American Educational Research Journal
October 2018, Vol. 55, No. 5, pp. 965–1006
DOI: 10.3102/0002831218763587
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Into the Storm: Ecological and Sociological Impediments to Black Males' Persistence in Engineering Graduate Programs

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While much is known about how Black students negotiate and navigate undergraduate studies, there is a dearth of research on what happens when these students enter graduate school. This article presents the results of a study of 21 Black male graduate students in engineering from one highly ranked research-intensive institution. This article provides evidence of structurally racialized policies within the engineering college (e.g., admissions) and racialized and gendered interactions with peers and advisors that threaten Black males' persistence in engineering. We argue for taking an anti-deficit approach to understanding Black males' persistence in engineering. We conclude with implications for policy, practice, and research

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that could further improve the scholarship and experiences of Black males in engineering graduate programs.

Keywords: Black males, broadening participation, engineering, graduate education, persistence

> It is not just [my] advisor, but also the department, the school, and the social scene. I think all of those things. If you don't feel like you have a positive or supportive environment in any of those, they could all be reasons that you wouldn't want to stick around here for a long time.
>
> —Paul (fourth-year doctoral candidate in electrical engineering)

The topic of persistence for high-achieving Black male collegians, especially those attending predominantly White institutions, has gained considerable attention for more than two decades (W. R. Allen, 1992; Bonner, 2000; Cuyjet, 1997; Fries-Britt, 1998; Fries-Britt & Griffin, 2007; Griffin, 2006; Harper, 2005; McGee & Martin, 2011a). This corpus of scholarship tends to promote a strengths-based approach to uncover the myriad ways undergraduate students successfully navigate educational spaces in the face of obstacles such as racism, isolation, and tokenism (Harper, 2010, 2015; McGee & Martin, 2011b). This work underscores how Black males' persistence relates to their connections to the institution vis-à-vis nurturing relationships with faculty, administrators, and staff. It also points to the benefit of Black males' identification and interactions with other high-achieving Black males.

The emphasis on high-achieving Black males at the undergraduate level begs the question: What happens to those high-achieving Black males after they complete their undergraduate studies? Some of them, like Paul, who is quoted previously, decide to attend graduate school (McCallum, 2016; McCoy & Winkle-Wagner, 2015; Winkle-Wagner & McCoy, 2016), where they may have equally tumultuous academic experiences due to gendered racism throughout the educational environment (Harper & Palmer, 2016; Ingram, 2007). Essed (1991) coined the term *gendered racism* to describe the specific dilemmas Black women face. She believed that racism and sexism "narrowly intertwine and combine under certain conditions into one, hybrid phenomenon" (p. 31) and pointed out that "Black men are [also] confronted with racism structured by racist constructions of gender roles, notable examples being the absent father stereotype or the myth of the Black rapist" (p. 31). Similarly, Smith and colleagues (Smith, 2010; Smith, Allen, & Danley, 2007; Smith, Yosso, & Solórzano, 2007) differentiated between the comparable experiences of racism that both Black men (and boys) and women (and girls) faced and those that were of a specific form of

anti-Black misandry, defined as an "exaggerated pathological aversion toward Black men created and reinforced in societal, institutional, and individual ideologies, practices, and behaviors" (Smith, Allen, et al., 2007, p. 563). In short, Black males have been subjected to gender-specific stereotyping, subordination, repression, and oppression. Yet when high-achieving Black males who learned how to successfully navigate predominantly White spaces as undergraduates continue to experience challenges on the graduate level, assumptions are often made that their challenges are individualized, which places the onus of academic difficulties on the shoulders of Black males themselves. This perspective not only represents a deficit approach, it removes all accountability for students' success from college and university communities.

Black males' success (and that of other underrepresented populations) in engineering communities is vital to addressing persistent calls for broadening participation in engineering (Brazziel & Brazziel, 2001; Chubin, May, & Babco, 2005; Maton & Hrabowski, 2004; Moore, 2006; National Action Council for Minorities in Engineering [NACME], 2014; National Academy of Sciences, National Academy of Engineering, Institute of Medicine, 1995). Yet the number of Black males in engineering remains startlingly low. Recent statistics highlight the gross underrepresentation of Black males in the field. According to Yoder (2015), 11,702 doctoral degrees in engineering were awarded in 2015. Of those, Black males only made up 1% (or 112) of earned engineering doctorates; these data include Black males who attended Historically Black Colleges and Universities but not those with "foreign national" status. While these statistics are not new or surprising, they should no longer be ignored. What are the implications for national security, infrastructure, technological advancement, and innovation if engineers who may see problems from different vantage points are excluded? Expanding the representation of Black male engineers will expand the talent pool contributing to solving the problems of the nation and world.

