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"Diversity is key for success": Why engineering needs more BAME women - an exploration of the underrepresentation of Black women in Science, Technology, Engineering and Maths (STEM) careers and education

Abstract

This paper explores the underrepresentation of Black women in Science, Technology, Engineering and Maths careers and education, making the argument that engineering would benefit from the inclusion of more women from Black, Asian and Minority Ethnic backgrounds. Arguing that diversity is key for success, the author reviews and critiques the key theories of intersectionality and Critical Race Theory. Concluding that racism and sexism remain relevant issues in society, the author calls for categories of oppression (including race and sex) to be considered collectively. In doing so, the author argues for the value of adopting an intersectional approach in the study of diversity.

Key words: Black women; Diversity; Engineering; Gender; STEM

Introduction

In July 2020, *The Guardian* published an article based on a statement that "diversity is the key to success" by Jeanne Lantz (Manning, 2020), concerning gender, ethnicity and race in Science, Technology, Engineering and Mathematics (STEM) education and careers. This article revealed that women are under-represented in STEM careers. However, this is only one aspect of the problem; Manning (2020) discusses how 8.1% of men and women working in engineering were from Black, Asian and Minority Ethnic groups. Although careers in

STEM fields are key to the future, Black women remain underrepresented (McGee and Bentley, 2017). In this paper, I critically analyse gender and race issues in the STEM sector and consider how gender and ethnicity intersect with other categories in educational experiences and/or attainment, focusing on Black women.

Considering the context *of The Guardian,* Baker (2012) identifies the paper as a liberal broadsheet. Pew Research Center (2014) states 72% of *The Guardian*'s readers hold left or left-of-centre political values. Smith (2019) gives insight on these views, outlining that 77% of left-wingers positively view the multiculturalism of Britain. Notably, *The Guardian* has been commended for its coverage of sensitive issues such as Islamic extremists, and recommended as a benchmark for other newspapers (Baker, 2012). Denver (2003) highlights national press in Britain is notably partisan, deliberately sided with a particular political party or candidate. Seymour-Ure (1974) contended "press-party parallelism" has to be recognised as a scale ranging from strong to weak affiliation, and reflecting patterns of party ownership of the press influencing editorial policy and the party affiliations of readers. In order to achieve democracy, individuals must respect those opposing them, however Levendusky (2013 p. 565) reports partisans distrust "not only elites of the opposite party, but even ordinary partisans of a different stripe".

Before one can suggest any solutions to achieve diversity, we must understand the obstacles and limitations of Black women in STEM fields. When investigating the validity of the claims that Black women are underrepresented, Critical Race Theory (CRT) cannot be ignored. Themes of CRT are evident in *The Guardian's* newspaper article as Manning (2020) contends that the challenges faced by women are often "multiplied for women of colour, who are typically held to stricter standards of competence than whites and are less likely to be recognised for their skills". From a CRT standpoint, race is considered as ordinary, highlighted in the definition of White supremacy. hooks

(1989) presents a discussion of white supremacy outlining when racism ceased to be a term which outlined the exploitation of a person of colour. When liberal whites do not recognise methods and the implementation of these views, it supports domination and oppression, even though they do not support racism. Gillborn (2005) observes how hooks (1989) explores further than most conventional limited viewpoints on organisations, which are profoundly racist, adding how they draw focus to more normalised robust variations of white supremacy.

Additionally, Bell (2004) presents "interest convergence" drawing attention to the notion that "blacks" reaching equality racially is only adapted to when there is interest from powerful "whites". Bell (2004) encapsulates the idea as the following- Justice for blacks vs. racism = racism and Racism vs. obvious perceptions of white self-interest = justice for blacks. In Bell's (1992) parable *The Space Traders* concerned with an invasion of aliens who propose to solve fiscal, environmental, and energy needs in exchange for all persons of African descent in the planet. Primarily, considerable numbers of white individuals objected to this, happy to exchange the quality of life, lives and liberty of African Americans, in exchange for their own needs, such as education. As a result, it is evident that white Americans for their own personal gains, are willing to sacrifice the wellbeing of black individuals, economic and legal structures which promote white privilege sustain the ostracisation of "blacks" (Taylor, 1998). Rosa and Mensah (2016) stress within STEM how underrepresentation of Black women converges with the dearth of trained scientists. Governments providing funding, for example, result in giving Black women the support they need to persist in STEM. This emphasises the fact that advances in race are only established when benefiting white elites, restricting civil understanding, and protecting against fundamental changes (Gillborn and Ladson-Billings, 2010).

