FEATURE ARTICLES

Interrogating Structural Racism in STEM Higher Education

Ebony Omotola McGee[1]

The racialized structure of STEM (science, technology, engineering, mathematics) higher education maintains gross inequities that are illustrative of structural racism, which both informs and is reinforced by discriminatory beliefs, policies, values, and distribution of resources. Thus, an examination into structural racism in STEM is needed to expose the marginalization of underrepresented groups in STEM and to improve understanding of the STEM policies, practices, and procedures that allow the foundation of racism to remain intact. I argue that, even at the top of the education hierarchy, Black STEM doctorate students and PhD degree holders consistently endure the racist residue of higher education institutions and STEM employers. Thus, this manuscript also discusses how universities institutionalize diversity mentoring programs designed mostly to fix (read "assimilate") underrepresented students of color while ignoring or minimizing the role of the STEM departments in creating racially hostile work and educational spaces. I argue that, without a critical examination of the structural racism omnipresent in the STEM, progress in racially diversifying STEM will continue at a snail's pace.

Keywords: cultural analysis; disparities; doctoral; engineering education; entrepreneurship; HBCUs; higher education; mentoring; minoritized; race; STEM; structural racism; technology

Underrepresented and racially minoritized (URM) people in the United States—Blacks/African Americans, Latinxs/Hispanics,[1] and Indigenous peoples (e.g., American Indians/Alaska Natives, Native Hawaiians)—are some of the biggest consumers of computing and technology innovations, yet they do not own a large-scale computer company, social media company, or an aerospace company, to name a few.[2] So why, when URM people play virtually no role in the ownership and leadership of such companies, are they such avid consumers? Why do diversity campaigns and outreach efforts by STEM (science, technology, engineering, mathematics) industries' largest companies and trade groups position employment in their firms as the goal for URMs, rather than creating pathways to ownership? What role do these companies play in (un)intentionally stifling URMs' pathway to becoming thought leaders in the STEM industries? Furthermore, why has the percentage of URMs employed in the largest computing and technology companies increased only slightly, despite the companies' diversity outreach efforts? My attempt to answer these questions took me on an exploration into the foundation and structures of the STEM fields, particularly how racism operates in the experiences, ideologies, practices, and policies of STEM training programs. This historical structural analysis is a departure from many analyses on the lack of racial diversity in STEM graduate education and employment, which generally is explained using the pipeline analogy that translates into the rationale that too few racially diverse people in STEM educational trajectories results in the lack of diversity in STEM fields (Cannady et al., 2014).

Dr. Lou Matthews (2016), former minister of education in Bermuda, argued that the pipeline analogy is an insult to pipelines, which flow with much less dysfunction than this passive metaphor implies. How do these same "pipes" work well for Whites and some Asian/Asian American groups while simultaneously creating treacherous pathways for URM groups? In the past 40 years, more than 135,000 academic articles have discussed the STEM pipeline in some form or another, including almost 14,000 about the *leaking pipeline that causes "minorities and women" (this widely used metaphor largely ignores minoritized women of color) to "leak out", of STEM somewhere along their educational or employment trajectory (Garbee, 2017).* This metaphor, used prominently in a host of government-sponsored reports and education policies since the early 1990s, has led to patchwork solutions and simplistic remedies for STEM attainment. There has been less emphasis on the key gatekeepers

[1]Vanderbilt University, Nashville, TN

Educational Researcher, Vol. XX No. X, pp. 1–12
DOI: 10.3102/0013189X20972718

at each stage of the STEM pipeline: high school guidance counselors, standardized tests, high school algebra (a key STEM gatekeeper course), gifted programs, advanced placement, and the ethnic/racial makeup of STEM teachers and college faculties and the STEM workforce (Cannady et al., 2014). Only a scant number of publications has challenged the metaphor and the myth of the STEM pipeline (e.g., Cannady et al., 2014; H. Metcalf, 2010), and these efforts do not challenge the anti-inclusive design of STEM education and participation that at its core is structurally racist. After all, White men constitute about half of the scientists and engineers employed in science and engineering occupations. If we include Asian men, the percentage rises to 66%, and when we add White and Asian women to that group, the number skyrockets to 88% (National Center for Science and Engineering Statistics, 2019).

This article postulates that STEM education and occupations are designed to attract White men who are heterosexual, abled-bodied, Christian or atheist, middle-class and above, and that the curriculum and the culture have created an inhospitable culture for students, faculty, and employees who are assumed not to fit these criteria (Allen, 2017). Thus, URM students have the choice to try to emulate or embody hegemonic values, navigate an environment that is hostile to their identities, or leave the field (Turk-Bicakci & Berger, 2014). Those who do attempt to navigate it are forced to cope with and manage their suffering, over and over again (McGee et al., 2019).

Using examples of how structural racism manifests in STEM, I detail the limits of interventions that center predominately on equipping, changing, and fixing the student, rather than on doing the more challenging work of assessing the ways institutions and departments are perpetrating racism and other "isms" in STEM, which leaves these structures under- or unexplained (McGee, 2020). The interventions implemented most frequently are mentoring programs, which undeniably have a direct impact on the retention of URM students in STEM. However, a majority of mentoring programs fall short in terms of recognizing, let alone acknowledging, the structural racism that is so pervasive in STEM academic and industry contexts (National Academies of Sciences, Engineering, and Medicine, 2019b).[3] Arguing for the need to move from mentoring that prepares students to assimilate into a flawed and biased system to supporting systems that are more racially affirming, I profile historically Black colleges and universities (HBCUs) that have significantly added color to the STEM landscape and thus are challenging racist structures and changing the face of STEM. Despite the tremendous benefits HBCUs provide, I explain why leaving this work to these institutions, which are matriculating Black STEM students without sufficient resources and opportunities, stops short of dismantling the inequity and the historical and structural racism prevalent in STEM.

Rationale for a Structural Perspective of the Underrepresented and Racialized in STEM

Theoretically, I draw from race-based frameworks that are deeply and systemically linked to the dynamics of education, and more specifically to educational inequality and discrimination in STEM. These approaches complicate the roles that racism plays in education, including understanding the interplay between everyday racism (e.g., Essed, 2002), institutional racism (e.g., Murji, 2007), structural racism (e.g., Bonilla-Silva, 2015), and color-blind racism (e.g., Bonilla-Silva, 2018). Everyday racism is an ideological construction that has social ramifications for how power is structured in our society, which informs the use of biological and cultural factors to determine a group's supposed attributes, or lack thereof. Everyday racism also views race as structural because of the dominance along racial and ethnic lines that is widely reproduced through U.S. laws, policies, regulations, and rules that are based on philosophically inequitable principles. Everyday racism situates race in the everyday practices that confirm the power structure and the ideologies that define what it means to be raced. These practices are adapted to changing social, political, and economic conditions (Essed, 2002).

Institutional and structural racism directly challenge meritocracy, including the recent push for race-neutral policies, and attempts to dismantle affirmative action programs and civil rights laws. Institutional racism includes discriminatory treatment, unfair policies, and inequitable opportunities for URMs that are perpetuated by institutions such as schools, corporations, etc. (Zambrana et al., 2017). Institutional actors use the power of the institution to perpetuate advantage and disadvantage based on race and other social identities. Ideological narratives supporting unrelenting competition, survival of the fittest, meritocracy, grit, individualism, working to fatigue, compromising one's well-being as normal and expected Eurocentric characteristics of hard-working STEMers, thereby reinforcing these STEM systems of White privilege and URM group marginalization (McGee, 2016).

The far-reaching consequences of structural racism affect most domains of American society, such as healthcare, housing, education, employment, earnings, benefits, credit, media, politics, and criminal justice (e.g., Bailey et al., 2017; Groos et al., 2018; Milner, 2020). Institutional racism in educational settings often goes unnoticed. The practices that breed institutional racism are part of day-to-day operations that are widely accepted without consideration of how they privilege certain groups while oppressing, marginalizing, and silencing historically marginalized groups. Examples of how institutional racism becomes methodized include state HBCUs receiving disproportionately less funding than their historically White counterparts (detailed later in this article); the norms, values, and perspectives that influence an institution's laws, policies, and systems of evaluation, which often are founded and maintained in keeping with Eurocentric thought and White supremacy; and the disproportionate number of White males who are board members, endowed chairs, and have college buildings named for them. In contrast, when Black and Brown students raise issues of equity they often are labeled as radical activists, come under surveillance, and may be sanctioned or even blacklisted (Gardner, 2019; Jackson, 2019).

