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Intersectionality and STEM: The Role of Race and Gender in the Academic Pursuits of African American Women in STEM

LaVar J. Charleston
University of Wisconsin-Madison

Ryan P. Adserias
University of Wisconsin-Madison

Nicole M. Lang
University of Wisconsin-Madison

Jerlando F. L. Jackson
University of Wisconsin-Madison

African American women are disproportionately underrepresented in the domains of science, technology, engineering and mathematics (STEM) in relation to their share of the United States population. This disparity must be reduced in order for the United States to maintain its global standing in the competitive arenas of technology and innovation. However, current research tends to underexamine how the intersection of race and gender identities impact the experiences of African American women pursuing STEM careers. This dearth of knowledge is addressed in this study, which examines the multifaceted marginalization that African American women typically experience in the process of obtaining their STEM degrees, particularly in the computing sciences. Accordingly, this study utilizes intersectionality theory as a theoretical foundation to explore the role race and gender play in the STEM pursuits of African American women, offering a window into some of the strategies this population employs in accomplishing STEM educational goals and pursuits.

INTRODUCTION

The director of the National Science Foundation (NSF), among others, has identified increasing the number of minority graduates in science, technology, engineering and mathematics (STEM) fields as a national priority. In 2010 testimony before the House Subcommittee on Research and Science Education, then director, Arden L. Bement Jr., noted that changes in national demographics no longer allow for "linear growth" but that increases in minority STEM graduates must shift into what he called "geometric growth" (as cited in Basken, 2010, p. 1). Accordingly, the goal of increasing the proportion of women and minority graduates in STEM fields is driven, in part, by research about these groups' lack of representation in STEM academia and industries.

The NSF's National Center for Science and Engineering Statistics 2010 dataset illustrates the significant hurdles facing women and African Americans in science and engineering (S&E) fields. Analyses show that despite African Americans comprising nearly 11% of the total 2010 U.S. labor force, 5.5% or 247,000 jobs classified as S&E occupations were held by African Americans; and of those 247,000 S&E occupation jobs, 108,000, or 2.4% of all S&E jobs, were held by African American women. However, those African American women who do work in STEM fields enjoy a smaller wage gap compared to women in non-STEM fields (as cited in Beede et al., 2011).

In light of the statistical documentation demonstrating both women, overall, and minority women's underrepresentation in STEM occupations and academic programs, numerous scholars have contributed empirical evidence and theoretical conceptualizations concerning the factors affecting women's college decision-making processes in regards to STEM fields (Morgan, Gelbgiser, & Weeden, 2013). Among these empirical and theoretical contributions include the role of stereotype threat in hindering women's performance in mathematics (see Spencer, Steele, & Quinn, 1999); institutional variables affecting undergraduate STEM student completion rates (see Eagan, Hurtado, & Chang, 2010; Griffith, 2010; Perna et al., 2009); faculty influence on minority women's persistence in science (see A. C. Johnson, 2007); the postbaccalaureate career and educational goals of women in STEM majors (see Cole & Espinoza, 2011); and the overall role of gender-based stereotypes (see Nassar-McMillan, Wyer, Oliver-Hoyo, & Schneider, 2011). While these contributions serve to inform the current study, this study aims to better understand the intersections of race and gender, and how these identities intersect in the process of STEM education and matriculation among African American women in computing. As such, the primary research question driving this study was as follows: What role does race and gender play in the academic pursuits of African American women in the STEM field of computing sciences?

REVIEW OF THE LITERATURE

Women hold STEM jobs at a far lower rate compared to their overall participation in the job market—while African American women make up about 6.4% of the total population, they hold only 2.4% of all S&E jobs. Within mathematical and computing science occupations, African American women accounted for 65,000 of the more than 3.5 million people employed in these fields in 2010, or approximately 2% of the total mathematical and computing sciences jobs (Women, Minorities, and Persons with Disabilities in Science and Engineering, 2013). Additionally, statistics measuring income disparities between White and African American women in computer information systems (CIS) fields show that on average, African American women earn 25% less than their White women counterparts (Women, Minorities, and Persons with Disabilities in Science and Engineering, 2013). While these numbers demonstrate an underrepresentation of African American women in CIS for one recent year, the proportional lag in the representation of African American women in STEM fields overall has persisted since at least the 1970s (Ong, Wright, Espinosa, & Orfield, 2011).

