Theory is a useful analytic framework because it will facilitate and contribute to a more nuanced perspective of the multiple barriers they encounter simultaneously as computing and engineering doctoral students given the relative absence of scholarship that has foregrounded their experiences, and has thus explained the subsequent and numerous academic and social inequalities they experience in the academy.

#### 4. METHOD

Qualitative interviews were collected with  $n = 37$  Black female computing and engineering doctoral students from educational institutions across the United States. The institutions that these Black female doctoral students attend are mostly predominately White institutions (PWIs). Black women’s mean doctoral grade point average was 3.62. The majority of the participants were either at the coursework stage of the doctoral program (27.3%), the predissertation stage (27.3%), or the All But Dissertation stage (22.7%). All but one student participant identified as multiracial out of all 37 doctoral students that were interviewed. Recruitment strategies consisted of attending national conferences such as the National Society of Black Engineers and The National GEM Consortium, sharing the research opportunity on email listservs, and word of mouth (i.e., snowball sampling). Upon completion of the interview portion followed by a 10-minute demographic survey, each participant received a \$25 gift card.

Furthermore, this research study undertook a grounded theoretical approach. This approach is a social science research method employed to generate theory that is grounded within the data, which in turn, are both collected and analyzed to identify developing themes and patterns (Noble and Mitchell, 2016; Tie et al., 2019). Qualitative

interviews were collected over a four-month period from January 2017 to May 2017. Aliases were provided for each participant to protect their anonymity. The interview protocol guide consisted of 30 interview questions, with the addition of 15 probing questions. On average, phone interviews ranged from 50 to 90 minutes, and the interviews were audio recorded and were professionally transcribed. After the interview transcripts were transcribed, the transcripts were then uploaded to Dedoose software in order to be coded and analyzed by the research team.

To identify emergent themes and patterns that became apparent from the qualitative data, each team member began coding themes independently. After each team member analyzed a set of interview transcripts, another research team member analyzed those same transcripts (i.e., a checking process). Each of the interview transcripts was coded twice by two researchers to ensure that there was agreement about how the qualitative data were to be coded and analyzed. Our research team triangulated the qualitative data to increase credibility by writing memos for each participant, ensuring data saturation, analyzing both the interview transcript data and survey data, creating a definitive codebook to be used for each round of coding across the entire research team, and by conducting an audit trail (Adams, 2015; Carter et al., 2014; Lincoln and Guba, 1985; Johnson et al., 2017; Morrow, 2005).

#### **4.1 Authors' Positionalities**

All of the researchers of this study identify as Black women who are either completing or have already completed their doctoral programs in the field of sociology, engineering, physics, and counseling psychology. These scholars serve as the assistant dean of diversity, equity, and inclusion in computing and engineering at a large public university, a professor and director of graduate counseling at a small private university, founder and senior researcher of a company dedicated to equity and inclusion for engineers, and as a doctoral candidate studying the academic experiences of undergraduate and graduate students. The researchers' intersectional identities inform their positionality as researchers on major components of the research process (i.e., data collection, data analysis, and presentation of the content). However, Black women interviewing within racial and gender boundaries are beneficial in qualitative research because there are fewer obstacles to overcome, which can lead to a more authentic interview (Johnson-Bailey, 1999). In order to mitigate bias that can emerge from researcher subjectivity, the researchers used safeguards to ensure trustworthiness and rigor. These safeguards included implementing a logical, traceable, and documented audit trail to ensure credibility, dependability, confirmability, and authenticity (Patton, 2002).

#### **4.2 Protection of Vulnerable Populations**

To protect the research participants, no identifiers were included as it pertains to the participants' actual names, respective educational institutions, or other signifiers that would disclose their identity. Each participant has been assigned a pseudonym. In ad-

dition, the researchers conducted a national study with research participants from over 15 educational institutions. This multisite measure was undertaken to further anonymize the research participants instead of conducting a study where all of the students attend the same educational institution. These research practices, among others, were used to protect the Black women featured within this manuscript.

## 5. RESULTS AND DISCUSSION

This study examined the following research questions: (1) What are the perceived expectations of Black women enrolled in computing and engineering doctoral programs, and (2) What are the perceived realities of Black women enrolled in computing and engineering doctoral programs? The findings within this study revealed several prominent themes based on the experiences of Black doctoral women in computing and engineering programs. The following themes emerged from the data analysis: (1) The Lone Black Woman, (2) Disputes with Faculty Advisors, and (3) The Role of Code-Switching. Black doctoral women's expectations and realities are expanded upon in this section.