Bonilla-Silva (2015) describes structural racism as

> a network of social relations at social, political, economic, and ideological levels that shapes the life chances of the various races. This structure is responsible for the production and reproduction of systemic racial advantages for some (the dominant racial group) and disadvantages for others. (the subordinated races). (p. 1360)

Bonilla-Silva (2001) offers an alternative interpretation of racism as racialized "societies in which economic, political, social, and ideological levels are partially structured by the placement of actors in racial categories or races" (p. 37). His call for researchers to spend less time studying racial attitudes and individual acts of racism and more time interrogating the mechanisms that produce and reproduce inequities has led to a more robust understanding of the historical, institutional, and structural forces that shape the everyday systems of privilege and inequality for advantaged and marginalized groups, respectively (Bonilla-Silva, 2018).

Bonilla-Silva and Dietrich (2011) contend that colorblind racism is an institutionalized and structured system that minimizes the force of racism and to some make racism a past-tense system. Colorblind ideologies nurture and promote notions of unhealthy forms of resilience while our social, political, and education systems continue to abuse and neglect URM bodies and minds (Bonilla-Silva, 2015). These ideologies enable racism to go uncontested in situations where such social inequalities are easily justified if challenged, while calls for racial justice were until just recently considered taboo and even trite (Bonilla-Silva, 2015). Relying on a hierarchical system of inequitable distribution, these forms of racism protect a racist education system by silencing or minimizing the effects of racialized social systems in which economic, educational, political, and social ideologies routinely advantage White people while producing adverse outcomes for URM groups (Bonilla-Silva, 2018).

STEM Higher Education: Founded on Eurocentric Ideologies and Exclusion

U.S. higher education has traditionally structured its system and pedagogical praxis around a Eurocentric epistemology that focuses on developing only the "best and brightest" minds. Postsecondary institutions participate in a complex network of discriminatory and biased practices that subordinate URMs' culture and language, as well as their educational, social, economic, and political positions. Moreover, this institutional framework connects racialized systems and structures with the lives and academic pathways of URM students. A great many fields in higher education emerged from a White male supremacy paradigm that reflects ideas about non-White peoples' genetic inferiority and advances White hegemony (Freedman & Ferri, 2017; Roberts, 2013). This includes eugenics, a late-nineteenth and early twentieth-century development that identified "desirable" and "undesirable" racial stereotypes under the guise of science. Eugenics advocated the intentional and selective mating of people with desirable Eurocentric traits to "breed out" undesirable characteristics, for example, Black skin or disabilities, which eugenicists thought led to poverty and criminal behavior (David & Derthick, 2017). In the words of White supremacist David Lane, eugenics sought to "secure the existence of our people and a future for white children" (Serwer, 2019). U.S. postsecondary institutions acted on eugenic principles when they excluded underrepresented ethnic groups from producing or being acknowledged as producers of scientific knowledge (McGee & Robinson, 2019).

STEM departments' legacy of exclusionary practices continues to shape toxic and discriminatory educational experiences for the URM ecosystem, that is students, staff, faculty, and administrators (McGee, 2020), that become evident through the voices of those who inhabit these racially hostile STEM spaces. They illuminate themes that emphasize the racially hierarchical nature of postsecondary STEM that honors Whiteness, masculinity, and (upper-)middle-class knowledge (Battey & Leyva, 2016; Mutegi, 2013). Madden et al. (2019) succinctly characterize STEM as an instantiation of White institutional space:

> Such spaces are characterized by (1) the exclusion of those who are not white from positions of power, (2) the development of a white frame that organizes the logic of these institutions and normalizes white racial superiority, (3) the historical construction of a curricular model based on the thinking of white elites, and (4) the assertion of knowledge and knowledge production as neutral and unconnected to power relations. (p. 74)

Structural racism in STEM often manifests as meritocracy and colorblindness (Basile & Lopez, 2015; Brunsma et al., 2017). Colorblindness diminishes or attempts to negate the realities of systemic racism (Bonilla-Silva, 2018), which plays out extensively in STEM spaces. Traditionally marketed as a competitive and meritocratic field, research has shown that there is more bias in STEM professions than their non-STEM counterparts (Leath & Chavous, 2018; National Academies of Science, Engineering, and Medicine, 2016). STEM is also known to have a survival of the fittest culture that deemphasizes both structural racism and students' raced and gendered identities, thus implying that students' success is due solely to individual "intelligence" (M. J. Williams et al., 2019). This approach is convenient for universities because it puts most of the weight for the recruitment and retention of URM STEM students on the consequences of a mythical pipeline and ignores the role racialized bias plays in their STEM departments and programs, thus labeling URM students as deficient and blaming them for their lack of representation (Baber, 2015; Malcom & Malcom, 2011; McGee & Robinson, 2019). Structural racism perpetuates racial disparities at the highest levels of STEM achievement, which helps to explain why URMs who hold STEM degrees leave the STEM workforce disproportionately more than their White and Asian counterparts (Turk-Bicakci & Berger, 2014).

Countless scholars have detailed the consequences of being raced and of gendered racism in STEM for URM students and faculty (Brown et al., 2017; Bullock, 2017; Martin, 2019). Much of the research on and discussion of the plight, experiences, and outcomes of URM students in STEM education have centered on personal experiences of discriminatory behaviors and practices. STEM researchers, including myself, have detailed countless incidents of racial microaggressions, racial stereotyping, and other forms of racialized bias in our field (Alexander & Hermann, 2016; Brown et al., 2016; Mutegi, 2013). Many studies outline the omnipresent racial stereotypes that devalue the intellectual ability of URMs in STEM departments but give less attention to the discriminatory culture of their STEM departments that exacerbates the consequences of being racialized (Carter et al., 2019; McGee, 2016). However, this is only half the story of structural racism in STEM.

Material Consequences of Structural Racism at the Highest Levels of STEM

Although there is traditionally more admiration and intellectual respect associated with doctoral students and degree holders at the top of the academic hierarchy, racially underrepresented STEM doctoral students and PhD holders continue to endure a host of structurally discriminatory practices and policies in university STEM departments. The lack of diversity at the graduate level in engineering is an even greater problem than at the undergraduate level. The number of master's and doctoral engineering degrees conferred upon URMs increased from 2011 to 2016 but had little bearing on diversity among engineering graduate degree holders (Anderson et al., 2018). To provide a bit of context, the number of all students earning doctoral degrees in engineering has grown from 7,812 in 2010 to 12,156 in 2018, an increase of 29.73% (Roy, 2019). However, the disparity in the number of URM students earning this degree continues. From 2009 to 2018, enrollment of Asian engineering doctoral students increased from 13.2% to 13.9%, Hispanic from 3.8% to 6%, and foreign nationals from 55.1% to 58.3%. In this period, African American engineering doctoral student enrollment had both the lowest percentage and the smallest increase, from 3.8% to 4.2% (Anderson et al., 2018).

Critical understanding of structural racism can elucidate why Black STEM PhDs are the most likely to leave the STEM industries (21%, compared with 17% of Whites, 14% of Asians, and 14% of Hispanics; Turk-Bicakci & Berger, 2014). One in six STEM PhDs pursues a career outside the field, with Black people and women most likely to do so; these two groups experience higher unemployment and lower salaries than White and Asian men with similar academic backgrounds (National Center for Science and Engineering Statistics, 2019). A recent study by the Pew Research Center calculated the median earnings of Blacks ($58,000) and Hispanics ($60,758) working in STEM occupations, which is less than those of Whites ($71,897) and Asians ($90,000). Using four cycles of data (2003, 2006, 2008, 2010) from the National Science Foundation's Survey of Doctorate Recipients, Campbell and Adamuti-Trache (2016) found that the mean salary of White men in 2010 was $99,400, with White women earning $85,900, male URMs $95,300 and female URMs $78,800. And finally the National Science Foundation's National Center for Science and Engineering Statistics, Scientists and Engineers Statistical Data System reported a $30,000 salary disparity between Asian and Black science and engineering PhD holders (Table 1).

However, the analysis above, while critically important in understanding the wealth gap for the Black middle class (Darity et al., 2020), does not fully explain the treacherous plight of URMs' participation in STEM. For example, URM STEM PhDs graduate with more debt than their White and Asian counterparts; within the past 10 years, the rate of African American doctoral degree recipients in the STEM fields who accrued any debt was more than 20% higher than the rate of non-URM recipients who accrued any debt (49% vs. 27%). Furthermore, among STEM PhD graduates, URMs were more than twice as likely as non-URMs (25% vs. 10%) to report student loan debt in excess of $30,000 (Zeiser et al., 2013). Among URMs, Black doctoral students and graduates disproportionately endure the most devastating consequences. For example, Black PhDs take longer to complete a STEM doctorate than Hispanic doctoral students, who in turn tend to take longer than non-URM PhD students (Maton et al., 2016).