While some have drawn on stereotypes to explain the underrepresentation of minority women—attributing it to a lack of interest among these women to pursue STEM-related majors and occupations—research provides no evidence of STEM aspiration gaps (Bonous-Hammarth, 2000; Smyth & McArdle, 2004; Staniec, 2004). On the other hand, underscoring the salience of social identity in minority women's STEM academic and career goals, Ong and associates (2011) consistently found social identity to be among the most important in assuring STEM success. In their analysis, Ong and colleagues (2011) note that the intersectional identities of minority women play an important role in the development and persistence of these women in STEM fields. Additionally, Carlone and Johnson (2007) noted that the development of a *science identity* provided a solid foundation for future career success among the 15 minority women who participated in their study. Conversely, others identified factors decreasing the likelihood of persistence of minority women in STEM majors include: the lack of science talent development (Ong, 2005), the delegitimization of minority women within STEM communities, and the isolation minority women often experience when they are all-too-often among the few, if not only, minority woman in their laboratory or academic department (Carlone & Johnson, 2007).

Intersectionality and STEM. An intersectional analysis of minority women's experiences in STEM fields holds that minority women are subject to the complex interplay of sexism and racism, conceptualized as the *double bind* (Ong et al., 2011). The double bind consists of a set of "unique challenges minority women [face] as they *simultaneously* experienced sexism and racism in their STEM careers" (p. 175). In the context of African American women interested in STEM fields, the double bind concept holds that these women face the unique problem of pursuing career paths that are not only in conflict with their racial identity (A. C. Johnson, Brown, Carlone, & Cuevas, 2011) but also with their gender identity while situated in an environment historically dominated by White and Asian males (Jackson & Charleston, 2012; Brown, 1997; A. C. Johnson et al., 2011; Malcom, 1996; Margolis, Goode, & Bernier, 2011).

Research supporting the importance of intersectional identities suggests that African American women's success in STEM fields may hinge on the development of an identity that is compatible with their gender and racial identities, as well as their academic interests (Borum & Walker, 2012; Espinosa, 2008; Fogliati & Bussey, 2013; A. C. Johnson et al., 2011; Ko, Kachchaf, Ong, & Hodari, 2013; McGee & Martin, 2011; Rosenthal, London, Levy, & Lobel, 2011). Although the development of strong, intersectional identities have been identified as critical cultural and societal factors in development (Rosenthal et al., 2011), the intersections of Black women's racial, gender, and scientific identities may conflict with many of the messages Black women and girls receive throughout the educational pipeline, and may thus pose a significant challenge to their ability to successfully develop a Black woman scientist identity.

Challenges in the educational pipeline. From a young age, girls tend to be alienated by science (Brickhouse, Lowery, & Schultz, 2000). The conflation of numerous factors, including gendered-stereotypes, pedagogical techniques, and science curricula, conspire against many young women's ability to develop and maintain an interest in science, as well as to develop a science identity (Brickhouse et al., 2000). Other factors, such as exposure to science and technology outside the classroom, have been identified as an impediment to young women's interests in STEM fields. For example, researchers have shown that as compared to Whites, Black girls are less likely to be exposed to computers and technology at an early age, contributing to limiting their initial interest in the field (Fisher, Margolis, & Miller, 1997; Margolis et al., 2011). In addition to the likelihood of decreased exposure to science, technology, and computers outside the classroom, young women and girls of color are less likely to succeed in the areas of math and science at all levels of their academic careers, leaving them underprepared to achieve success in STEM fields at the undergraduate level (ACT, 2006; Buzzetto-More, Ukoha, & Rustagi, 2010; Espinosa, 2008; A. C. Johnson et al., 2011; Perna et al., 2009). Despite the likelihood of depressed avenues of exposure and underpreparation, the literature posits that the underrepresentation of Black women in STEM is due not to a lack of interest or competency, but instead is owed to the tendency of the American education system to disengage, under-educate, and underutilize women of color at all levels of the academic pipeline (Farinde & Lewis, 2012; A. C. Johnson et al., 2011; Ko et al., 2013; Margolis et al., 2011; Syed & Chemers, 2011). From the elementary to high school level, young Black women have historically underperformed in the areas of math and science in comparison to their White counterparts, which has negatively impacted young Black women's intentions to strive for careers in STEM fields (ACT, 2006). Although efforts to eradicate this disparity have been studied, and some models which have achieved success have been developed (e.g., the Meyerhoff Scholars Program described in Maton, Hrabowski, & Schmitt, 2000), exemplars demonstrating broad-based, successful initiatives remain sparse. Thus, for young Black women, several significant factors compound early on to generate barriers to their success in STEM including: The socially-constructed incongruence of gender, racial, and science identities (A. C. Johnson et al., 2011); systemic educational barriers to Black girls' engagement in STEM (Brickhouse et al., 2000; Farinde & Lewis, 2012; A. C. Johnson et al., 2011; Syed & Chemers, 2011); and barriers inhibiting early science and technology exposure (Fisher et al., 1997).