### 5.1 Expectation vs. Reality: The Lone Black Woman

Many of the Black women in this study experienced being the lone Black woman in their departments. They described feeling isolated and alienated at the intersection of their gender and race. Several Black women indicated that they expected to experience isolation prior to enrolling in graduate school because they dealt with being few in number as undergraduate students at PWIs, with the exception of those students who attended HBCUs. Unfortunately, this underrepresentation suggests that those Black women in computing and engineering programs at PWIs experience isolation and alienation for a minimum of ten years, given their underrepresentation at both the undergraduate and graduate level at PWIs. A Black doctoral student named Raven who attends an HBCU currently does not understand how Black students could attend a PWI for both their undergraduate and graduate-level degree programs because of the racism that they regularly encounter at these particular institution types. She states:

*I definitely can say I don't understand how some people, or some Blacks go to a predominately White institution for undergrad and then turn around and do graduate school. I guess maybe it's the conditioning, but I couldn't have done that. I meet a lot of undergraduate students... and they're just tired, just completely tired, and completely over [attending a predominately White institution]. They don't want to go to graduate school because of some [of the] things they are experiencing [now as undergraduate students] ... I think that's really strenuous.*

Raven's quotation illuminates the racial battle fatigue that many Black students experience when they attend PWIs for their undergraduate and graduate education. Smith

et al. (2007) define racial battle fatigue as the “social-psychological stress responses (e.g., frustration; anger; exhaustion; physical avoidance; psychological or emotional withdrawal; escapism; acceptance of racist attributions; resistance; verbally, nonverbally, or physically fighting back; and coping strategies) associated with being [a Black student] on historically White campuses” (p. 552). Raven consciously decided that she did not want to attend a PWI because she did not want to encounter racism in the midst of pursuing her education from faculty and colleagues at her institution, nor did she want to deal with the repercussions of racism, including the psychological toll it can have on her psychological health and well-being. Given the intersection of being severely underrepresented across race and gender, including having to deal with racism, Raven was left feeling grateful because she chose to attend an HBCU that she mentioned both supports and uplifts her as a Black female scientist in the academy.

Moreover, a student named Elizabeth, who currently attends a PWI, realized that she would have to deal with isolation in her doctoral program because during recruitment weekend, “I was the only Black woman [at the event] or even Black person in general, and so I was isolated a lot. Sometimes I felt like the token Black girl or token Black person, so it was really hard to try and connect with people [in order to] fit in.” Overall, Elizabeth was dismayed by the fact that no one during Admit weekend was Black because she was hoping to see other people who resembled her. She was left wondering what her experiences would actually be like after matriculating into her program as the only Black woman in her department. Likewise, other Black women in this study questioned to what extent they would be accepted given their intersectional identities. They questioned their acceptance as Black women in their computing and engineering doctoral programs because they understood the associated stereotypes that their social identities hold. Not only do Black female doctoral students experience a lack of belonging and question whether they will be accepted by their colleagues and faculty advisors, but their token status also results in some of them being the first historic Black female doctoral student in their engineering or computing departments.

One student named Chloe in particular proclaimed, “when I first came [to my program], I was the only one. They never had a Black woman PhD graduate in the department [before].” On one hand, being the first Black woman in her department to complete her doctoral program symbolized a sense of pride because Chloe would be able to show other Black women that they too could pursue and complete a doctoral program in the natural sciences. On the other hand, being the first Black woman to complete a doctoral program in the natural sciences caused intense feelings of anxiety and stress because Chloe’s well-meaning advisors and mentors always shared with her how proud they were of her and the accomplishments she made in the program. Being monitored at all times due to her historic status left Chloe as well as other Black women in this position feeling burdened by the pressure to perform well and succeed.

For Black women computer scientists and engineers, the status of being “the only one” or “one of a few” in their departments engendered feelings of hypervisibility and hyperinvisibility due to the intersection of their gender and race. Being the lone Black woman also led a student named Marie to perceive that her colleagues would character-

ize her as “entitled” because of the support and resources she regularly needed to ensure her academic success. Marie illustrated this point by saying:

*Right now, I feel invisible. Sometimes I feel like people think I'm entitled, and I feel hyperaware when I'm asking for things and support. I feel a little bit like a shapeshifter [or] a code-switcher. I feel angry. I feel alone. I feel passionate and excited that I have this opportunity. Yeah, I think I feel all of those things at once; overwhelmed, yeah. A lot of those things.*

These mixed emotions and feelings that Marie experienced as the lone Black woman in her doctoral program were caused by the fact that she does not want her colleagues and faculty advisor to view her as needing too much help or assistance. Marie flounders emotionally because she does not want to be labeled as “entitled.” This perceived sense of entitlement from others leaves her feeling irritated and annoyed among an array of other depressive emotions despite still being passionate about pursuing a doctoral degree program in her field. In no way did Marie want to appear as though she was having a hard time in her program. Due to her token status, she feels compelled to appear competent in her abilities as a scientist and researcher at all times. There are no breaks for Black women given their intersectional identities, which is why Marie feels like a shapeshifter or code-switcher. She is always on guard because she is unable to be her full self in the educational space that she both operates and exists within.