Multiple research findings reveal that Black PhD STEM students experience elevated stress levels as they attempt to cope with the racialized and oppressive environments in which they earn advanced degrees (Burt et al., 2018; Burt et al., 2019; Niemann & Sánchez, 2015). Consistent with prior research on role strain and John Henryism (i.e., trying to overcome a chronic stressor by working harder), McGee et al. (2019) found that seeking success in training, employment, work, or career was more important to these Black graduate students and postdocs than safeguarding their mental or physical health. The participants' focus and sacrifice may have helped them complete their degrees, but these strategies exacted a psychological, emotional, and physical toll. Black STEM PhD students experienced (a) stresses and strains that made them question their qualifications; (b) racialized experiences that were often the source of stress, strain, and academic performance anxiety; (c) discordance between the racial makeup of their academic environments and their racialized engineering and computing identities, which appeared to exacerbate impostor phenomenon; and (d) proactive racialized coping mechanisms that took an emotional toll and fostered feelings of self-doubt (McGee et al., 2019). Thus, identifying supportive environments where Black STEM PhD students can thrive and not just simply suffer through the doctoral process is critical to their retention moving into STEM career trajectories (Ireland et al., 2018; Jones et al., 2015).

STEM Diversity Mentoring Programs Position URM Students as in Need of Fixing

Much of the programming dedicated to support URM students includes mentoring to increase their advancement and retention.[4] Other components, such as stipends, research/internship opportunities, and opportunities to attend conferences and present research, are often touted as crucial because they increase students' self-efficacy in their academic domain. What scholars argue is most critical in terms of promoting URM students' long-term commitment to and persistence in the STEM fields is helping them develop a strong STEM identity and to feel like scientists (Carlone & Johnson, 2007; Maton et al., 2016). Receiving psychosocial or emotional support is particularly critical for URM students because it can strengthen their science identities (Ong et al., 2018). While same-race and same-gender mentors are theoretically best suited to provide psychosocial support to URM students, these pairings are frequently not possible due to the lack of faculty members with similar social identities (Fries-Britt & Snider, 2015; Griffin, 2012).

Social identities are defined by a common set of norms, attitudes, traits, and stereotypes, which together form the prototype of a group member (Stets & Burke, 2000). Individuals who deviate from this prototype are marginalized within their social group. In STEM fields, those who are not White, not male, not heterosexual, not able-bodied, not middle class or higher, and not historically represented as scientists are barred from enjoying the full range of opportunities afforded members of more highly

Table 1
Median Annual Salary (US$) Among Science and Engineering Highest Degree Holders Working Full Time

Characteristic	1995	2003	2015
Sex			
Female	34,000	45,000	57,000
Male	49,000	68,000	86,000
Race and ethnicity			
American Indian or Alaska Native	s	48,000	62,000
Asian	45,000	64,000	85,000
Black	35,000	48,000	55,000
Hispanic	38,000	50,000	59,000
Native Hawaiian or Other Pacific Islander	NA	56,000	74,000
White	45,000	60,000	78,000
More than once race	NA	50,000	78,000
All	44,000	60,000	75,000

Note. Data from National Science Board, Science & Engineering Indicators 2018. NA = not available; s = suppressed for reasons of confidentiality and/or reliability.

regarded groups. Furthermore, these students' social identities are often deemed irrelevant to science; research shows that students underrepresented by race and/or gender are often expected to conform and assimilate into the dominant (i.e., White male) culture and minimize their raced and gendered identities (Johnson et al., 2011). URM students thus often maintain separate social and academic peer networks (Arevalo et al., 2016; Brooms, 2018). Some confirm that they minimize their raced and gendered identities and compartmentalize their critical personal identities and their science identities (McCoy et al., 2015).

I postulate further that URM STEM students have been socialized in educational spaces that foster pulling oneself up by the bootstraps—that is, exhibiting resilience in the face of constant challenges—adopting colorblind ideologies, being gritty, and embracing meritocracy mantras that allow their disparate educational outcomes to be attributed to cultural bias and personal characteristics (Battey & Leyva, 2016; Collins, 2018). Much of the mentoring literature is flawed, as it misidentifies, minimizes, or downplays URM students' plight in STEM participation, which can in turn challenge their sense of authenticity and of belonging in their discipline. When URMs infer from their mentors that they must change themselves to fit in, they often suffer from depression, poor psychological well-being, and impaired academic performance (Assari, 2018; Hudson et al., 2016). One explanation for these poor psychological outcomes is that when individuals deemphasize a social identity, like race, by subscribing to racial ideologies that stress the similarities between URMs and others, they tend to attribute their invalidating academic experiences and outcomes to internal rather than external causes (Oyserman et al., 2014)—that is, to their own shortcomings. In her overview of racial and ethnic identity development, Byars-Winston (2014) suggested that therapists can help minoritized students identify, understand, and cope with racism by helping them depersonalize invalidating experiences while reinforcing their self-efficacy in their field. This could extend to STEM faculty members who mentor minoritized students or are themselves minoritized.

Even programs designed to increase racial diversity in STEM contribute to disparities. A recent study evaluated a highly competitive, federally funded technology and engineering education doctoral program for White, Black, and Hispanic doctoral fellows who were specially groomed for professorships (Niemann & Sánchez, 2015). The Black fellows were the only participants who did not obtain tenure-track academic positions, even though their qualifications matched or exceeded those of their fellow program graduates. Researchers concluded that the Black program fellows were evaluated by stricter, more subjective criteria (e.g., skepticism about their suitability for academic positions) than their counterparts. They also lacked the professional development and training needed to succeed in racialized STEM departments, whose culture requires keen skills to navigate the politics associated with being Black in STEM (Niemann & Sánchez, 2015; Varnedoe et al., 2020). So, even when programming is designed to benefit all students, Black students experience more adverse outcomes than their peers, thereby re-creating significant persistent racial disadvantage. Sowell et al. (2015) found that most interventions that aim to facilitate URM student degree completion focus on condescendingly "helping" or "fixing" the students, which takes the burden off the hegemonic institutional causation. Myriad findings suggest that the burden of adjusting to this environment cannot rest solely with students; the institutional culture must strive to become antiracist, equitable, and inclusive (Adserias et al., 2017).

HBCUs: On the Front Line in Addressing Structural Racism in STEM

The nation's 105 HBCUs constitute less than 1% of U.S. higher education institutions. There are 101 accredited public and private HBCUs in 19 states (down from the 121 institutions that existed during the 1930s), the District of Columbia, and the U.S. Virgin Islands, which enroll almost 300,000 students, approximately 80% of whom are African American and 70% from low-income families (UNCF, 2017). Yet HBCUs educate

approximately 11% of the U.S. African American population (Boykin et al., 2017). A 2015 Gallup-USA Funds Minority College Graduates Report shows that HBCUs provide Black graduates with a better college experience than they would get at non-HBCUs. The Gallup study concludes that Black HBCU graduates are more likely to be thriving in purpose and financial well-being than Black graduates who did not receive their degrees from HBCUs (UNCF, 2017). For example, Xavier University, an HBCU in New Orleans with approximately 80% of students attaining middle-class status, promotes more mobility into the middle class than any other HBCU (Nathenson et al., 2019).

HBCUs have been on the front lines of attainment for African Americans gaining entry into STEM education and careers (Toldson, 2018); National Science Foundation data show that HBCUs on average graduated 29% of the total science and engineering degrees for African Americans from 1994 to 2001.[5] HBCUs accounted for 17% of the bachelor's degrees earned by African Americans overall and 24% of the degrees earned by African Americans on all levels in STEM fields (bachelor's, master's and PhD; UNCF, 2018). Eight HBCUs were among the top 20 institutions to award the most science and engineering bachelor's degrees to Black graduates from 2008 to 2012 (Gasman & Nguyen, 2018). HBCUs have had disproportionate success in graduating African American students, particularly in the STEM fields (UNCF, 2017), and although only a small subset of HBCUs have STEM doctoral programs, they have long graduated a disproportionately large percentage of the African American students who earn STEM PhDs (Rice et al., 2016). Researchers studying this phenomenon attribute HBCUs' success largely to their administrative and faculty leadership (Savage, 2017). HBCUs succeed despite limited budgets, small endowments, and a lack of world-class facilities, and they enroll Black students many predominantly White institutions (PWIs) would reject (National Academies of Sciences, Engineering, and Medicine, 2019a). Much can be learned from HBCUs' successes that can help to produce a new generation of Black STEMers for all types of institutions and industries. Rather than looking to PWIs to take the lead in diversifying STEM higher education, researchers should study HBCUs' leadership styles and the strategies employed by their faculty members and administrators (Center for the Advancement of STEM Leadership, 2020; National Academies of Sciences, Engineering, and Medicine, 2019a).