In the transition from K-12 to higher education systems, much of the published literature to date has emphasized adequate preparation at early and secondary levels of education as most integral to sustaining Black women STEM scholars in higher levels of academia (Ehrenberg, 2010; George, Neale, Van Horne, & Malcolm, 2001; Perna et al., 2009; Price, 2010). In light of the significant obstacles confronting many young Black women in the K-12 pipeline, particularly early on, it may be that young Black women develop lower levels of perceived self-efficacy in math and science, a related factor contributing to depressed levels of later STEM degree attainment (Espinosa, 2008). Indeed, research examining the decision to choose a STEM major found that that earlier achievement in mathematics contributed both significantly and positively to perceived math self-efficacy for underrepresented minorities, which in turn played a significant role in students' decisions to choose a STEM major (see Wang, 2013). In light of Wang (2013) and others' findings (e.g., Frank et al., 2008; Riegle-Crumb, King, Grodsky, & Muller, 2012; Riegle-Crumb, Moore, & Ramos-Wada, 2011), significant attention should be paid to early science and math achievement as a precursor to later high math and science self-efficacy development.

At the undergraduate level, many studies point to social factors and academic rigor as hindrances to Black women's persistence in STEM and computing sciences. Evidence that demonstrates that students of color are more likely to discontinue their STEM studies for a variety of reasons, such as social isolation, academic difficulties, and financial stresses

(Buzzetto-More et al., 2010; Charleston, 2012; George et al., 2001), and may negatively contribute to Black women undergraduates' experience based on their racial identity. Other scholars, such as Palmer, Maramba, and Dancy (2011), discovered that underrepresented minorities are apt to experience feelings of alienation in STEM classes, and underlined the need for institutions to be more mindful of minority student integration and support at all levels of undergraduate experience including in the classroom culturally, and in terms of extracurricular activities (e.g., academic-related student clubs and organizations). For Black undergraduate women in STEM fields, the intersections of gender and race present unique barriers, as Black women often report instances of multifaceted discrimination based on both their gender and racial identities (D. R. Johnson, 2011).

These barriers to success remain for Black women at the graduate level, where they are often faced with cultural boundaries that discourage their ability to amalgamate their other, and often-conflicting gender, racial, and academic identities. Studies concerning students from Historically Black Colleges and Universities (HBCUs), many of whom have gone on to pursue graduate degrees at Predominantly White Institutions (PWIs), have shown HBCU environments to be conducive to Black students' success in STEM fields (Malcom, 1996; Owens, Shelton, Bloom, & Cavil, 2012; Perna et al., 2009; Perna, Gasman, Gary, Lundy-Wagner, & Drezner, 2010). In one qualitative study, "From one Culture to Another: Years One and Two of Graduate School for African American Women in the STEM Fields," Joseph (2012) investigated the HBCU-to-PWI pipeline and found that these students, who had experienced extremely nurturing and supportive cultural support at their undergraduate HBCUs, found their experience at the graduate-level in PWIs to be markedly cold and alienating, causing many of them to question their academic abilities. A similarly alienating culture was found in laboratory settings, where Black women often reported feeling like the *other* instead of successfully assimilating into their respective laboratory settings (see Ko et al., 2013).

At higher levels of academia, such as doctoral or faculty positions, African American women face even more obstacles in advancing their careers in their respective fields (Syed & Chemers, 2011). These women face the unique problem of balancing their career advancement and their family lives while upholding culturally acceptable roles for their gender as well as their race (Cech, Rubineau, Silbey, & Seron, 2011; Ko et al., 2013). Moreover, many underrepresented minority women in STEM who pursue careers in academia report experiencing instances of sexism at their institutions of employment when faced with family-related matters such as maternity leave, which negatively affects their attitudes toward their own success (Turner et al., 2011). Another barrier to the retention of Black women in STEM fields at higher levels is the desire for activism. A qualitative study conducted by Ko, Kachchaf, Ong, and Hodari (2013) found that many women of color in STEM express a strong desire to improve conditions for younger generations of underrepresented racial identities and women through recruitment, volunteerism, charity work, or other activities—all of which can take precedence over their own professional advancement.

Despite an increase in the amount of attention paid to the experiences, challenges, and barriers to women and minorities in STEM fields, research is still needed to better understand the specific barriers causing the underrepresentation of Black women in the computer sciences and the merits of various proposed prescriptions. By qualitatively exploring the experiences of African American STEM aspirants in computing science academic trajectories, this research study seeks to investigate and illuminate the current gaps in the literature in an effort to better formulate solutions to these obstacles. As mentioned previously, this study is guided by the following question: What role does race and gender play in the academic pursuits of African American women in the STEM field of computing sciences?

THEORETICAL FRAMEWORK

Conceptually and practically, intersectionality serves a dual role as both a theoretical lens and methodological framework. Intersectionality both critiques and offers alternatives to traditional modes of understanding the subjugating experiences of women whose marginalization emanates from multiple angles—in the case of Black women, as both a subjugated racial minority and as a woman. Further, intersectionality shifts the focus, as Cho, Crenshaw, and McCall (2013) put it, "beyond the more narrowly circumscribed demands for inclusion with the logics of sameness and difference" (p. 791). This shift in focus "addressed larger ideological structures in which subjects, problems, and solutions were framed" (Cho et al., 2013, p. 791). In other words, intersectionality's utility is not confined to conceptual or theoretical applications; it also offers scholars a set of practical methodological tools to give voice to individuals with multiplicative marginalities. Through the creative and innovative deployment of empirical methodological traditions, researchers are better able to uncover, challenge, and undermine the phenomenon of multiple overlapping sources of subjugation.