Moreover, Marie also does not feel that her academic and social needs are being adequately met by her department. Due to the low enrollment and retention rates in her department among Black women specifically, Marie now understands that her department was never prepared to advise students such as herself—i.e., Black women. She states:

*I feel invisible in a lot of ways, in terms of how my needs are not being met, because there hasn't been a lot of people before me and [now] I realize like, 'Why is this happening?' Is [it] because this place was not [made] for [people like] me originally?*

Black women enrolled in computing and engineering doctoral programs bear the undue responsibility of having to operate and succeed in educational spaces that are not historically or contemporarily designed for their participation. In addition, these Black women do not have faculty advisors who share their social identities. This causes them great distress and trouble because they are unsure of how to navigate their doctoral education, and which steps to take as they complete their degree-related milestones with little to no support from their faculty advisors nor the graduate school counselors.

Additionally, Black women experience feeling “very out-of-place” on their college campuses because of their physical appearances. For Black women, hair is a very important construct because of the way in which Black hair has been policed in the Black community (Patton, 2006; Thompson, 2009). Black women encounter a number of chal-

lenges in both the workplace and at their educational institutions for the distinct ways in which they wear their natural hair (i.e., afros, braids, etc.)—hairstyles that do not succumb to the European female aesthetic (i.e., wavy or straight hair). Thus, the politics of respectability for Black professional women are quite burdensome as their existence is challenged day in and day out (Brown, 2014). Another student named Lauren mentions the gruesome experiences she has with her hair as the lone Black woman:

*Well, I can tell you, sometimes it can be horrible. I am the only Black woman in my building. So, just on a personal level, I get super self-conscious. Like, I don't get relaxers. I don't straighten my hair, and I wear my hair out. Just on a personal level, some days I come into work and some days my hair is just unruly, and it won't do what I want it to do. I just feel very out-of-place here. Okay, and even just within the space ... so, my building is on the medical school campus, and it's a bit separated from the rest of the campus. On [the] regular ... I don't actively see Black people around me at all, and I'm very aware and self-conscious of that.*

Lauren is very self-conscious about her natural hair because she wants to ensure that she looks and feels good at all times as a Black woman. However, at the same time, she is encumbered by the European hair and beauty standards that have been imposed on Black women by the wider society. White standards of beauty oppress Black women—rather than them being able to fully focus on their lab experiments and other doctoral-related degree milestones, women such as Lauren have to constantly reflect on the way they look. Bencosme (2017) purports that “hair texture and how [Black women choose] to style it plays a huge role in the caste system” (p. 5). Lauren consciously understands that she may experience judgment if her hair is “out-of-place” or “unruly.” Given that Lauren does not subscribe to the notion of getting relaxers or straightening her hair to appear in a particular way to her non-Black counterparts, she is hyperaware of her token status as a Black woman with natural hair who happens to be a scientist. The intersection of being the lone Black woman in a doctoral program and the respectability politics that are present at all times for Black women is a disturbing cause for concern for students such as Lauren as they attempt to navigate and negotiate their status as Black female computer scientists and engineers.

Being the lone Black woman in a doctoral program triggers a number of challenges that both create and maintain psychological stressors and hurdles that they have to continuously jump through as they complete their programs (Shavers and Moore, 2019). As such, women of color physicists “trying to establish their ordinances in physics often utilize strategies involving the manipulation of their bodies that lead either to the fracturing or to the reconciliation of their female, racial/ethnic, and physics identities” (Ong, 2005, p. 600). As Ong (2005) previously stated, our study also finds that some of the Black female engineers and computer scientists are required to decide whether they will alter or modify themselves to more closely fit the historically “perceived” aesthetic of who and what a scientist looks like or reflects based on the wider society’s preconceived

notions, given the elusive role of racism and sexism in science. More specifically, Black female scientists have to determine whether or not they want to perform Whiteness in order to obtain some level of acceptance in their respective scientific communities (Ong, 2005). Overall, some of the major problems that are associated with isolation and alienation among Black female scientists include long-term and consistent feelings of anger and sadness, a lack of sense of belongingness, code-switching, and being self-conscious about their physical appearance (i.e., respectability politics). Black women enrolled in computing and engineering doctoral programs deal with these stressors simultaneously given the insurmountable complexities of their social identities that are constantly at play with each other.