Structural Racism Stifles HBCUs' STEM Legacies

The tremendous positive impact of HBCUs is hampered by structural racism. For example, while public 4-year HBCUs rely more heavily on federal, state, and local funding than public 4-year non-HBCUs (54% vs. 38% of overall revenue, respectively), the United States has a long history of inequities in state and federal support for HBCUs (K. L. Williams & Davis, 2019). Researchers recently revealed in the *Journal of Finance Economics* that HBCUs pay higher underwriting fees to issue tax-exempt bonds, compared with similar non-HBCUs. This study reflects how structural racism play a discriminatory role associated with higher costs of finding willing buyers. This study also revealed that credit quality plays little role and the effect is three times larger in the Deep South, where racial animosity and segregation remains the most severe (Dougal et al., 2019).

To offer a few poignant examples, Tennessee State University (TSU), an HBCU in Nashville, was shorted about $37 million between 2000 and 2016 because the state did not match federal funds (White, 2019). The 1887 the Hatch Act requires states to match federal education dollars at land grant colleges. Tennessee has two land grant colleges, TSU and University of Tennessee Knoxville (UTK). In 1934, UT Knoxville received $450,000 from the state legislature while TSU got $52,000, and that disparity has persisted ever since (White, 2019). This inequity in state funding between HBCUs and White institutions has been well documented since the establishment of these institutions (Lee & Keys, 2013). In 2007, the University of North Carolina at Chapel Hill and North Carolina State University (both PWIs) received approximately $15,700 per student in state funding, compared with approximately $7,800 per student at North Carolina A&T State University[6] and Fayetteville State University, both HBCUs (Minor, 2008).

In 2006, Maryland's four HBCUs—Morgan State University, Coppin State University, Bowie State University, and the University of Maryland Eastern Shore—filed a lawsuit against the state of Maryland, claiming that it failed to remove systemic barriers that led to segregation in Maryland's higher education system. The lawsuit contends that more than $577 million dollars is owed to these four HBUCs; Maryland's governor made a "final offer" of $200 million to settle, which would leave these universities woefully underfunded. Thirteen years later, the case remains unresolved (Gaines, 2019).

Morehouse College, an HBCU in Atlanta whose students are predominately African American men, made national news when Robert F. Smith, the founder, chair, and CEO of Vista Equity Partners, provided a $34 million gift to eliminate the debt of all members of the class of 2019. What was given considerably less attention was a series of initiatives Morehouse College recently introduced to tighten its budget. Most staff and faculty members will be required to take a 1-day unpaid furlough each month, and the college will stop making matching contributions to employees' retirement accounts. The estimated $3 million these measures will save will be used in part to support students who are struggling to finance their education (Carlson, 2019).

HBCU graduates experience disproportionately high debt, a byproduct of these institutions being inequitably funded and HBCU's continued commitment to enroll Black students from low income families, who have substantial financial need and limited access to additional financial resources (UNCF, n.d.). The median federal debt load for African American HBCU graduates is about $29,000 at graduation, which is 32% higher than that of graduates of other public and private nonprofit 4-year schools (Mitchell & Fuller, 2019). Saunders et al.'s (2016) comprehensive analysis details stark financial disparities between HBCU graduates and their non-HBCU counterparts. For example, students who attend HBCUs must borrow at higher rates and, consequently, graduate with substantially higher debt than their peers at non-HBCUs. In 2013, 80% of HBCU students took out federal loans. Fifty-five percent of their non-HBCU

counterparts did the same. The percentage of HBCU graduates who borrowed $40,000 or more from the federal loan program was 4 times that of non-HBCU graduates. The authors suggest that policymakers should reduce the complexity of federal student aid, make loans less costly via a manageable repayment process, and increase grant aid and work–study opportunities. Other researchers agree that saddling these primarily Black graduates with debt undermines the advantages of attending an HBCU (Mitchell & Fuller, 2019).

HBCUs, along with Minority Serving Institutions (MSIs) and Tribal Colleges and Universities, which collectively serve more than four million students, were in jeopardy of losing $255 million dollars, due to the recent expiration of mandatory federal funding, but after several delays, and an successful campaign raising attention to this matter by UNCF (2019), U.S. senators, and HBCU alumni, funding was finally reinstated (Schwartz, 2019; Weissman, 2019). Despite the increased attention from presidential primary candidates (e.g., Joe Biden pledged $70 billion, Elizabeth Warren $50 billion, Pete Buttigieg $50 billion, and Bernie Sanders free HBCU tuition and $15 billion to MSIs) and celebrities (e.g., former NBA basketball player Charles Barkley gifted $1 million to Miles College, an HBCU in Alabama; Beyonce's documentary *Homecoming* showcased the affirming culture of HBCUs), it is ultimately the equitable financial practices of federal and state investments and fair lending and accreditation practices that are necessary for HBCUs to thrive. These structurally racist federal and state funding and debt patterns worsen inequities in higher education. In summary, HBCUs have a unique ability to bolster URMs' participation in STEM academic and professional communities. If the structural racism that has created the problems outlined above were addressed, they could play an even more critical role in increasing the number of URMs who hold STEM PhDs.

However, I would be remiss if I did not address that the Whiter STEM community does not view URM groups as the knowledge or thought leaders in STEM. In over 100 years, we have never seen a Black or Indigenous scientist become a Nobel laureate.[7] Structural racism and gendered racism are weaved through the selection process. To even be considered as a possible Nobel laureate, the criteria include being a prolific principal investigator or a research professor at a prominent institution, which leaves most URM serving institutions out of reach for the prize (Morgan, 2018). Racism is deeply embedded in the very structure of STEM, which not only impacts those who are pushed out of STEM fields but has implications for those who are considered as highly successful but still not successful enough.[8]

What If the Next Apple, JetBlue, Tesla, or Lyft Were Created and Operated by URMs?

As I noted at the beginning of this article, in attempting to account for the lack of URM owners or even employees of STEM companies I have highlighted the impact of racialized institutional defensiveness and resistance—discriminatory policies, practices, and laws—to racial diversity in STEM. Let me be clear, STEM higher education needs to be fully restructured to be more equitable and inclusive. With URMs within and beyond STEM spearheading such an effort, the field could pursue goals that celebrate racial diversity in STEM innovation. This effort must include a radical critique of the applications of scientific knowledge and challenge dominant thinking about how science and technology are created, implemented, and maintained. For example, Dr. Joy Buolamwini (2016, 2018), an MIT scientist and founder of the Algorithmic Justice League, has published research that uncovered significant gender and racial bias in AI systems sold by tech giants like IBM, Microsoft, and Amazon. Benjamin (2019) eloquently argues in her book, *Race After Technology: Abolitionist Tools for the New Jim Code*, that "the employment of new technologies . . . reflect and reproduce existing inequities but . . . are promoted and perceived as more objective and progressive than the discriminatory system of the previous era" (p. 4). While we need a revolution in STEM education, it also would be empowering for URMs to begin to own more of the STEM enterprise and create companies that expose, correct, and eradicate racialized bias in STEM (McGee, 2020).

It is obvious that there is a direct relationship between STEM innovation and economic power, as STEM company owners and executives are some of the most capable, influential, and dangerous leaders on the planet. Facebook, for example, with its 2.3 billion users, has abused its power to influence the U.S. presidential election. It analyzes its subscribers' every online move (Alvarado et al., 2018) while allowing a genocidal and racist platform to thrive and fuel hate with the emergence of White nationalist groups. It creates discriminatory algorithms that promote and reinforce the maintenance of structural, everyday, and individual racism in technology (Bornstein, 2017; Nishi et al., 2015; Noble, 2018). As of 2018, Facebook earned about $56 million a day, Apple $151 million daily, and Google $121 million per day (Associated Press, 2018), so we can conclude that these companies could certainly fund culturally affirming technology products and real value propositions that actually lead to a more racially diverse workforce. Instead, Facebook actively monitors Black racial activists and censors their posts against racism as hate speech (Eschmann, 2019; Guynn, 2019). Apple stores have a long history of racial profiling Black males and falsely accusing them of "almost" stealing (poised to steal; Couts, 2011; A. Metcalf, 2017; Nichols, 2017), while the facial recognition on the iPhone X could not accurately recognize people of color (Curtis, 2017). Google's image recognition system notoriously failed to distinguish Black people from gorillas, and their search engine design results in algorithmic racism (Guynn, 2019; Noble, 2018). I understand that these companies are capitalist ventures focused on making profits, but if they are as interested in ingenuity and innovation as they market themselves to be, they should be rushing to hire and make significant and resourceful efforts toward securing URM STEM employees and fueling ownership. These companies are basically stunting their own growth by not having other diverse companies in the landscape to create more cross-company interdisciplinary innovation in STEM.

