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BLACK WOMEN IN STEM: REIMAGINING THE ROLE OF INFORMATION SCIENCE AS A PATHWAY TO STEM EQUITY IN THE UNITED STATES

Abstract
The persistent underrepresentation of Black women in Science, Technology, Engineering and Mathematics (STEM) fields is largely attributed to their race and gender. With measures and interventions being continually undertaken to attain race and gender parity in STEM workforce, there is a lack of information science-based approaches in literature and practice. This might account for the less progress and increase recorded in the participation of Black women in the profession. This gap in STEM fields is an issue of national importance that seeks urgent solution. This paper aims to highlight the experiences of Black women in STEM, and implications for policy and practice.

Introduction
The need to increase the participation of Black women in Science, Technology, Engineering, and Mathematics (STEM) fields has been highlighted by many researchers in their various studies. The low representation of women in color in STEM disciplines and careers is an issue of social justice and economic advancement in the United States which will always require constant effort and interventions for the gap to be bridged (Charleston et al., 2014; Ferguson and Martin-Dunlop, 2021). According to Dickens, Ellis & Hall (2021), the lack of ethnic and gender diversity in STEM undergraduate programs in institutions led to the problem of diversity and (in)equity in STEM careers. NCSES (2023) reports that in year 2021, half (51%) of the US workforce consists of women, however, only a third of these women were represented in STEM fields. There was a 3% increase (21% - 24%) in the population of STEM workers from 2011 to 2021 due to the high demand of skilled technical workers; more so, because the United States have made efforts to increase the number of STEM graduates because of the contributions of STEM fields to the nation (Morton and Parsons, 2018). However, men (65%) were more represented than women (35%) especially in the Computing and Engineering profession. Only 9% of the total workforce were Black or African American and only 14% aged between 18- 34years were in a post-secondary STEM disciplines of which half of them were female.

Lots of research, funding, and systemic initiatives have been implemented towards increasing the participation of Black women in STEM fields but despite this, there have not been notable developments (Casad et al., 2020; Ferguson and Martin-Dunlop, 2021). Perhaps, the dearth of literature on diversity, equity and inclusion in STEM from information science researchers limits contributions and interventions from an information science lens towards achieving race and gender parity in STEM fields. This paper lays the foundation to a work-in-progress that explores the STEM gap on the low participation of Black women in STEM detailing their racial and

gendered experiences as major setbacks for success and retention. This paper is significant in exploring the perceptions and challenges of Black women in STEM fields through intersectionality theory to suggest targeted and result oriented approaches using information science methods and theories that will address the marginalization Black women face in STEM, hence, closing the gap by increasing their participation and retention in these fields.

Intersectionality Theory

Crenshaw (1991) posited that the experiences of women of color are often the result of intersecting patterns of racism and sexism and it's almost difficult to get a full picture into these experiences if race and gender identities are viewed separately. The intersection of the two identities is the key to fully capturing the lived experiences of Black women. This theory has been used in many studies to recognize and understand the impact of multiple identities on people's perceptions of others and the experiences that become a product of these perceptions (Charleston et al, 2014; Morton and Parsons, 2018; Dickens et al, 2021). The intersections of race and gender identities bring about the creation of uncommon stereotypes that can't otherwise be gotten separately (Eaton, Saunders, Jacobson and West, 2020). The identities of African American women as being doubly marginalized have always come to the forefront and serve as critical tools to examine social, institutional and organizational structures that directly or indirectly impact STEM fields

Therefore, it is necessary to use the theory of intersectionality to examine the experiences of Black women in STEM fields through the combined lens of their race and gender.

Literature Review

Black women in STEM academic spaces

Women are significantly underrepresented in STEM fields in the academia, and it is much worse for women of color (Casad et al., 2020). Black female undergraduates in STEM majors feel isolated and excluded because that environment was toxic to them; having to grapple with multiple self-identities of which race and gender are in the forefront in a race and gender-exclusive space, and experiencing challenging and difficult situations because of the need to juggle multiple identities at once are some of the experiences of Black women who are trying to get education in STEM fields (Ong et al, 2011; Charleston et al., 2014). Black female students who were Chemistry majors in a predominantly White college experienced racism and sexism in their department (Esposito, 2011). Doctoral and post-doctoral students in an Engineering department experienced lack of Black female Faculty and faced gendered micro aggression (McGee and Bentley, 2017).

On the issue of admission into STEM disciplines, Black women more than White women show interest in choosing a STEM program, but not all actually graduate from college with STEM degrees (Nguyen et al., 2021). In 2016, only 5% of Black women were awarded a baccalaureate degree in STEM while White women consisted of 27% and even less than 5% in recent years (National Science Foundation, 2019). Black women's experiences in the pursuit of STEM programs in colleges play a role in their retention in STEM fields. Black girls in STEM classes in K-12 schools especially in a predominantly White school also experience an environment where they feel ostracized by their teachers comment or when made fun of by their White classmates because they are the only Black girl in a classroom (Morton and Parsons, 2018). Despite all these experiences, Black girls and women develop coping mechanisms to ensure their success in STEM courses and majors (McGee and Bentley, 2017) but the experiences and mechanisms developed do not contribute to a broad participation in the fields.