Uniquely, storytelling is identified as a key aspect within CRT, evident in Ladson-Billings' (1998) recitation of their experience in a VIP lounge. Ladson-Billings (1998) described how she sat reading a newspaper, dressed for success after a lecture in a university, when a white man arrived in with a pronounced southern accent, asking when she would be serving him. West (1992) responded claiming this story highlights the effectiveness of storytelling and how race is still a factor. Delgado (1989) also supports the success of storytelling in showcasing different readings of the world, prejudices, and masked racism.

Similarly, King and Pringle (2018) write of a young black girl's experience with Science, describing the mundane nature of the class, where she just took down notes, which is typical for students in public schools who are underrepresented in Science. Basu and Barton (2007) and Mensah (2013) support this view, stating that students of colour attending public schools, particularly in economically challenged areas, find science boring and confusing. As diversity among schools is continuously increasing, it is essential students are afforded equal access to adequate education (Horsford, 2011; Juárez & Hayes, 2010; 2012). Furthermore, in STEM this diversification can contribute to new insights and interpretations that further advancement in these fields (Meador, 2018). Although there are higher percentages of students achieving in Science and Maths, data reveals that advancement is slow (Corbett, Hill and St Rose, 2008).

Although the origins of CRT are in legal studies, it has been more recently applied to education and the examination of women in STEM (Ladson-Billings and Tate, 1995). Dixson (2017) cites Anderson (1988) who claims fights for equality originated in hush harbours during slavery with enslaved Africans learning to read and write. These fights now have emerged into city centres for education equality (Dixson, Buras and Jeffers, 2015). Racism presents, for example, in distribution of materials, inclusive teachers and education resources

(Gillborn, 2008). Regarding this, colour blind approaches are evident, which do not recognise the realities of race and focus on merit which is determined through testing. This ignores that black children are less likely to achieve high grades, which is influenced by factors such as educational resources at home (Ladson-Billings, 2006). Therefore, they are less likely to present in STEM jobs. Additionally, it is argued that educational curriculums contain white supremacist themes; Swartz (1992 p. 341) contends: "Master scripting silences multiple voices and perspectives, primarily legitimizing dominant, white, upper-class, male voicings as the "standard" knowledge students need to know. All other accounts and perspectives are omitted from the master script unless they can be disempowered through misrepresentation. Thus, content that does not reflect the dominant voice must be brought under control, mastered, and then reshaped before it can become a part of the master script". Sociocultural research in science education has shown the ways in which the culture of Science is aligned with social norms of White, middle-class, heterosexual males (Brickhouse, 2001; Hussenius & Scantlebury, 2011), thus potentially privileging students who enter Science classes with these attributes (Ko et al., 2013; Ong et al., 2011).

Contrastingly, when critiquing the CRT agenda Dixson and Rousseau (2005 p. 269, citing Ladson-Billings, 1999 and Tate, 1999) have advised CRT scholars about moving at too fast a pace from the original legal studies, which should be elaborated on. Additionally, Cole (2009) believes CRT views all white people as racist, supporting white supremacy which is mainly based on the stereotype and how it ignores racism against those who do not have dark skin.

As well as CRT, Manning (2020) reveals intersectionality as a barrier for Black women, believing the influence of the interconnections impact decisions about whether to pursue careers in STEM. Crenshaw (1991) coined the term intersectionality to conceptualise the intersection at which race and gender interact to create disadvantages

to oppress Black women; Crenshaw (1991) uses her own experiences of racism and sexism to help others going through similar experiences, linking back to the importance of storytelling. Gillborn (2008) defines how race, gender, age, nationality, disability for example, interconnect in numerous diverse aspects as encompassing all axes of differentiation and oppression.

The continuing debate surrounding intersectionality should be acknowledged; some have celebrated it as a theory or grand meta-theory (Davis, 2008). Contrastingly, others have accentuated it as a metaphor (Crenshaw, 1991). Walgenbach (2010) adds a proportion of intersectionality advocates contended that it represents a new paradigm for the scientific community and therefore foresee it as a positivist approach. Intersectionality's lack of methodology has both been celebrated and critiqued. Nash (2008) points out that ambiguity surrounding methodological inclusion leads to additional problems. Furthermore Erel et al. (2010) claim that focusing on categories can pose difficulties when theorising their relationships. Cho et al. (2013) announce that rather than debating what intersectionality is, we should focus on what it does, specifically focusing on its intentionality and performativity, which is useful for intersectionality issues today.