## **5.2 Expectation vs. Reality: Disputes with Faculty Advisors**

Another emergent theme that impeded the academic and social success of Black female doctoral students is unsupportive and unreliable faculty advisors. Some of the students mentioned that the faculty in their respective departments would not speak to them outside of class nor assist them with difficult coursework or with their research projects despite the continued promises and commitments made by their faculty advisors. Before arriving to graduate school, the participants believed that they would receive the academic and social support they personally needed to thrive as many of them did as undergraduate students. These students were told if they attended their respective educational institutions for graduate school that they would be supported academically. Statements such as these were told to them during recruitment weekend or during private conversations with their prospective faculty advisors or from the graduate advisors more generally.

Overall, many of the Black female doctoral students were excited to attend their doctoral programs because of the extensive bonds that they were able to make with their advisors prior to matriculation. They also heard from other graduate students that their potential advisors would be willing and able to both assist and support them. These same graduate students also told them which faculty to beware given their poor academic advising with former graduate students. Altogether, the students believed that they would receive instrumental mentorship. Examples of instrumental mentorship include coaching students, providing feedback to students concerning their scholarly research, and teaching students how to write research proposals and grants, as well as assisting students in writing manuscripts for publication in order for students to achieve their academic and professional goals (Blake-Beard et al., 2011; Curtin et al., 2016; Karcher et al., 2006; Taylor and Neimeyer, 2009; Tenenbaum et al., 2001).

However, many of the Black female doctoral students in both computing and engineering were met with little to no support from their faculty advisors and were oftentimes left to their own devices to figure out how to navigate academia altogether. This lack of adequate academic support for Black women consisted of the following: no assistance with rigorous coursework, no assistance with comprehensive examinations, no assistance with research projects, no assistance with the selection of a dis-

sertation topic, and no assistance while on the academic job market. Fundamentally, a few of the Black women did not receive any type of doctoral degree related support as they attempted to surpass each major milestone in their programs. In addition, one academic advisor told her student, Raven, that she should have never pursued her doctoral degree program because she's more of a "technical student" rather than a doctoral student.

Altogether, Raven lacked both instrumental and psychosocial mentorship from her faculty advisor. Examples of psychosocial mentorship include providing encouragement and emotional support, helping students balance their academic studies and personal livelihoods, building meaningful relationships with students, and affirming students' social identities (Gibson, 2004; Gutierrez, 2012; Kumar and Johnson, 2017; Wladkowski and Mirick, 2019). Take the following excerpt from Raven, who lacked instrumental and psychosocial mentorship from her faculty advisor:

*I decided to work with another female advisor. I think just because I was in such a low place. She told me things like, 'you shouldn't even have a bachelor's degree. You're more of a technical student. Go to a two-year tech school. You have no academic ability. I don't see how you got into the program.' I was at a very low place.*

Raven's faculty advisor believed that her abilities were not up to par for a successful doctoral student nor for a research scientist upon completing her doctoral program. This disparate treatment only worsened when Raven's faculty advisor told her that she should have never completed a bachelor's degree program. She also questioned why Raven was admitted into the doctoral program at their institution. Raven's faculty advisor was under the impression that Raven would not become a successful doctoral student and research scientist because she struggled to stay on track from time to time because of her decreasing psychological health and well-being and the relative difficulty of the work. Not once did Raven's faculty advisor ask her what she was struggling with or check in on her to see what type of support she would need to be successful and thrive. Instead, her advisor would tell her she had "no academic ability." As a result, Raven was affected by carrying low self-confidence and trauma for being viewed and typecast as an unintelligent and incompetent scientist who should instead be enrolled at a "two-year tech school."

More exactly, Raven's advisor reproduces the myth of Black anti-intellectualism wherein Blacks have historically been typecast as uneducated, uncivil, and unrefined. This persistent racialized myth maintains the status quo within wider society given the permeance of race and racism in the United States and the undue subjugation Blacks continue to endure. Cokly (2003) argues that it is when Black students are educated within "predominately Black educational environment[s]" that they perform better academically, which in turn "may contribute to greater academic confidence" (p. 553). Overall, because of her unsupportive advisor, Raven had to switch advisors to ensure she would receive the academic support she needed to thrive in her program.

To make matters worse, some of the Black female doctoral students have even left their research groups due to a critical lack of instrumental and psychosocial mentorship from faculty. Having unsupportive faculty advisors causes Black women to fall behind academically in their studies because they have to deal with the politics of academia—that is, learning how to navigate and negotiate the racialized terrains of their educational institutions as the lone Black woman in academia. Shavers and Moore (2019) assert that “when Black women are confronted with demanding expectations of a doctoral program, they are often challenged with identifying meaningful approaches to persist and cope with the doctoral process” (p. 211). Overall, this negligence to support Black women hinders their success. Select quotations from Cynthia and Nia respectively highlight the academic and social experiences of Black female doctoral students enrolled in computing and engineering programs.