Intersectional lenses and methodologies have been deployed well beyond the law—intersectionality's field of origination—and have made contributions to other fields such as geography (e.g., Valentine, 2007); sociology (e.g., Choo & Ferree, 2010); psychology (e.g., Shields, 2008); leadership studies (e.g., Sanchez-Hucles & Davis, 2010); religion (e.g., Lee, 2012); queer theory and sexuality studies (e.g., Battle & Ashley, 2008; Fotopoulou, 2012; Moore, 2012; Stirratt, Meyer, Ouellette, & Gara, 2008); international and transnational studies (e.g., Choo, 2012; Lewis, 2013); and education (e.g., Alejano-Steele et al., 2011; Grant & Zwier, 2011; C. E. Harper, 2011; S. R. Harper et al., 2011; Museus & Griffin, 2011; Museus, 2011; Pifer, 2011; Stirratt et al., 2008). Although intersectionality has been widely applied in other areas of social science research (particularly in gender and critical race theory research contexts), Museus and Griffin (2011) noted intersectionality has been applied less frequently, and indeed runs counter to trends among higher education researchers, who tend to examine singular identities. Museus and Griffin (2011) further contend that contemporary unidimensional analytical frameworks at best obscure and overlook, and at worst contribute to the perpetuation of marginalization of some groups in higher education. By ignoring the true diversity of populations in postsecondary institutions, such scholarship overlooks those whose identities exist at the margins and reinforces ignorance about how intersecting identities impact inequality.

Qualitative research methods have been identified by, among others, Stephanie Shields (2008) as appropriate for tackling questions of interrelated and intersectional identities. Shields (2008) observed that qualitative methods "appear to be more compatible with the theoretical language and intent of intersectionality" (p. 306). Further, unlike traditional quantitative methodologies of hypothesis testing, researchers employing qualitative methods are less burdened by *a priori* knowledge making (Shields, 2008). McCall (2005) identified research tools commonly employed in the anticategorical complexity approach that "crosscut the disciplinary divide between the social sciences and the humanities" (p. 1778)—both of which feature traditions strongly rooted in qualitative methodologies. McCall (2005) hailed ethnography as an appropriate intersectionality research design, while Nash (2008) noted the successful application of poetry, narrative, and standpoint epistemological methods in the service of conducting intersectional research.

METHOD

Chism and Banta (2007) suggest qualitative methods, especially those employing semi-structured and open-ended approaches, allow participants to "introduce themes that the interviewer might not have anticipated in framing questions" (p. 16), which can be informative in measuring a wide variety of topics within institutions of higher education. Further, researchers suggest qualitative methods can be useful for assessing institutional cultures related to diversity (see Museus, 2007), and they are especially appropriate for discovering variables and conducting initial explorations of a research problem (see Creswell, 2012). In the case of this study, which seeks to illuminate experiences based on the intersectional identities of African American women in computing sciences, we chose to employ a qualitative research design to allow for participants to give voice to their own identities and experiences (Cole, 2009).

A phenomenological design was well-suited to the study because our inquiry aims to understand a common experience of a group of people, allowing the researchers to use data from participants to develop foundational knowledge about the phenomenon (Moustakas, 1994; Shank, 2002). A focus group was conducted lasting approximately 90 minutes in duration and moderated by an African American woman. Participants provided consent orally and were made aware of their right to suspend the session at any time. The focus group session was recorded and the tape was transcribed and filed for possible future use as a promotional/professional aid (based on the consent of the participants). The session was comprised of a series of closed and open-ended questions designed to gather information relative to the participants' experiences, with specific attention to the roles gender and race play within their academic trajectories within the computing sciences.

Characteristics of Focus Group Participants

This study employed purposeful sampling techniques (Lincoln & Guba, 1986), wherein all participants identified as "African American" or "Black" women, were enrolled full-time or were recently (in the last three years) in an academic computing program, and were no younger than 18 years of age and no older than 35 years of age. Fifteen African American women participants from a 2007 conference dedicated to African Americans in STEM were recruited and took part in this study. Each participant either majored in or were majoring in a computing-science related area of study as an undergraduate or graduate student. While all participants attended colleges within the continental United States, their schools were geographically dispersed. Likewise, at the time of the study, two participants had already obtained a PhD in computing sciences, 12 were current graduate students (PhD aspirants), and one participant was completing her baccalaureate degree. The undergraduate student participant was attending an HBCU, and all graduate students and current PhD holder participants were receiving or had received their graduate degrees from a PWI. Though the researchers involved with this study were only able to interact with this small group of participants together during this singular session, the following efforts to ensure the validity of this study bolster the study's findings.