It is ironic that companies and education institutions increasingly acknowledge publicly that diverse experiences, perspectives, and backgrounds are crucial to the development of new ideas, which makes hiring diverse employees a business imperative.

Numerous initiatives promise to promote diversity in the STEM fields, including organizations founded for that very purpose, and many institutions and organizations are developing recruiting initiatives for URMs that address race, ethnicity, gender, sexual identity, and disability.[9] However, I believe the goal of some of these programs is to create narrow pathways for URM people educated in STEM to work for Oracle, Boeing, or Jaguar, for example, rather than to nurture their potential to create their own global computer company, aerospace, or automobile company. Moreover, URMs in STEM continue to be exploited, tokenized, and woefully undervalued for their intellectual and creative abilities (Baber, 2015; Burt et al., 2018). Preparing URMs to qualify for STEM jobs at mostly White companies is not a sustainable agenda. Serious investment in STEM for URMs requires building an infrastructure (e.g., venture capital, technology screening and assessment, entrepreneurial resources, intellectual property strategy, licensing, investor network; Bradley, 2019) that supports their ownership of STEM businesses.

URM groups in STEM have largely been left out of this economic prosperity: we have not entered the space race in significant numbers, or the computing enterprise, or the airline industry. Why not? The answer is partially rooted in slavery and Jim Crow laws, while structural racism has stifled URM entrepreneurship, particularly in real estate exploitation, a system that has historically enriched White people at the expense of Black and Indigenous people, which still hinders economic opportunities for URM groups (Marable, 2015). We must acknowledge and understand the power associated with a STEM-educated community and that students and employees of color participate in a system replete with racist and other discriminatory barriers that have proven harmful not only to their well-being but to the advancement of technology (Browne, 2015; McGee & Stovall, 2015). Racialized bias permeates the STEM fields, to the detriment of scientific and technological advancement in the United States, as it disconnects from the humanity of URM groups and is attentive to the characteristics, ideologies, and values of White men (Noble, 2018).

Marcus Nivet (2011), a former chief officer of diversity policy and programs at the Association of American Medical Colleges, wrote an invaluable commentary about the slow pace of diversity in higher education. He explained that diversifying higher education involves alleviating the barriers facing disadvantaged and marginalized populations. He also asserted that promoting diversity involves developing a culture of inclusion that fully appreciates different perspectives. Retaining URM students and employees should not be merely a matter of compliance; it must be the core of the academic/company mission. This will require a commitment from diverse thinkers who appreciate the desires and goals of underrepresented students, employees, faculty, and staff members of color.

Conclusion

The current state of STEM education and employment weaponizes science and technology by reproducing racism and creating new forms of marginalization and vulnerability through technology and other types of flawed scientific innovation (Benjamin, 2016). What we really do not need in STEM is more of the same type of students, from the same institutions, taught by the same professors, learning the same curriculum, working at STEM institutions where everybody looks (and quite possibly thinks) similarly. As long as there is widespread reluctance in these fields to address the insidious, complex effects of structural racism, which range from the individual to the institutional, STEM education will ultimately result in less robust, innovative, creative STEM industries and outputs. This reluctance highlights the reality of the nation's economic, educational, political, and social systems, which routinely advantage Whites while producing chronically adverse outcomes for URM groups (Bonilla-Silva, 2018). STEM is no exception.

Continued research on structural racism in STEM can be the necessary catalyst to unpack and undo the stressors associated with this racialized system. Starting with structural racism, rather than individual acts of racism, can improve understanding of cultural and interpersonal racism, both of which currently compromise the career trajectories and satisfaction of URM STEM students and employees. Working to unravel structural racism in the STEM arena will lead to a more fulfilling life for all who participate in STEM and enable URMs to be full members of the professional community that is shaping and determining our technological and scientific future.

NOTES

I would like to acknowledge *Educational Reseacher*'s anonymous reviewers for their thoughtful and critical insights.

[1]Latinx is a gender-neutral neologism, sometimes used instead of Latino or Latina to refer to people of Latin American cultural or ethnic identity in the United States. The ⟨-x⟩ suffix replaces the standard ⟨-o/-a⟩ ending of nouns and adjectives. I use the term Hispanic when it used by the cited study or authors.

[2]I use the term *underrepresented and racially minoritized* to signify the marginalization and subordination in U.S. institutions, including colleges and universities. Minoritized acknowledges a system of actionable policies and practices that racialize people of color, rather than the passive minority implying some inherent (and normalized) state of affairs. Instead, they are rendered minorities, by overrepresentation of White Supremacy that actively creates a society that elevates and normalizes a hegemonic world view to the determinant of non-White people.

[3]I assisted in the research and writing of this report, particularly Chapter 3 titled "Mentoring Underrepresented Students in STEMM: Why Do Identities Matter?," pp. 51–74; and Appendix B, "A Selection of STEMM Intervention Programs That Include Mentoring Experiences," pp. 237–262.

[4]It is difficult to define which programming components qualify as mentoring and which further complicate the investigation of multilayered graduate programming. Research that determines if mentoring programs have led to change at the departmental or institutional level is scant. Moreover, mentoring is often a single component of a multifaceted program, thus any reported outcomes that do not disaggregate the program components cannot be attributed solely to mentoring. To my knowledge, the research and academic communities do not systematically evaluate the impact mentoring programs have on the culture of departments and institutions, perhaps because it is difficult to operationalize and measure cultural change and to control for other factors that have an impact on institutional change.

[5]Administrators at many HBCUs indicate that their economic survival necessitates enrolling a non-Black student population, arguing that tuition paid by students from other racial backgrounds help to keep

HBCUs alive. But the presence of non-Black students at HBCUs is not without controversy and is viewed by some as being insensitive to the benefits associated with Black environments. See Shorette and Arroyo (2015); https://www.thenation.com/article/diversity-look-like-hbcus/.

[6]Full disclosure: I am an intensely proud engineering graduate of North Carolina A&T State University (Aggie Pride!).

[7]Latinx scientists have been awarded Nobel prizes in physics, chemistry, physiology or medicine; however, the last laureate was in 1995 (Morgan et al., 2018).

[8]From the anonymous *Educational Researcher* Reviewer 1 (Thank you): "The Circadian clock that earned a prize was authored by 25 scientists yet only 3, only white males, received the prize. They were not even the first authors on the papers coming out of the research. Stephen C. McGuire, at Southern University (an HBCU) worked on the LIGO along with other scientists (nearly 300) but again only 3 white males received the prize. Therefore, this marker is by its very design/nature stacked against equity and diversity" (Southern University, 2017).

[9]These initiatives include the Minority Science and Engineering Improvement Program, *Louis Stokes Alliances for Minority Participation*, STEM Innovation for Inclusion in Early Education Center, Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science, Black in Engineering, Black in Computing, Black In Neuro, Gladstone Institutes, Algorithmic Justice League, Black in AI, Tech Exchange, Codepath.org, and Graduate Assistance in Areas of National Need; more can be found at https://www.pathwaystoscience.org/index.aspx.

REFERENCES

Adserias, R. P., Charleston, L. J., & Jackson, J. F. (2017). What style of leadership is best suited to direct organizational change to fuel institutional diversity in higher education? *Race Ethnicity and Education*, *20*(3), 315–331. https://doi.org/10.1080/13613324.2016.1260233

Alexander, Q. R., & Hermann, M. A. (2016). African-American women's experiences in graduate science, technology, engineering, and mathematics education at a predominantly white university: A qualitative investigation. *Journal of Diversity in Higher Education*, *9*(4), 307–322. https://doi.org/10.1037/a0039705

Allen, A. M. (2017). *Do we know who is really doing the planting? A case study of traditionally white institutions identified as top degree producers of black engineering undergraduates* [Unpublished doctoral dissertation]. University of Pittsburgh.