Interestingly, Ahmed (2007) notes that concepts and theories do not always perform in the ways in which they claim, emphasising significance of understanding non-performativity and claims critiques should always be explored, as claims cannot replace the act of the critique. It has become increasingly represented as having emerged from within the field of Gender Studies, although in fact it emerged from Black feminist traditions and Third World Liberation. This critique has been made prominent by Bilge (2013) and Carbin and Edenheim (2013), who identify themselves as poststructuralists. Salem (2018) highlights Foucault (1970) claiming that placing intersectionality's openings within Gender Studies, exposes that intersectionality has

been 'whitened' erasing beginnings in Black feminist histories and Third World Liberation movements.

The status of women of colour in STEM was first presented in the publication The Double Bind: The Problem of Being a Minority Woman in Science (Malcom, Hall and Brown, 1976). Alongside intersectionality came the term "double binded" - Ong et al. (2011) outline this as the unique challenge minority women face as they simultaneously encounter sexism and racism. Charleston (2014) outlines how this presents itself 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, but also with their gender identity in an environment historically dominated by White and Asian males (Jackson and Charleston, 2012; Brown, 1997; Johnson et al., 2011). It has been suggested that Black women's success in STEM may centre on the growth of an identity that is compatible with their gender, racial identities and academic interests (Borum and Walker, 2012; Espinosa, 2008; Johnson et al., 2011; Ko et al., 2013). While the expansion of strong intersectional identities have been recognised as cultural and societal factors in development critically (Rosenthal et al., 2011), the intersections of Black women's racial, gender, and scientific identities may conflict with messages Black women and girls receive throughout educational, abilities succeeding in STEM. Various studies have shown Black women Science learners face doubts about their intellectual abilities as a consequence of racism and sexism in science learning spaces (Coker, 2003; Charleson et al., 2014; Carlone and Johnson, 2007).

Moreover, from a young age, girls tend to be alienated by Science (Brickhouse, Lowery and Schultz, 2000). Brickhouse et al. (2000) outline an accumulation of factors such as pedagogical techniques and Science curricula which negatively influence Black women's ability in developing and preserving education and careers in STEM. Additionally, outside the classroom, other factors can negatively

impact Black women's interests in STEM. Research supports this stressing that Black girls are less likely to be exposed to Computers and Technology in younger years, contributing to restricting their preliminary interest in STEM (Fisher, Margolis and Miller, 1997; Margolis et al., 2011). King and Pringle (2018) cite Morris (2007) who reported in middle-class schools a corrupt perception of Black femininity with girls being judged as inadequately feminine as they do not conform to models of womanhood. This discrepancy between cultural practices and school norms influences marginalisation within their science classes (Nasir et al., 2012).

Furthermore, as Black women are less successful in Maths and Science in younger years, they are left underprepared to achieve success in STEM at undergraduate levels (Espinosa, 2008; Johnson et al., 2011; Perna et al., 2009). At undergraduate level, studies identify how social and academic factors affect Black Women's persistence in STEM with Black women being less likely to complete their STEM studies, because of a range of issues including social, academic and financial difficulties (Buzzetto-More et al., 2010; Charleston, 2012; George et al., 2001). Additionally, Palmer, Maramba and Dancy (2011) identify their feelings of alienation in STEM classes. Essentially, the underrepresentation of Black women in STEM is a result neither of competency nor interest, rather of education systems disengaging, under educating and utilising Black women (Farinde & Lewis, 2012; Johnson et al., 2011; Ko et al., 2013).