Validity

The researchers employed a naturalistic approach to address reliability and validity of the qualitative inquiry within this study. Validity in terms of credibility and fittingness were the main goals of this qualitative approach as prescribed by Lincoln & Guba (1986). More clearly, special care was taken to create a research design that could be replicated if so desired contingent upon a similar set of circumstance in an effort to establish reliability. Moreover, in the tradition of naturalistic inquiry, data were coded based upon replicable themes and theories that emerged from the data.

Prolonged engagement, persistent observations, field notes and the analysis of multiple data sources helped to establish credibility based on triangulating these multiple data sources. Through spending ample time with study participants to check for distortions during the data collection process, both corroboration and prolonged engagement with study participants were simultaneously achieved. Due to the allotted length of the focus group (90 minutes), the participants' experiences were explored in sufficient detail, enabling persistent observation to occur. The significant number of open-ended (and follow-up) questions enabled the researcher to more effectively comprehend the nature of the participants' assertions. Additionally, the multiple sources of data were attended to through the process of comparing digital audio recordings, field notes as well as physical transcriptions. The aforementioned comparisons of multiple forms of data enabled the in-depth assertions from participants to be captured by the researchers, and was illustrative of the collective the collective and individual voices of African American women's experiences in the STEM educational pipeline. The collaboration of the researchers, along with the interaction with study participants, assists with the credibility of this study through the process of peer debriefing, revising working hypotheses throughout the data collection process, clarifying preliminary findings with study participants, and audio/video taping the interviews in an effort to compare to other means of data collected, which Rudestem and Newton (1992) asserts are necessary procedures to ensure the credibility of a study.

Positionality

As cultural outsiders as it relates to race, gender, and/or educational foci, this study was approached with both sensitivity and a strong desire to uplift the voices and experiential realities of African American women in STEM fields. In order to do so, the team of investigators sought to be reflective of our own positionality and how our multiple identities might interplay with the data collection process and analysis. As such, the researchers regularly interrogated their interpretations to be reflective, addressed potential assumptions and biases, and attempted to ensure consistency with phenomenology. While the investigators had varying roles throughout the research process (e.g., some were involved in analyses but not focus group interviews), having multiple team members enabled each team member to serve as an auditor of the research study as a whole (Creswell, 1997). Multiple members of the research team transcribed and coded the focus group recording, which allowed for peer debriefing and the inclusion of thick-rich descriptions in the findings. Moreover, the use of inductive data strategies allowed the data to serve as the foundation of understanding wherein the findings are acutely descriptive and conveyed through direct quotes and thematic analyses.

FINDINGS AND DISCUSSION

Utilizing the guidance of the intersectionality framework, this study explored the role that race and gender play in the academic pursuits of African American women in the STEM field of computing sciences. Two main themes emerged from the data: (a) racial and gender challenges related to the computing sciences educational trajectory; and (b) a shared sense of isolation.

Racial and Gender Challenges Related to the Computing Sciences Educational Trajectory

Conflicts and integrations of racial, gender, and academic identities arose repeatedly as participants reported grappling with their self-identities as women of color in race- and gender-exclusive academic spaces. Although participants described their experiences as women of color in computing sciences in a variety of ways, the group's consensus was that it is exceptionally challenging and difficult. One participant simply and directly exclaimed, "It's tough." Participants' racial and gendered identities were proclaimed largely depending upon the situation context. In other words, their primary identities varied based upon the social space within a particular educational environment. One participant relays this sentiment like this: "At different times, different identifications come to the forefront," demonstrating a set of unique—although previously-documented—challenges facing Black women at the intersections of race, gender, and science identities.

Many participants indicated that ascertaining the root of maltreatment proved difficult, wondering whether this treatment was based upon either their racial or gendered identities (e.g., a result of being a woman or a result of being Black). Several participants emphasized that their skin color was the initial focus of identity that dictated how others would treat them. "My belief is that the perception is that I am seen as a Black person first," expressed one participant. However, other participants indicated that their intersections of race and gender were inseparable. "At the end of the day, I am who I am. I am a Black woman, and there's no middle ground," exclaimed one participant. The stereotype regarding being a Black woman in a STEM field was an area of confluence among all study participants. One participant described it like this: "There are often assumptions that I am supposed to act a certain way because I am a Black woman," continuing that it was clear that others expected her to act angry or attitudinal when challenges or conflicts would occur. This is in congruence to broader societal stereotypes of African Americans and women that run counter to the assumed qualities of the researcher and scientist. Popular stereotypes assume African Americans to be intellectually inferior (Aronson, Fried, & Good, 2002), and scientists to be men (Cromley et al., 2013). Prior research investigating the effects of stereotypes on the academic performance of students with stereotype-congruent (e.g., Asian men in mathematics) and stereotype-incongruent (e.g., women in engineering) identities demonstrated that the effect of stereotypes is especially pernicious for those whose identities are both salient and *threatened* by the stereotypes. That is, the negative academic effects of stereotypes accrue the most among those whose stereotype-incongruent identity is the most threatened. Thus, among the participants of this study, their intersectional identities as Black women are placed squarely within a *double-bind* first described by Malcom, Hall, and Brown (1976) and elaborated upon by Ong and colleagues (2011). Collectively, and against the backdrop of perceived stereotypes associated with their intersectional identities as Black women, all 15 participants expressed how the computer science culture in their respective departments was clearly unwelcoming to women, and even more ostracizing to African American women.