*[My professor is] not a good mentor [because] he doesn't necessarily help you navigate graduate school in [a] way that is beneficial for you as a person. He's pretty well regarded but he's not very good at introducing you to the right people. He's also not very good at helping you map out how your career path should begin. He's not very good at aligning with your [research]. You can have these separate ways of existing in the lab where you're doing okay, and you're doing what you need to do, but you may not really know what your career should be. He's not very good about that.*

*So, the professor I had issues with told me in an email [stating] 'I'm not going to help you because I don't really like you.' I'm like, 'I don't care. You don't have to like me [but] it's your job to be able to convey the information in an effective manner. And I'm telling you right now you're not doing it.'*

Both Cynthia and Nia reported dissatisfaction with their faculty advisors who they found to be unsupportive and unprofessional. Because of these faculty members' inability to support and advise Black female doctoral students, Cynthia ended up struggling during the first two years of her degree program. More specifically, she struggled to navigate life as a graduate student and did not believe that her advisor made it a priority to support her academic and personal goals as a doctoral student. Cynthia was also dismayed by the fact that her advisor did not introduce nor connect her to other researchers and scholars who held similar research interests. Additionally, Cynthia and her advisor grappled with added stressors because her advisor did not prioritize Cynthia's research nor assist her with crafting a career plan. Overall, Cynthia described her experiences with her advisor as rocky and she had to develop the mental stamina to remain resilient and persist academically. In this way, Cynthia's advisor did not provide instrumental mentorship that would have been advantageous for helping her further develop her research agenda and career plans.

In Nia's case, she did not receive instrumental support of any kind because her advisor simply disliked her as a person. Nia had to continuously remind her advisor

that it is their duty and obligation to ensure that she succeeds as a student. The power differential between Nia and her advisor caused her a great deal of stress. Overall, Nia was left in the dark as it pertains to whether she was going to receive the support she needed to complete her degree. Unfortunately, Nia did not receive the support she needed. As a result, she had to constantly find other mentors so that she could remain successful while enrolled in her degree program. Nia also mentioned how her faculty advisor was unsupportive because she “put me in a bad position three times in one semester, and each time [my advisor] didn’t help get me out of it even though [she] put me in it. So I don’t trust [her] . . .” Nia discussed the implicit conflicts she encountered with her advisor below:

*So, she gave me advice about a class that I should take, and I told her, ‘I have never taken a [prerequisite for] this class and I’ve never taken a theory course.’ She goes, ‘oh, you’ll be fine.’ I was like, ‘are you sure?’ I was like here is my credential, here’s my background, these are the courses I’ve taken, [and] here’s why I don’t think I should [take] this course just yet. I think I should take a semester [and enroll in] a proofs course, and then take this [course]. I got in the course [and] she said it will be fine, ‘I’ll help you.’ So when I got in the course, and I needed help, I kid you not like half way through [the course] she kind of gave me the run around and finally she was like, ‘yeah, I can’t help you. I don’t remember this [course material].’ I was angry. I was like, ‘are you freakin’ serious bro? You got me signed up for this class [and] I’m struggling.’*

Nia struggled academically in her doctoral-level proofs course because she did not receive the support that her faculty advisor assured her she would receive. This lack of instrumental support resulted in Nia feeling frustrated and contemplating whether she would be able to complete the course. Nia’s advisor eventually informed her that she would be unable to assist her with the course material because she no longer remembered how to do proofs. Given the disputes Nia encountered continuously with her faculty advisor, she describes her ideal advisor:

*I’d say a good advisor is somebody who takes personal interest in what they want to do with your life and where you want to go, and tries to align the research and what you’re doing to put you in that position. To me, a good advisor’s like a mentor, right? You’re not doing the work for me, but you’re helping guide me. A lot of these advisors can’t guide you because they don’t have the formal training [and] they don’t know what that [guidance] looks like. They [themselves] didn’t have it.*

Nia believes that doctoral students should have an advisor that positions them to be successful by taking into consideration the students’ goals and aspirations upon graduation. Specifically, Nia believes that faculty advisors should be trained as doctoral students on how to provide adequate guidance and instrumental support to their students

once they become faculty. She believes that faculty struggle to mentor and support their students due to the lack of guidance and support they received as students themselves.