Alvarado, C., Devadoss, N., Rivens, R., & Engels, D. W. (2018). It's your data: A blockchain solution to Facebook's data stewardship problem. *SMU Data Science Review*, *1*(4), Article 2. https://scholar.smu.edu/datasciencereview/vol1/iss4/2

Anderson, E., Williams, K., Ponjuan, L., & Frierson, H. T. (2018). *The 2018 status report on engineering education: A snapshot of diversity in degrees conferred in engineering*. Association of Public and Land-Grant Universities. https://www.aplu.org/library/the-2018-status-report-on-engineering-education-a-snapshot-of-diversity-in-degrees-conferred-in-engineering/file

Arevalo, I., So, D., & McNaughton-Cassill, M. (2016). The role of collectivism among Latino American college students. *Journal of Latinos and Education*, *15*(1), 3–11. https://doi.org/10.1080/15348431.2015.1045143

Assari, S. (2018). Health disparities due to diminished return among black Americans: Public policy solutions. *Social Issues and Policy Review*, *12*(1), 112–145. https://doi.org/10.1111/sipr.12042

Associated Press. (2018, April 27). *Apple, Amazon, Facebook, Alphabet, and Microsoft are collectively worth more than the entire economy of the United Kingdom*. https://www.inc.com/associated-press/mind-blowing-facts-tech-industry-money-amazon-apple-microsoft-facebook-alphabet.html

Baber, L. D. (2015). Considering the interest-convergence dilemma in STEM education. *Review of Higher Education*, *38*(2), 251–270. https://doi.org/10.1353/rhe.2015.0004

Bailey, Z. D., Krieger, N., Agénor, M., Graves, J., Linos, N., & Bassett, M. T. (2017). Structural racism and health inequities in the USA: Evidence and interventions. *Lancet*, *389*(10077), 1453–1463. https://doi.org/10.1017/S1742058X11000130

Basile, V., & Lopez, E. (2015). And still I see no changes: Enduring views of students of color in science and mathematics education policy reports. *Science Education*, *99*(3), 519–548. https://doi.org/10.1002/sce.21156

Battey, D., & Leyva, L. A. (2016). A framework for understanding whiteness in mathematics education. *Journal of Urban Mathematics Education*, *9*(2), 49–80.

Benjamin, R. (2016). Innovating inequity: If race is a technology, postracialism is the genius bar. *Ethnic and Racial Studies*, *39*(13), 2227–2234. https://doi.org/10.1080/01419870.2016.1202423

Benjamin, R. (2019). *Race after technology: Abolitionist tools for the new Jim Code*. Wiley.

Bonilla-Silva, E. (2001). *White supremacy and racism in the post-civil rights era*. Lynne Rienner.

Bonilla-Silva, E. (2015). The structure of racism in color-blind, "post-racial" America. *American Behavioral Scientist*, *59*, 1358–1376. https://doi.org/10.1177/0002764215586826

Bonilla-Silva, E. (2018). *Racism without racists: Color-blind racism and the persistence of racial inequality in America*. Rowman & Littlefield.

Bonilla-Silva, E., & Dietrich, D. (2011). The sweet enchantment of color-blind racism in Obamerica. *Annals of the American Academy of Political and Social Science*, *634*(1), 190–206. https://doi.org/10.1177/0002716210389702

Bornstein, A. (2017, December 21). Are algorithms building the new infrastructure of racism? *Nautilus*. http://nautil.us/issue/55/trust/are-algorithms-building-the-new-infrastructure-of-racism

Boykin, T. F., Hilton, A. A., & Palmer, R. T. (Eds.). (2017). *Professional education at historically Black colleges and universities: Past trends and future outcomes*. Routledge.

Bradley, J. (2019, August 6). *From good science and engineering research to entrepreneurship*. https://blackengineeringphd.org/mentoring-portal/

Brooms, D. R. (2018). "Building us up": Supporting Black male college students in a Black male initiative program. *Critical Sociology*, *44*(1), 141–155.

Brown, B. A., Henderson, J. B., Gray, S., Donovan, B., Sullivan, S., Patterson, A., & Waggstaff, W. (2016). From description to explanation: An empirical exploration of the African-American pipeline problem in STEM. *Journal of Research in Science Teaching*, *53*(1), 146–177. https://doi.org/10.1002/tea.21249

Brown, B. A., Mangram, C., Sun, K., Cross, K., & Raab, E. (2017). Representing racial identity: Identity, race, the construction of the African American STEM students. *Urban Education*, *52*(2), 170–206. https://doi.org/10.1177/0042085916661385

Browne, S. (2015). *Dark matters: On the surveillance of blackness*. Duke University Press.

Brunsma, D. L., Embrick, D. G., & Shin, J. H. (2017). Graduate students of color: Race, racism, and mentoring in the white waters of academia. *Sociology of Race and Ethnicity*, *3*(1), 1–13. https://doi.org/10.1177/2332649216681565

Bullock, E. C. (2017). Only STEM can save us? Examining race, place, and STEM education as property. *Educational Studies*, *53*(6), 628–641. https://doi.org/10.1080/00131946.2017.1369082

Buolamwini, J. (2016). How I'm fighting bias in algorithms. *November, TEDx Beacon Street* [Video file].

Buolamwini, J. (2018, June). When the robot doesn't see dark skin. *New York Times*. https://www.nytimes.com/2018/06/21/opinion/facial-analysis-technology-bias.html

Burt, B. A., Williams, K. L., & Palmer, G. J. (2019). It takes a village: The role of emic and etic adaptive strengths in the persistence of Black men in engineering graduate programs. *American Educational Research Journal*, *56*(1), 39–74. https://doi.org/10.3102/0002831218789595

Burt, B. A., Williams, K. L., & Smith, W. A. (2018). Into the storm: Ecological and sociological impediments to Black males' persistence in engineering graduate programs. *American Educational Research Journal*, *55*(5), 965–1006. https://doi.org/10.3102/0002831218763587

Byars-Winston, A. (2014). Toward a framework for multicultural STEM-focused career interventions. *Career Development Quarterly*, *62*(4), 340–357. https://doi.org/10.1002/j.2161-0045.2014.00087.x

Campbell, T. A., & Adamuti-Trache, M. (2016). Science and engineering doctorate recipients entering the labor market: Income disparities for underrepresented minorities. *Career and Technical Education Research*, *41*(2), 85–105. https://doi.org/10.5328/cter41.2.85

Cannady, M. A., Greenwald, E., & Harris, K. N. (2014). Problematizing the STEM pipeline metaphor: is the STEM pipeline metaphor serving our students and the STEM workforce? *Science Education*, *98*(3), 443–460. https://doi.org/10.1002/sce.21108

Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching*, *44*(8), 1187–1218. https://doi.org/10.1002/tea.20237

Carlson, J. (2019, September 26). Budget woes latest crisis to hit Morehouse. *CBS 46*. https://www.cbs46.com/investigations/budget-woes-latest-crisis-to-hit-morehouse/article_de20e4ec-e0a4-11e9-9177-ff59c2807e39.html

Carter, D. F., Dueñas, J. E. R., & Mendoza, R. (2019). Critical examination of the role of STEM in propagating and maintaining race and gender disparities. In L.W. Perna (Ed.), *Higher education: Handbook of theory and research* (pp. 39–97). Springer.

Collins, K. H. (2018). Confronting color-blind STEM talent development: Toward a contextual model for black student STEM identity. *Journal of Advanced Academics*, *29*(2), 143–168. https://doi.org/10.1177/1932202X18757958

Couts, A. (2011, May 26). NYC Apple Store sued over alleged racial profiling. *Digital Trends*. https://www.digitaltrends.com/apple/nyc-apple-store-sued-over-alleged-racial-profiling/

Curtis, S. (2017, December 22). iPhone X racism row: Apple's Face ID fails to distinguish between Chinese users. *Mirror*. https://www.mirror.co.uk/tech/apple-accused-racism-after-face-11735152

Darity, W., Jr., Addo, F. R., & Smith, I. Z. (2020). A subaltern middle class: The case of the missing "Black bourgeoisie" in America. *Contemporary Economic Policy*. Advance online publication. https://doi.org/10.1111/coep.12476

David, E. J. R., & Derthick, A. O. (2017). *The psychology of oppression*. Springer.

Dougal, C., Gao, P., Mayew, W. J., & Parsons, C. A. (2019). What's in a (school) name? Racial discrimination in higher education bond markets. *Journal of Financial Economics*, *134*(3), 570–590. https://doi.org/10.1016/j.jfineco.2019.05.010

Eschmann, R. (2019). Unmasking racism: Students of color and expressions of racism in online spaces. *Social Problems*, *67*(3), 418–436. https://doi.org/10.1093/socpro/spz026

Essed, P. (2002). Everyday racism. In D. T. Goldberg & J. Solomos (Eds.), *A companion to racial and ethnic studies* (pp. 202–216). Blackwell.

Freedman, J., & Ferri, B. A. (2017). Locating the problem within: Race, learning disabilities, and science. *Teachers College Record*, *19*(5), 1–28.