Racism and sexism among Black women in STEM

As reported by Charleston et al., (2014) on a study of the racialized and gendered experiences of some African American women who were pursuing STEM degrees, several Black women recognize their race and gender identities as the most important factors governing people's interactions with them and upon which assumptions and stereotypes are formed about them especially in the Computer Science field. This perhaps could be responsible for the failure of Black women in Computer Science discipline as popularly known. Many college students pursuing a STEM discipline would usually doubt their competence because the STEM environment presumed them to lack necessary aptitude and ability to succeed because of their color and gender (McGee and Bentley, 2017). Google's 2019 diversity report is evidence of the number of Black women who managed to successfully graduate and continued in the STEM profession. From the 2019 report, only 3% of Google's employees were Black and only 2% of the new employees that year were Black women (Broussard, 2023). As Morton & Parson (2018) surmised, if solutions to systemic and social injustice are race or gender-based, Black women will be "othered" and found at the bottom of the hook. The only way to create solutions for the injustice of Black women in STEM fields is by developing race and gender centered approaches.

Challenges faced by Black women in STEM

The challenges faced by Black women in STEM will be discussed under the following thematic areas that were recurrent in the literature reviewed.

Maltreatment.

The findings of Charleston et al (2014) revealed that challenging and difficult situation as women of color serve as a limitation to their success in their pursuit of STEM education/degrees. Their experiences include maltreatment which they could not ascribe to either their race or gender, but some believed their skin color was the first identity upon which they were (mis)treated. Maltreatment is also inherent when professors or colleagues deny seeing color of their Black colleagues especially when these group of women face a lot of extenuating circumstances because of the obvious reason that others who could make it better deny (McGee and Bentley, 2017).

Assumptions and stereotypes.

There are onset assumptions and stereotypes that people have about Blacks and more unsettling, being a Black woman in STEM (Charleston et al, 2014). For example, a bias that Blacks are supposed to get angry or display some forms of reactions over a conflict; Blacks are intellectually inferior; men are the scientists, etc. Some respondents also face bias that impacted their careers (Allen et al, 2022). Assumptions about Black women's intelligence level usually surface which generate questions about their competence by instructors, PI, and classmates at any show of weakness (Morton and Parsons, 2018). Some STEM scholars who participated in a study that rated candidates in a hiring process rated Black women as less competent and hirable than White or Asian men even though with the same qualifications (Eaton, Saunders, Jacobson and West, 2020). Because of these experiences, Black women in STEM try to prove themselves otherwise by disproving negative stereotypes if they are going to maintain or be deemed qualified for a position in that field.

Unwelcoming environment/culture.

Black women in the Computer Science discipline reported that their class culture was not welcoming to them as women and even more ostracizing to Blacks (Charleston et al, 2014). They were faced with feelings of exclusion and doubts from people about their academic intelligence and abilities. Others reported having an alienating classroom experience and a cold environment which caused them to nearly make the decision to quit their STEM programs (Allen et al, 2022).

Unsupportive relationships.

Lack of good and positive relationships both with class instructors and colleagues were the experiences of some respondents who transferred to a university from a community college (Allen et al, 2022; Wong and Copsey-Blake, 2023). There was a lack of connection among colleagues in the university unlike the community college. For a few of them, in comparison to their teachers in community college, the course instructors in the university did not foster a good relationship between them and the course design and instruction method brought about negative experiences.

Implications for Information Scientists and STEM policy and practice

Various factors contribute to the low participation of Black women in STEM, but race and gender are major contributors that determine success and retention in the fields. Racial bias in technology, access to data, and other elements of digital divide are less obvious congruent factors that contribute to the racial and gendered equity in STEM. Researchers have used models and theories such as Critical Race Theory, Black Feminist Theory, and Resiliency Theory to propose solutions to this problem but there is a lack of information science theories used. I propose using models and theories from the information science discipline to give a holistic inquiry into this problem and propose actionable approach and strategies to close this STEM gap. To this end, information science researchers should explore patterns in the information behaviors of successful women in STEM disciplines and careers to identify interrelationships between these behaviors that will be beneficial in creating strategies that will encourage participation and aid the success of Black women in STEM fields (Lee, Ocepek, and Makri, 2021).

Directions for Future Research

The low participation of Black women in STEM careers is the result of the underrepresentation of Black undergraduates' women in STEM disciplines. To further understand the low participation and retention of Black women in STEM higher education, future studies should examine factors underlying recruitment methods and criteria set by universities admission board, especially considering the 2023 supreme court ruling against race being used as a factor for admission purposes. To establish evidence on the importance of creating inclusive admission strategies and decisions for STEM programs, more research need to be done on the relationship between social and family background of Black girls and women, and their STEM experiences.

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