On the other hand, some of the faculty advisors are supportive of their students when they are dealing with unfair or disparate treatment at the hands of other faculty or staff members at their respective institutions. Given the racialized inequities that Black women encounter in higher education, it is imperative that they receive adequate mentorship and support from their advisors and formal and informal mentors. Without this strong support and effective mentorship from their faculty advisors and formal and informal mentors, Black women tend to feel isolated and alienated because no one is there to assist them during difficult times (Simpson, 2008). Moreover, encountering racism is extremely stressful and traumatic. Take the following excerpt below from Kimberly:

*There was a situation I had with one of our minority coordinators [of an] engineering minority program. I went to speak with [the coordinator] about wanting to implement all of the service initiatives that I proposed in my NSF fellowship application and she was surprised and said that 'you know not many people do that. You don't have to.' I started setting up everything for this community service initiative [and] getting in contact with different schools. I told her that I got in contact [with the different schools and] they emailed me back immediately [and] they were really excited and she told me that maybe it would be great if we'd made the connection with the school [and] it would be great if a more senior student [took] it over. That, I mean definitely hurt and I guess I should probably say that she's a Caucasian female over a minority program. And so, I told my advisor and he told me that 'was bull crap.' He said that if I needed him to step in [to] let him know. He said because that is ridiculous and that is something that I've envisioned and that I've set up so why would I let her take that away from me.*

When Kimberly's advisor mentioned he would get involved and assist her with psychosocial support—this left Kimberly feeling supported and uplifted as a Black woman because she would not have to endure this heavy burden alone without any type of support from faculty. Kimberly is currently operating and existing within a very vulnerable educational space given the power differentials between herself as a Black female doctoral student and the "Caucasian female" who leads the minority program at her institution. Kimberly consciously makes note of her race and gender to provide additional context concerning why this issue may be rather difficult for her to address due to her intersectional identities and the power differential that exist. This intended removal of the NSF service initiative opportunity that Kimberly had developed on her own left her feeling depressed as she had to figure out how to address this problem due to the fact that her project was to be given to a more senior graduate student.

Other Black female doctoral students mentioned they appreciated having their faculty advisors root for them and reach out to them because of the intersection of their

gender and race. Some of the Black women's advisors understood their trials and tribulations at the doctoral level. Two doctoral students named Shirley and Barbara stated:

*I think that I've definitely met with some professors who were like, 'yeah, I like you and I'm rooting for you. Let me know if you need help.' Or a professor would say, 'make sure you give me an update on your research. If you need help with anything, if you want to talk about anything let me know and I'd be happy to discuss whatever is on your mind with you.'*

*Outside of my department, there have been faculty that have reached out to me [and] not for research purposes, just for, 'I see that you're a Black woman in engineering trying to succeed. I see your struggles, and I'm here to help you.' Not only have they been consistent in helping me, but have reached out when I haven't responded, or if I ran in the swamp and haven't responded or thought they probably just didn't have time for me to continue to reach out.*

In the few instances when Black women did receive the academic support they needed, students such as Shirley and Barbara felt that they would succeed as doctoral students because of the instrumental and psychosocial support they received within and outside of their respective departments. Furthermore, Black women were also elated by the opportunity to have former advisors and mentors who instructed them on how to select appropriate and supportive faculty advisors in their current programs. This meaningful advising was all in a concerted effort to help them complete their doctoral programs. Black women were told that it is important that they are content with the educational institution that they select to pursue their degree programs, the advisors they choose, and the associated research interests and activities they participate in. Black women were also advised that the doctoral journey or program is not that difficult but that it is reaching certain degree milestones that makes the process rather difficult depending on one's advisor among other closely related factors that can either positively or negatively shape Black women's academic success. Ella mentioned:

*When it comes to advisors and other mentors that I have had, they would tell me to pick an advisor that can help me grow in the field. Pick an institution that I'll be comfortable with because a PhD is a journey; it's not something that'll just take place quickly. You don't want to do a lot of jumping. You want to be able to focus. So, it was those key components that they wanted me to hone in on, to not necessarily select the institution based on its name, but [making] it about who [I will] work with. Make sure you're happy with what you're doing because you're going to need that action to drive yourself and complete the program. Actually, it was very common for me to hear that the PhD isn't hard; it's actually just going through the process to complete it and just making sure you set up milestones for yourself that you want to achieve, and that you make sure you*

*achieve them and obtain what you want at the end of the day from that program. So, things like this is what I mainly heard from other individuals.*

This quotation by Ella sheds light on the importance of providing Black women with instrumental support that guides them toward completing their doctoral-related degree milestones. Ella emphasizes that Black women's voices need to be heard so that their advisors are well aware of their professional and personal goals as doctoral students. Altogether, when Black women do not have supportive faculty advisors, they struggle to develop their research agendas and remain in their doctoral programs. This causes stress and anxiety because Black women doctoral students end up having to identify new advisors, restart their research projects under new advisement, and determine how to successfully navigate the doctoral education landscape in their respective departments. The process of obtaining a doctoral degree in computing or engineering is rather difficult because some of the Black women in this study are the first in their families to pursue a doctoral degree. Similarly, some of the participants in this study are the first historic Black women enrolled in their doctoral programs. Thus, they will prospectively be the first Black women to graduate from their programs. As a result, their doctoral programs are not properly established and organized to support Black women from both an instrumental and psychosocial standpoint.