Fries-Britt, S., & Snider, J. (2015). Mentoring outside the line: The importance of authenticity, transparency, and vulnerability in effective mentoring relationships. *New Directions for Higher Education*, *2015*(171), 3–11. https://doi.org/10.1002/he.20137

Gaines, D. E. (2019, September 27). Hogan proposes $200 million "final offer" in HBCU lawsuit. *Maryland Matters*. https://vtechworks.lib.vt.edu/bitstream/handle/10919/89184/PublicPrivateHbcus.pdf

Garbee, E. (2017, October 20). The problem with the "pipeline." *Slate*. https://slate.com/technology/2017/10/the-problem-with-the-pipeline-metaphor-in-stem-education.html

Gardner, L. (2019, October 13). Students under surveillance? *The Chronicle of Higher Education*. https://www.chronicle.com/article/Students-Under-Surveillance-/247312

Gasman, M., & Nguyen, T. H. (2018). Historically black colleges and universities as leaders in STEM. *The Helmsley Charitable Trust*. https://cmsi.gse.upenn.edu/sites/default/files/MSI_HemsleyReport_final_0.pdf

Griffin, K. A. (2012). Learning to mentor: A mixed methods study of the nature and influence of Black professors' socialization into their roles as mentors. *Journal of the Professoriate*, *6*(2), 27–58. http://works.bepress.com/kimberly_griffin/5/

Groos, M., Wallace, M., Hardeman, R., & Theall, K. P. (2018). Measuring inequity: A systematic review of methods used to quantify structural racism. *Journal of Health Disparities Research and Practice*, *11*(2), 190–205. https://digitalscholarship.unlv.edu/jhdrp/vol11/iss2/13

Guynn, J. (2019, April 24). Facebook while black: Users call it getting "Zucked," say talking about racism is censored as hate speech. *USA Today*. https://www.usatoday.com/story/news/2019/04/24/facebook-while-black-zucked-users-say-they-get-blocked-racism-discussion/2859593002/

Hudson, D. L., Neighbors, H. W., Geronimus, A. T., & Jackson, J. S. (2016). Racial discrimination, John Henryism, and depression among African Americans. *Journal of Black Psychology*, *42*(), 221–243. https://doi.org/10.1177/0095798414567757

Ireland, D. T., Freeman, K. E., Winston-Proctor, C. E., DeLaine, K. D., McDonald Lowe, S., & Woodson, K. M. (2018). (Un) hidden figures: A synthesis of research examining the intersectional experiences of Black women and girls in STEM education. *Review of Research in Education*, *42*(1), 226–254. https://doi.org/10.3102/0091732x18759072

Jackson, J. (2019, April 9) The FBI appears to be engaged in a modern-day version of COINTELPRO: CounterSpin interview with Nusrat Choudhury on FBI targeting of black activists. *FAIR*. https://fair.org/home/the-fbi-appears-to-be-engaged-in-a-modern-day-version-of-cointelpro/

Johnson, A., Brown, J., Carlone, H., & Cuevas, A. K. (2011). Authoring identity amidst the treacherous terrain of science: A multiracial feminist examination of the journeys of three women of color in science. *Journal of Research in Science Teaching*, *48*(4), 339–366. https://doi.org/10.1002/tea.20411

Jones, T. B., Osborne-Lampkin, L. T., Davis, D. J., & Patterson, S. M. (2015). Creating a safe and supportive environment: Mentoring and professional development for recent Black women doctoral graduates. *International Journal of Doctoral Studies*, *10*(1), 483–499. https://doi.org/10.28945/2305

Leath, S., & Chavous, T. (2018). Black women's experiences of campus racial climate and stigma at predominantly white institutions: Insights from a comparative and within-group approach for STEM and non-STEM majors. *Journal of Negro Education*, *87*(2), 125–139. https://doi.org/10.7709/jnegroeducation.87.2.0125

Lee, M. J., & Keys, S. W. (2013). *Land-grant but unequal state one-to-one match funding for 1890 land-grant universities*. Association of Public and Land-Grant Universities. https://www.aplu.org/library/land-grant-but-unequal-state-one-to-one-match-funding-for-1890-land-grant-universities/file

Madden, K., Pereira, P., Rezvi, S., Trinder, V. F., & Martin, D. B. (2019). Cartographies of race, gender, and class in the white (settler) spaces of science and mathematics: Navigations by Black, Afro-Brazilian, and Pakistani women. In E. O. McGee & W. H. Robinson (Eds.), *Diversifying STEM: Multidisciplinary perspectives on race and gender* (pp. 69–106). Rutgers University Press.

Malcom, L., & Malcom, S. (2011). The double bind: The next generation. *Harvard Educational Review*, *81*(2), 162–172. https://doi.org/10.17763/haer.81.2.a84201x508406327

Marable, M. (2015). *How capitalism underdeveloped Black America: Problems in race, political economy, and society*. Haymarket Books.

Martin, D. B. (2019). Equity, inclusion, and antiblackness in mathematics education. *Race Ethnicity and Education*, *22*(4), 459–478. https://doi.org/10.1080/13613324.2019.1592833

Maton, K. I., Beason, T. S., Godsay, S., Sto Domingo, M. R., Bailey, T. C., Sun, S., & Hrabowski, F. A. III. (2016). Outcomes and processes in the Meyerhoff Scholars Program: STEM PhD completion, sense of community, perceived program benefit, science identity, and research self-efficacy. *CBE—Life Sciences Education*, *15*(3), ar48. https://doi.org/10.1187/cbe.16-01-0062

Matthews, L. (2016). *Reconstructing Bermuda's pipeline for black males in education: From mazes of mediocrity to pathways to success* [Paper presentation]. International Colloquium on Black Males in Education, Hamilton, Bermuda.

McCoy, D. L., Winkle-Wagner, R., & Luedke, C. L. (2015). Colorblind mentoring? Exploring white faculty mentoring of students of color. *Journal of Diversity in Higher Education*, *8*(4), 225–242. https://doi.org/10.1037/a0038676

McGee, E. O. (2016). Devalued Black and Latino racial identities: A byproduct of college STEM culture? *American Educational Research Journal*, *53*(6), 1626–1662. https://doi.org/10.3102/0002831216676572

McGee, E. O. (2020). *Black, brown, bruised: How racialized STEM education stifles innovation*. Harvard Education Press.

McGee, E. O., Griffith, D. M., & Houston, S. (2019). "I know i have to work twice as hard and hope that makes me good enough": Exploring the stress and strain of Black doctoral students in engineering and computing. *Teachers College Record*. *121*(4), 1–38. http://www.tcrecord.org/Content.asp?ContentId=22610

McGee, E. O., & Robinson, W. H. (2019). *Diversifying STEM: Multidisciplinary perspectives on race and gender*. *Rutgers University Press*. https://www.rutgersuniversitypress.org/diversifying-stem/9781978805675

McGee, E. O., & Stovall, D. O. (2015). Reimagining critical race theory in education: Mental health, healing, and the pathway to liberatory praxis. *Educational Theory*, *65*(5), 491–511. https://doi.org/10.1111/edth.12129 (Republished as the center-piece article in *Harvard Journal of African American Public Policy (2015-16)*, 41–60)

Metcalf, A. (2017, March 6) Lawsuit alleges racial profiling at Bethesda Apple Store. *Bethesda Magazine*. https://bethesdamagazine.com/bethesda-beat/courts/lawsuit-alleges-racial-profiling-at-bethesda-apple-store/

Metcalf, H. (2010). Stuck in the pipeline: A critical review of STEM workforce literature. *InterActions: UCLA Journal of Education and Information Studies*, *6*(2), 1–20.

Milner IV, H. R. (2020). Fifteenth annual AERA Brown lecture in education research: Disrupting punitive practices and policies: Rac(e)ing back to teaching, teacher preparation, and Brown. *Educational Researcher*, *49*(3), 147–160.

Minor, J. T. (2008). *Contemporary HBCUs: Considering institutional capacity and state priorities: A research report*. Michigan State University, College of Education, Department of Educational Administration.