Among participants, identifying as a Black woman conjured a wealth of misperceptions and stereotypes regarding their academic identity as well as their intellectual capacity. Like similar stories told by many of the participants, one participant described an encounter with a White male peer who blatantly questioned her academic abilities when they were paired on a team assignment. This participant explained how her teammate would submit components of the group assignment, making all of the decisions for the group, fully dictating how the project would be carried out without her input. "Maybe there was the perception that I was female, I was Black, and I was incompetent. His perception was I was going to pull him down," she shared. Another participant added, "I get to [University] and the first question someone asked was if I was someone's secretary… because I'm Black? A woman? I can't tease those things apart." These aforementioned examples illustrate the complexities and intersections of race and gender in computer science and support previous scholarship documenting the broader challenges associated with establishing oneself and gaining legitimacy as a Black woman academic (Brewer, 1999).

A Shared Sense of Isolation

Feelings of isolation were salient findings among the participants in this study. Social interaction with peers proved limited among study participants throughout their STEM education trajectories, particularly in STEM graduate degree programs. One participant remarked how "it took a good six weeks before people were finally opening up to me." The inundated consistency of isolation, precipitated by the lack of support from faculty and their respective institution alike, was a critical factor in participant's considerations to withdraw from their programs and reconsider their choice in majoring in their computing-related discipline. Participants also indicated that the field of computing as a whole is very sexist in nature and indicated that based on their experiences, computing "isn't seen as a discipline for women." Additionally, participants posited comments they would receive from their White counterparts that they felt were directly resultant of their race, gender, and thoughts about their inability to achieve in STEM: "Why are you still in school?" and "Why aren't you married and taking care of somebody?" were common expressions of astonishment among their White colleagues during their initial interactions.

These stories highlight the confluence of race and gender for Black women in CS departments and further bolster findings from multiple bodies of literature related to the isolation experienced by African American students, including those in STEM fields, graduate programs, and women in the sciences. Among the findings relevant to this study, Sharon Fries-Britt's (1998) scholarship on Black undergraduate participants in the Meyerhoff Scholars Program observed that high-achieving Black students in STEM fields experienced isolation within the larger African American community. Fries-Britt's (1998) findings underscored previous scholarship showing high-achieving African American students too often experience isolation from their African American peers due to larger educational disparities in the K-12 educational pipeline that persist at the collegiate level. While Fries-Britt (1998) found evidence that the community isolation experienced by these Black scholars was, to some degree, ameliorated by participation in a race-specific program and the resulting social networks they fostered, such social ties were not experienced among the participants of this study. In fact, as one participant indicated, developing a race- and gender-peer social network was nearly impossible to establish within an institution and field with so few Black women. Similarly, the experiences reported by this study's participants echo the findings of two previous works: Genva Gay's (2004) study documenting the isolating experience of being among African American women in graduate-level studies, and that of Settles, Jellison, and Pratt-Hyatt (2009) which found that over time, women who increased their self-perceptions as scientists and women fared better as scientists than those who did not. While the latter study did not specifically interrogate the role of race as a factor in the integration and co-development of gender and scientist identities, the findings do suggest that increases in both lead to positive personal and professional outcomes.

Given that most CS departments are heavily populated by White males, cultural isolation and was highly prevalent throughout participants' educational experiences related to STEM. While feelings of cultural isolation are commonly associated with acclimating to highly technological environments, wherein Black women are typically an anomaly, the intersection of race and gender were factors that proved salient in the negative experiences recounted in-depth by study participants. As many projects at the graduate level are collaborative in nature, the intersectionality of race and gender in these spaces facilitated consistent challenges to study participants. One participant explained it like this: "[As] the only Black [student], no one wants to partner with you and you have to do all the experiments by yourself." Additionally, this sort of discrimination, particularly if facilitated by the professor was contagious in that classmates "no longer want to work with you," as one participant recounted. As other students attempt to look favorable in the eyes of the professor, pairing with a Black woman in class was seen as detrimental to the academic progress of other students. In other words, participants felt that their experiences were definitively unique, even as it related to the subject of gender. "Just having other females there just doesn't cut it because there's no one there that has your experience... there are no common threads that connect you," asserted one participant. Participants consistently echoed each other in the context of the focus group that illuminated the unique divisions and experiences as a result of the intersections of race and gender identities.