When Black women have access to supportive faculty advisors and formal and informal mentors, they encounter positive academic and social adjustment experiences as doctoral students. They are informed how to navigate academia, which includes the socialization processes involved to become faculty and industry professionals themselves. They receive regular feedback on their research projects and coursework assignments, and they are sought out because of their intersectional identities, and the subsequent difficulties that they may experience due to their race and gender. Dortch (2016) purports that faculty advisors should "make their expectations of doctoral students' assignments, exams, dissertations, and committee meetings clear and [provide] safe environments in which students understand that asking questions and seeking help is not an acknowledgment or demonstration of weakness, or lack of skill" (p. 358). Thus, when faculty advisors undertake an intersectional approach toward academically advising Black women via an instrumental and psychosocial lens, they help them develop the critical tools needed to succeed as scientists and researchers altogether.

### **5.3 Expectation vs. Reality: The Role of Code-Switching**

Code-switching is another problem that Black women experience while enrolled in their computing and engineering doctoral programs. Code-switching became a significant issue for Black women who were in engineering or computing departments because they perceived they did not belong. Being the lone Black woman made it especially complicated for them as they straddled being hypervisible yet hyperinvisible simultaneously. Code-switching seemed to be an even bigger issue for Black women who attended HBCUs as undergraduate students because they were unaware of what it means to be the

lone Black woman within predominately White educational environments. As a result, “navigating the politics of identity at the intersection can prove to be tricky, especially when power and privilege are at play. It becomes a negotiation between knowing and being oneself, while at the same time demonstrating behaviors so as not to appear to fit some stereotypes” (Rasheem and Brunson, 2018, p. 389). As current doctoral students at PWIs, Black women who attended HBCUs as undergraduate students filter their true selves at the intersection of their gender and race. However, regardless of whether Black women attended HBCUs or PWIs as undergraduate and graduate students, they code-switched. Many of the Black women code-switch as doctoral students by ensuring that their demeanor is professional at all times. They feel as though they cannot show the goofy or funny sides of their vibrant personalities. It’s all business for many of these Black women. They believe that they cannot survive within the walls of academia without code-switching as Black women. It’s hard for them to turn on and off being code-switchers because it has become mundane.

The code-switching is daily and continuous, and thus takes a psychological toll on their cognitive function because they want to be their full selves but cannot due to the fact that they have to determine when it is appropriate to be their full selves. For many, there is never a safe time to share their true selves with their colleagues and faculty advisors. In and of themselves, these Black women have to straddle two separate and distinct identities because their intersectional identities sharply contrast with who and what wider society perceives a scientist to be across gender and racial lines. Overall, the distinct ways in which many of these Black female engineers and computer scientists have been marginalized and oppressed keeps them treading lightly in their doctoral programs because of the stereotypes held against their mere existence as Black women. Take the following quotations below from Gina, Elizabeth, and Kimberly, respectively:

*In my academics, I'm more professional. I'm very straightforward. I don't really joke that much. In my personal life, it's [the] complete opposite. I'm very goofy. I'm laid back. I like to make jokes. I like to give my siblings a hard time. I like to dance. I like to laugh. I just like to make things funny versus when I'm in academic settings, I don't do that.*

*Outside of the PhD. program, [it] can be a little hard turning that on and off cause a lot of times you [tend] to feel [that] while I'm at school or I'm in the lab [that I should have] no emotions. I have to pretend that things don't phase me. So, I might go outside of the PhD ... it's hard for me to turn that on, 'Like, oh I'm human again.' So, a lot of switching back and forth, code-switching between who I am for real and the person I have to be to survive in this atmosphere.*

*As far as speaking, I have been code rich. I code [switch] for real depending on how comfortable I am with the person. When I first meet them, I'm like on guard, right, I'm kind of reserved. I don't want to; I'm trying to read them to*

*figure out if I could be my whole self with them. Like, because there's a lot of, I mean of course you're collaborating as researcher and academics, but there's collaborations ... You'll meet friends and colleagues, you know you go out for a drink with them or you do dinner with somebody you know as a networking thing.*

As scientists, Black female doctoral students perceive that they are under intense scrutiny wherein they do not feel safe to reveal their true selves because they do not want to be perceived in a negative light. There are a number of stereotypes for Black women and they have to ensure that they are perceived as competent and educated computer scientists and engineers. The onus is continuously placed on them as Black women. When they are with their families and friends, Black women can be their true selves because they are free of judgment. They understand that in order to survive in the academy that they must code-switch. They feel as though a surveillance camera is constantly watching their every move. This surveillance camera is their faculty advisors and colleagues.