Mitchell, J., & Fuller, A. (2019, April 17). The student-debt crisis hits hardest at historically black colleges. *Wall Street Journal*. https://www.wsj.com/articles/the-student-debt-crisis-hits-hardest-at-historically-black-colleges-11555511327

Morgan, A. C., Economou, D. J., Way, S. F. & Clauset, A. (2018). Prestige drives epistemic inequality in the diffusion of scientific ideas. *EPJ Data Science*, *7*. https://doi.org/10.1140/epjds/s13688-018-0166-4

Murji, K. (2007). Sociological engagements: Institutional racism and beyond. *Sociology*, *41*(5), 843–855. https://doi.org/10.1177/0038038507080440

Mutegi, J. W. (2013). "Life's first need is for us to be realistic" and other reasons for examining the sociocultural construction of race in the science performance of African American students. *Journal of Research in Science Teaching*, *50*(1), 82–103. https://doi.org/10.1002/tea.21065

Nathenson, R. A., Samayoa, A. C., & Gasman, M. (2019). *Moving upward and onward: Income mobility at historically Black colleges and universities*. Center for MSIs, Samuel DeWitt Proctor Institute for Leadership, Equity & Justice. https://cmsi.gse.rutgers.edu/sites/default/files/EMreport_R4_0.pdf

National Academies of Science, Engineering, and Medicine. (2016). *Barriers and opportunities for 2-year and 4-year STEM degrees: SySTEMic change to support students' diverse pathways*. National Academies Press. https://www.nap.edu/catalog/21739/barriers-and-opportunities-for-2-year-and-4-year-stem-degrees

National Academies of Sciences, Engineering, and Medicine. (2019a). *Minority serving institutions: America's underutilized resource for strengthening the STEM workforce*. National Academies Press. https://doi.org/10.17226/25257.

National Academies of Sciences, Engineering, and Medicine. (2019b). *The science of effective mentorship in STEMM*. National Academies Press. https://doi.org/10.17226/25568

National Center for Science and Engineering Statistics. (2019). *Women, minorities, and persons with disabilities in science and engineering*. https://ncses.nsf.gov/pubs/nsf19304/data

Nichols, S. (2017, March 31). Apple Store in Pennsylvania hit with discrimination complaint. *The Register*. https://www.theregister.co.uk/2017/03/31/apple_store_discrimination_complaint/

Niemann, Y. F., & Sánchez, N. C. (2015). Perceptions about the role of race in the job acquisition process: At the nexus of attributional ambiguity and aversive racism in technology and engineering education. *Journal of Technology Education*, *27*(1), 41–55. https://doi.org/10.21061/jte.v27i1.a.3

Nishi, N. W., Matias, C. E., & Montoya, R. (2015). Exposing the White avatar: Projections, justifications, and the ever-evolving American racism. *Social Identities*, *21*(5), 459–473. https://doi.org/10.1080/13504630.2015.1093470

Nivet, M. A. (2011). Commentary. Diversity 3.0: A necessary systems upgrade. *Academic Medicine*, *86*(12), 1487–1489. https://doi.org/10.1097/ACM.0b013e3182351f79

Noble, S. U. (2018). *Algorithms of oppression: How search engines reinforce racism*. New York University Press.

Ong, M., Smith, J. M., & Ko, L. T. (2018). Counterspaces for women of color in STEM higher education: Marginal and central spaces for persistence and success. *Journal of Research in Science Teaching*, *55*(), 206–245. https://doi.org/10.1002/tea.21417

Oyserman, D., Smith, G. C., & Elmore, K. (2014). Identity-based motivation: Implications for health and health disparities. *Journal of Social Issues*, *70*(2), 206–225. https://doi.org/10.1111/josi.12056

Rice, D., Bonner, F., Lewis, C., Alfred, M., Nave, F. M., & Frizell, S. (2016). Reversing the tide in science, engineering, technology and mathematics (STEM): Academically gifted African American students in historically Black colleges & universities. *Journal of Research Initiatives*, *2*(1), 1–14. http://digitalcommons.uncfsu.edu/jri/vol2/iss1/14

Roberts, D. (2013). *Fatal invention: How science, politics, and big business re-create race in the twenty-first century*. New Press.

Roy, J. (2019). *Engineering by the numbers*. American Society for Engineering Education.

Saunders, K. M., Williams, K. L., & Smith, C. L. (2016). *Fewer resources more debt: Loan debt burdens students at historically Black colleges & universities*. UNCF Frederick D. Patterson Research Institute.

Savage, G. (2017). Researchers seek key to success of STEM students at HBCUs. *Diverse Issues in Higher Education*. http://diverseeducation.com/article/100576/

Schwartz, N. (2019, December 19). Trump signs law restoring $255M to minority-serving institutions, streamlining FAFSA. *EducationDive*. https://www.educationdive.com/news/senate-proposes-restoring-255m-to-minority-serving-institutions/568487/

Serwer, A. (2019, April). White nationalism's deep American roots. *The Atlantic*. https://www.theatlantic.com/magazine/archive/2019/04/adam-serwer-madison-grant-white-nationalism/583258/

Shorette, C. R., II, & Arroyo, A. T. (2015). A closer examination of white student enrollment at HBCUs. *New Directions for Higher Education*, *2015*(170), 49–65. https://doi.org/10.1002/he.20131

Sowell, R., Allum, J., & Okahana, H. (2015). *Doctoral initiative on minority attrition and completion*. Council of Graduate Schools.

Stets, J. E., & Burke, P. J. (2000). Identity theory and social identity theory. *Social Psychology Quarterly*, *63*(3), 224–237. https://doi.org/10.2307/2695870

Toldson, I. A. (2018). Why historically Black colleges and universities are successful with graduating Black baccalaureate students who subsequently earn doctorates in STEM. *Journal of Negro Education*, *87*(2), 95–98. https://doi.org/10.7709/jnegroeducation.87.2.0095

Turk-Bicakci, L., & Berger, A. (2014). *Leaving STEM: STEM Ph.D. holders in non-STEM careers*. American Institutes for Research.

UNCF. (n.d.). *Biases in quality assurance: A position paper on historically Black colleges and universities and SACSCOC*. Frederick D. Patterson Research Institute. https://www.uncf.org/wp-content/uploads/Biases-in-Quality-Assurance_UNCF-Accreditation-White-Paper-Updated.pdf

UNCF. (2017, November 14). *HBCUs make America strong: The positive economic impact of historically Black colleges and universities*. United Negro College Fund. https://uncf.org/programs/hbcu-impact

UNCF. (2019, August 19). *UNCF launches "Protecting Our FUTURE", campaign; urges Congress to save HBCU federal funding*. United Negro College Fund. https://www.uncf.org/news/uncf-launches-protecting-our-future-campaign-urges-congress-to-save-hbcu-federal-funding

Varma, R. (2018). US science and engineering workforce: Underrepresentation of women and minorities. *American Behavioral Scientist*, *62*(5), 692–697. https://doi.org/10.1177/0002764218768847

Varnedoe, A., Naphan-Kingery, D. E., McGee, E. O., Robinson, W. (2020). Professoriate bound: Online coaching for Black engineering scholars. *Journal of Engineering Education*, *109*(4). https://onlinelibrary.wiley.com/doi/10.1002/jee.20278

Weissman, S. (2019, October 10). Education secretary Betsy DeVos addresses HBCU leaders about expired funding. *Diverse Issues in Higher Education*. https://diverseeducation.com/article/157123/

White, P. (2019, April 18). Rep. Harold Love, Jr. gets TSU $1.9M for reparations. *Tennessee Tribune*. https://tntribune.com/education/college/hbcu/tsu/rep-harold-love-jr-gets-tsu-1-9m-for-reparations/

Williams, K. L., & Davis, B. L. (2019). *Public and private investments and divestments in historically Black colleges and universities*. American Council of Education. https://vtechworks.lib.vt.edu/bitstream/handle/10919/89184/PublicPrivateHbcus.pdf

Williams, M. J., George-Jones, J., & Hebl, M. (2019). The face of STEM: Racial phenotypic stereotypicality predicts STEM persistence by—and ability attributions about—students of color. *Journal of Personality and Social Psychology*, *116*(3), 416–443. https://doi.org/10.1037/pspi0000153

Zambrana, R. E., Harvey Wingfield, A., Lapeyrouse, L. M., Dávila, B. A., Hoagland, T. L., & Valdez, R. B. (2017). Blatant, subtle, and insidious: URM faculty perceptions of discriminatory practices in predominantly White institutions. *Sociological Inquiry*, *87*(2), 207–232. https://doi.org/10.1111/soin.12147

Zeiser, K. L., Kirshstein, R. J., & Tanenbaum, C. (2013). *The price of a science Ph.D.: Variations in student debt levels across disciplines and race/ethnicity*. American Institutes for Research.

AUTHOR

EBONY OMOTOLA McGEE, PhD, is associate professor of diversity and STEM education at Vanderbilt University's Peabody College, PMB 230 GPC 230 Appleton Place, Nashville, TN 37203; *ebony.mcgee@vanderbilt.edu*. She investigates what it means to be racially marginalized while minoritized in the context of learning and achieving in STEM higher education and in the STEM professions. Her solo-authored book is titled: *Black, Brown, Bruised: How Racialized STEM Education Stifles Innovation*.

Manuscript received May 9, 2019
Revisions received October 21, 2019, and February 1, 2020
Accepted October 19, 2020