Computing science and other STEM faculty were particularly instrumental in creating an environment characterized by isolation and ostracization for this study's participants. One participant tells a story of a fellow (Asian) graduate student who intervened to address the professor on her behalf after recognizing maltreatment. This Asian student had a good working relationship with the faculty professor and upon the Asian student's inquiry, the professor said:

> I don't think she has talent. I think White professors gave her grades because of her race and they felt bad about slavery. I don't think there are any real computer scientists who are Black, and maybe she can be the first.

What was also salient among participants was their recognition of many similarities between being Black in highly technological domains, and being Black in broader society. They indicated that much of the isolation they experience in their academic department mirrors the isolation of the Black race in broader societal terms. However, the added intersection of the women gender on to the Black race also illuminated differential gender experiences among Black men and Black women in STEM educational spaces. More clearly, the isolation Black women experience could be remarkably different for Black men in the same space. Participants indicated that though many experiences are familiar due to issues germane to Blackness and the Black race, another peer who is of the same race is not always a valuable source of support or collegiality. Gender, as well as the isolating and competitive nature of STEM fields themselves, promote and entirely new element. One participant summarized this sentiment like so: “Just cause there’s another Black brother [in class] doesn’t mean they want to work with you either.” Participants posited that because White males were often seen in a favorable light, particularly from professors, Black men were more likely to establish relationships with them than their other Black women counterparts.

CONCLUSION

In concert with research from a wide array of social science fields (e.g., Settles, 2006), this investigation suggests that many Black women see their racial and gender identities among the most salient of their identities. Additionally, this study corroborates other empirical examinations of the racial and ethnic, sex and gender identities of Black women (e.g., Levin, Sinclair, Veniegas, & Taylor, 2002) that posit that some Black women hold their Black racial and ethnic identities to be more salient than their sex and gender identities, while other Black women view their sex, gender, racial, and ethnic identities as uniquely situated. Settles (2006) describes this uniquely-situated racial identity as being different from Black men, and Black women’s identity as being “distinct from other women because of their unique experiences, such as being potential targets of racial and gender discrimination and harassment,” therefore “tak[ing] precedence in their self-concept over the individual identities of Black person and woman” (p. 590). While the Black women from this study (and several others offered within this manuscript) may view their identity as unique, further investigation of the marginalization experienced by these Black women demonstrate that racial identities become, in certain settings, more salient than sex or gender identities. Settles (2006) postulated that a Black woman's racial identity may take precedence when in a room of White women while, in contrast, in a room of White men her identity as a woman may become most salient. The data from this study of computing aspirants, while situated in a different academic and social context, indicate similar dynamics.

The uniquely-situated Black woman identity described by study participants defines what is meant by intersectional identities and speaks to the basis upon which Crenshaw (1989) first outlined intersectionality as both a form of identity, and a theoretical framework for understanding how identities interact with and inform one another. Originating from her critique of the American justice system's treatment of Black women’s experience of workplace discrimination, Crenshaw's (1989) original intersectionality framework sought to illustrate how Black women experienced systematic erasure not only within the justice system, but within feminist theory and social justice political organizing and broader identity politics. As a departure from other research studies that aimed to explicate factors that increase recruitment, advancement, and retention in STEM fields among African American women (e.g., Charleston, 2012; Jackson & Charleston, 2012), the data from this investigation illuminates the inseparability and confluence of race and gender in the lives of Black women aspirants in the field of computing. Crenshaw (1989) further wrote, “Because the intersectional experience is greater than the sum of racism and sexism, any analysis that does not take intersectionality into account cannot sufficiently address the particular manner in which Black women are subordinated” (p. 140). Through the theoretical lens of intersectionality, the analysis from the data provided by participants’ own stories within this study exposed academic, social, and institutional barriers that are unique to this population, particularly within the STEM educational trajectory that remains virtually cordoned off in terms of racial and gender demographics.

Utilizing intersectionality theory enabled us to examine the intersectional identities of our participants while addressing the broader social and systemic erasures faced by women living with multiple marginalities in the STEM field of computing. The theory also helps put into perspective how some experiences of marginalization cannot be wholly accounted for within broader and widely-recognized marginalized identity statuses. This theoretical lens enabled us to discover not only how participants' multiple *personal* identities were *internally* formed and understood, but also how participants' multiple identities informed their social interactions. Many study participants had already obtained measures of success through undergraduate and graduate computing-related programs, despite many times being forced to work independently or with their same-race women counterpart in an effort to resist and respond productively to racist and sexist stereotypes. Participants of this study described instances of not feeling welcomed to work with their non-similar peers, including their African American men counterparts. An additional particularly poignant occurrence of such marginalizing interactions was shared by a participant who described being explicitly discriminated against by one of her professors, who told another student that he doubted her talents, and suspected that she received special, undeserved treatment from other professors out of guilt. Despite such experiences, however, the participants demonstrated that they were still able to persist in STEM. More clearly, the educational gains achieved by these participants (re)affirmed their ability to overcome their collective understanding of the challenges of pursuing STEM education as Black and as women. As a result of these challenges, future efforts that aim to address diversity in STEM fields should consider critically the educational climate for diversity, especially ways in which race and gender intersect to create spaces for privilege and oppression.