Hence, code-switching for them is not trying to subscribe to the notion of White culture—but instead, they are attempting to survive White culture within their educational settings that are also apparent for them within wider society. Overall, code-switching takes a psychological toll on Black women's well-being because they have to constantly conceal or hide parts of themselves by putting on an “academic mask as a strategy to overcome oppression and persist academically” (Shavers and Moore, 2014, p. 404). Black women do not want to code-switch but they are required to because they have to survive the racialized and gendered terrains of academia that have both historically and contemporarily pushed them to the margins. As such, they continue to play hide and seek as a surveillance camera is always watching and scrutinizing their every move as scientists in their engineering and computing doctoral programs.

## 6. CONCLUSION

In an effort to help improve the overall experiences of Black women in the academy, the objective of this paper was to provide a detailed account of how they characterize and perceive their doctoral-level experiences. Specifically, this study finds that Black women engineers and computer scientists suffer from the consequential effects of being the lone Black women in their programs and having unsupportive faculty advisors, as well as code-switching because they do not feel accepted due to their intersectional identities across gender and race. Being the lone Black woman in computing or engineering meant that they felt isolated and alienated and felt an internal pressure to succeed because some of them were the first historic Black women enrolled in their respective departments, and they did not want to let down their well-meaning faculty who have supported and uplifted them in any capacity. They also wanted to ensure that other Black women looking up to them as role models saw them as being successful and remaining in their degree programs all while being resilient. To some degree, this left some of the Black women stressed and anxious due to the act of perfectionism they regularly performed.

Black women also struggled with faculty advisors who did not support them with their coursework, research studies, or even while they were in the job market. Many of the Black women in this study were left to their own devices to figure out how to best succeed in order to continue moving forward with their doctoral degree-related milestones. For the few Black women who did receive support, they felt affirmed and uplifted because they had faculty mentors who reached out to them to let them know that they would be available to them in case they needed any type of support or simply wanted to talk about their overall experiences as graduate students. Black women also dealt with code-switching because they were unsure whether their faculty advisors and colleagues would support them given the associated stereotypes that their social identities hold. Black women felt that they were able to be their full selves when they were around family or friends only because they did not have to question themselves or their social identities specifically. Several limitations were present within this study. First, the majority of the participants in this study attend PWIs; therefore, different institution types would glean more evidence about students' academic and social experiences and how their experiences differ accordingly. Second, because some of the topics discussed in the interviews are considered sensitive in nature (e.g., racism, code-switching, etc.), it is important to note that some students may have been reluctant to share their detailed experiences in academia.

Given these critical findings, we find that it is important that Black women have advisors and mentors who both support and uplift them instrumentally and psychosocially. The racism and sexism Black women encounter causes them to code-switch, feel disconnected from their faculty advisors and colleagues, and feel isolated and alienated. A more nuanced understanding of their experiences is absolutely critical as graduate programs identify new strategies and tools for recruiting, retaining, and graduating Black women in the field of computing and engineering. Overall, it is essential that engineering and computing departments ensure a welcoming culture for Black women graduate students by bringing awareness to their multifaceted experiences, including how faculty and higher education administrators can promote a culture of transparency and accountability to both support and endorse the concerns and issues that Black women experience. And in order to foster greater diversity and equity within engineering and computing graduate programs, Black women must not be confronted by faculty nor fellow students but instead interactions should be rooted in compassion, understanding, and a commitment to the success of Black women.

Other most-promising tools, resources, and practices to improve Black women's academic experiences may include workshops that can help convey the educational experiences of Black women and the types of support they need to remain successful in their degree programs. Additionally, it is important that higher education administrators, faculty, and academic counselors create safe spaces for Black women where they have the opportunity to share their experiences, and get the support that they need to continue on in their studies, as well as a space where they can connect with other women and women of color as sources of support and mentorship. Trainings should also be conducted for faculty who advise students to share many of the disputes Black women face

while pursuing their degree programs (i.e., code-switching, discrimination, isolation and alienation, lack of mentorship).

Moreover, faculty should also take an active interest in educating themselves on Black women's experiences in academia given the extensive amount of scholarship that has been published for and by Black women alone. In terms of mentorship, faculty should consult with Black women regularly to ask them how they would like to be mentored and supported during their educational endeavors wherein they codevelop an academic plan that supports the students' academic and personal growth. In addition, faculty must be consciously aware that in order to be effective mentors that they must develop personal relationships with their students and provide them with instrumental and psychosocial support, and to help Black women deal with feelings of isolation and alienation, faculty can also "remind students of the wealth of organizations within or outside the university that might provide them with a sense of community" (University of Michigan, 2014, p. 18). Accordingly, future research is needed to further understand the race-gendered experiences of Black doctoral women in computing and engineering programs to help improve graduate education to ensure their ultimate success and well-being.

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