Regarding gender individually, women face sexism within STEM. This view is supported by Okeke (see Manning, 2020) as he states: "The truth remains that women are under-represented in engineering and technology". Modern scholars utilise the term gender, describing assumptions, norms and beliefs attributed to men and women from society, grounded in the perceptions of masculinity and femininity. Gender is thought to be "constructed" within a culture, often contrasted with "biological sex", referring to genetics and anatomy characterising

and differentiating men from women. Gender is real, however unbalanced due to redefining and reinterpretations within societies and intersecting with other categories (Perry, 2016). There are many clear findings examining women in STEM, such as a the gender pay gap (Beede et al., 2011) and the fact that college-educated women are much less likely than men to major in STEM fields. Even when women choose STEM degrees, their typical career paths diverge substantially from males. McGuire et al. (2020) cite WISSE (2018) who reports that women make up 22% of the STEM workforce in the UK. Men are more likely to have non-STEM management jobs than women; contrastingly, female STEM majors are twice as likely as men to work in education or healthcare (Beede et al., 2011).

Moreover, stereotypes surrounding STEM correspond with Western masculinity (Carli et al., 2016). Gender stereotypes initially emerge in childhood (Cvencek, Meltzoff and Greenwald, 2011) influencing success; engagement; motivation and how children categorise and compare themselves to their peers concerning STEM (Liben & Bigler, 2002; Renno & Shutts, 2015). When children recognise categories, broader interactions with adults reinforce stereotypical behaviour (Ruble, Martin & Berenbaum, 2006). Children from two years of age understand gender labels (Ruble et al., 2006) forming ideas about gender groups (Mulvey, Hitti and Killen, 2010). From ages three to five, children show less support for their peers who speak of counter-stereotypical STEM career choices, such as a girl wanting to be an engineer (Mulvey and Irvin, 2018). Stereotypes are subsequently reinforced by the considerable presence of male STEM teachers and classroom gender composition (Riegle-Crumb, Moore and Buontempo, 2017).

Such gender stereotypes are reinforced and perpetuated in broader society and STEM workplaces, threatening both career choices and length of time in jobs (Beasley and Fischer, 2012; Cundiff et al., 2013). Evidence suggests scientific ability is viewed as gender innate

(Mascret and Cury, 2015) and men are view as being born to succeed in STEM, thus damaging women's career motivation and STEM self-efficacy (Cundiffet al., 2013; Schuster and Martiny, 2017; Garriott, Hultgren and Frazier, 2017). In reality, meta-analytic evidence suggests that girls and boys do not, in fact, perform differently in STEM categories, such as Maths (Lindberg et al., 2010).

Additionally, stereotypes are reported to influence women's association with feminine characteristics such as wearing makeup (Hewlettetal, 2008). Banchefskyetal et al. (2016) note if women cannot freely express with regards to their femininity it will remain the status quo and reinforce masculinity. A study by Hartman and Hartman (2008) revealed 70% of engineering students reported problematic perceptions of women in the field. Banchefsky et al. (2016) add when women challenge these stereotypes they are deemed as less likeable, feminine and incompetent.

Consequently, feminist theory should be acknowledged when exploring gender issues in STEM. Adichie (2014) outlines feminists as individuals supporting equality socially, politically and economically for all. Sexism within STEM manifests itself in the belief that males are superior and dominant (Lorde, 1984). Second wave feminists such as Betty Freidan broadly discuss women's discrimination. The second wave of feminism sees a shift from the idea of women as mothers and carers, to their equality with men, replacing maternalism and political ostracism (Franceschet, 2004). Friedan's own life experiences influenced her role of a feminist activist, notably her work as a labour journalist complicates the typical portrayal of Friedan as a liberal feminist with a middle-class focus (Henderson, 2007).

hooks (1984) presented a new definition of feminism, outlining women should fight for men's equality also, irrespective of class, race or imperialism, aiming to end oppression and exploitation as all forms are inextricably intertwined. Freidan claims activities such as housework

make it impossible for women of adult intelligence to achieve human identity; hooks' critique of this influenced her definition (hooks, 1984). hooks (2000) argues that women can be as sexist as men, not excusing men, but identifying the erroneous nature of projecting the movement as being against all men.

Conclusion

To conclude, an article published in the far left leaning *The Guardian* stated 'Diversity is key for success': why engineering needs more BAME women (Manning, 2020). This paper delineates how success cannot be achieved, as evidently diversity and equality is not currently accommodated. Focus was shifted to the foundations of the discrimination and underrepresentation of Black women in STEM, to unpick the claims before a clear link was drawn to theories surrounding gender, race and intersectionality to support the validly of underrepresentation claims. Additionally, inadequate inclusion of diversity has been identified. The key takeaway idea is that racism and sexism are still relevant issues in society and rather categories of oppression should not be individually explored, but collectively acknowledged with their intersections.

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