Recognizing that intersectionality and its definition vary and are research-field-specific, the application of intersectionality theory for the purposes of this study maintained "a consistent thread" wherein the social identities of study participants served as organizing features of social relations that mutually constituted, reinforced, and naturalized one another (Shields, 2008, p. 302). This study confirmed the enduring presence of racism and sexism throughout the STEM and computing science educational trajectory. Although former studies alluded to the proliferation of racism throughout primary, secondary, and postsecondary education (e.g., Jackson & Charleston, 2012), this study presented an unbridled view of the racialized and gendered experiences of African American women in pursuit of STEM education and success. While the sample of focus group participants did not attempt to generalize, their stories illuminate vividly an unwelcoming and socially isolating culture in STEM and computing science in particular. This observation may provide at least part of the rationale for this demographic population's low participation rates in the computing science field.

As a theoretical contribution to higher education, intersectionality introduces the possibility for deeper analyses of identity among members of academic communities. The data from this study reinforces the notion that institutional culture is a significant consideration in the study of underrepresented and underutilized populations. This study also confirms others (e.g., Kvasny, Trauth, & Morgan, 2009) showing that power relations are indeed at the intersections of gender and race within STEM education. The unwelcoming computing landscape asserted by study participants, particularly at PWIs, is significantly more of a barrier at the graduate level of the trajectory (e.g., master's and PhD) than at the undergraduate level, emphasizing the need to redouble efforts intended to broaden participation among differential racial and gender group effects in the design of interventions. More concentrated and specific efforts are needed to ensure equitable and inclusive STEM education environments in order to reverse the trend of lagging attainment of master's and doctoral degrees among women of color (National Science Foundation, 2011).

Implications

There are a variety of implications for practice and policy based on the findings of this study. For higher education faculty and practitioners in STEM fields, a critical examination of personal biases and prejudices toward racial-ethnic minorities and women must occur in order to foster more inclusive STEM environments that broaden and ensure the educational success of *all* STEM aspirants. The complicit nature of the subjugation of African American women students in computing by peers and faculty alike led participants to question their belonging in the field at several points in the STEM education trajectory. As such, interventions that seek to improve the learning environment in STEM-related fields are needed. These may include developing and implementing student/faculty support groups or other efforts intended to create safe spaces where women of color can reflect on negative experiences, practice self-care, develop healthy responses to adversity, and develop a scientific identity that overcomes the negative external influences due to the intersection of race and gender.

In concert with the American Council on Education (2006) and the National Science Board (2012), the present study echoes the national call for broader participation and greater parity of representation among faculty and students of color in the computing sciences and other STEM fields, both within the academy and industry alike. Scholar Mary Howard-Hamilton (2003) suggested research concerning African American women in higher education is well suited for critical race theories and Black feminist thought theoretical frameworks—within and among which intersectionality is widely employed (Collins, 2000; Crenshaw, 1989, 1991). The utilization of these sorts of frameworks for research may help to illuminate ways to create more diverse faculty in scientific fields like computing, which may in turn promote a healthier educational climate that may serve to mitigate the isolating and insensitive culture of these fields, particularly toward women of color. Improving the recruitment and retention of women faculty of color serves to strengthen the pipeline for students who might aspire to enter STEM fields but lack same-race and/or same-gender role models. Broader representation among faculty may increase the likelihood for culturally specific mentoring and advising experiences for Black women that may result in increased entry and persistence in these fields.

The scientific leadership within the United States continues to support efforts to broaden STEM participation. Therefore, it is increasingly important that industry and institutional leaders address the varying needs of the diverse populations whose contributions are necessary in an effort to maintain a strong scientific workforce that enables the United States to remain globally competitive. The viability and effectiveness of current and future intervention programs will be greatly enhanced by recognizing and adequately addressing racial and gender issues affecting matriculation rates into computing science and other STEM-related programs. The merits of this study might be broadened by investigating African American women who did not persist in computing sciences and other STEM fields. Additionally, future research might investigate existing interventions and how they enhance or impede STEM participation by gender and race.

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Correspondence regarding this article should be addressed to LaVar J. Charleston, Ph.D., Assistant Director, Senior Research Associate, and Adjunct Professor, University of Wisconsin-Madison. Email: charleston@wisc.edu.