This article presents the results of a six-year study of 21 Black male graduate students in engineering from one highly ranked research-intensive institution. These participants represent the critical mass of Black males in their entire college of engineering. The article illuminates the challenges and barriers they faced with regard to navigating and negotiating gendered racialized experiences within the college. In this study, we interchangeably refer to the participants' persistent challenges as *gendered racism* and *gendered racialized experience* to emphasize the inability to disentangle intersections between race and gender. While we understand the unique roles that gender performance and masculinities may play in how others view Black males (Q. Allen, 2015), our operationalization of *gendered racialized experiences* refers exclusively to participants' biological beings: They were born Black and male, and people see them as Black males. Therefore, *gendered racism* and *gendered racialized experiences* refer to occurrences

related to gender and race. They could, for example, refer to interactions with others, observations of injustice, administrative policies and practices, and symbolic representations on college campuses that trigger gendered, racial, and ethnic identity awareness for students of color relative to others.

These gendered racialized experiences represent "the storm" referred to in the title of this paper. Black male participants in this study were well into the storm of their graduate programs at the time data were collected. Fortunately, at the time of this writing, more than half have made it through the storm by successfully earning engineering doctorates. While we applaud their collective accomplishments, this article does not serve as a "how to" guide for Black male students traversing dangerous engineering educational contexts. That is not our purpose here. Instead, we argue that Black males' low representation, persistence, and success in engineering are functions of gendered racialized structures within colleges of engineering. It is these gendered racialized structures that raise barriers to broadening participation. Thus, this article, based on empirical evidence, holds up a mirror to engineering colleges and the community members within them to reveal the gendered racialized storms systematically maintained in graduate engineering education. Investigating the college-specific experiences that engage students or turn them away from the science and engineering workforce can provide new understandings of the complexity of science and engineering participation.

Students of Color in Graduate School and Their Racialized Experiences

Relative to scholarship on the experiences of Black collegians in undergraduate studies, the literature on Black students in graduate education remains limited (DeFour & Hirsch, 1990; Harper & Palmer, 2016; Howard-Hamilton, Morelon-Quainoo, Johnson, Winkle-Wagner, & Santiague, 2009; Johnson-Bailey, Valentine, Cervero, & Bowles, 2009). Therefore, to frame the experiences of Black male engineers in graduate school, we include literature from the broader corpus of scholarship on students of color in graduate school, including but not limited to those in STEM fields. In the following sections, we describe students' graduate experiences in terms of ecological and sociological factors.

Ecological Factors: Racialized Experiences Within and Outside the Academy

A number of ecological factors influence Black males' graduate experiences. To begin, underrepresentation in STEM is a barrier to students' persistence. Between 1994 and 2014, the number of Black students pursuing graduate STEM degrees increased by 70% (National Science Foundation, 1994, 2014). In the aggregate, this increase is promising because it suggests

that more Black students are poised to earn advanced degrees in key subject areas where they have been historically underrepresented. However, it is important to note that the number of Black students—and Black males in particular—remains low despite increases over the past few decades. For Black males who are U.S. citizens and permanent residents, there appears to have been tremendous growth between 2003 and 2013. The number of Black males who earned doctorates in science and engineering increased by 25% during this time span. On the one hand, this looks like growth. On the other hand, the absolute numbers hardly increased at all. In 2003, 631 of 13,921 doctoral recipients were Black males; in 2013, the numbers were 798 of 16,542. This means that Black male representation has stayed basically flat, only growing from 4.5% to 4.8% of all science and engineering doctoral degree holders between 2003 and 2013 (Bidwell, 2015). While progress has been undeniable for these students, these numbers suggest that most STEM graduate programs still suffer from a lack of racial/ethnic diversity, especially regarding Black male student enrollment.

Establishing the landscape of higher education at the graduate level is important because even after decades of race-related educational research, students of color continue to report experiences similar to those from prior decades (DeFour & Hirsch, 1990). Most germane to this study are students' racialized experiences. Bonilla-Silva (2001) provides an understanding of how people and systems are racialized:

> Economic, political, social, and ideological [hierarchies] are partially structured by the placement of actors in racial categories. . . . The race placed in the superior position tends to receive greater economic remuneration and access to better occupations and prospects in the labor market, occupies a primary position in the political system, is granted higher social estimation . . . often has the license to draw physical (segregation) as well as social (racial etiquette) boundaries . . . and receives what W.E.B. DuBois called a "psychological wage." (p. 37)

Racialized incidents experienced by students of color on predominantly White campuses have been well-documented (Felder & Barker, 2013; George Mwangi, Fries-Britt, Peralta, & Daoud, 2016; Gildersleeve, Croom, & Vasquez, 2011). These experiences are not rare. They are commonplace in the everyday experiences of students of color. In fact, racialized incidents are so ingrained in the college campus experience that scholars regularly investigate the coping and resiliency strategies students of color employ to navigate these offenses. For instance, Truong and Museus's (2012) study of 26 doctoral students of color illustrates the racialized experiences faced by students of color on predominantly White campuses and their effects. Truong and Museus identified 12 forms of racialized experiences such as onlyness, isolation, low expectations, high standards, and violations of institutional and federal policies. They also identified 17 strategies for coping

with racial trauma, categorized into internal responses, controlled responses, and external responses. Similarly, McGee and Martin (2011b) argue that STEM students of color develop strategies to manage the stereotypes they face on their campuses. While these authors highlight patterns of resilience demonstrated by students, most significant to the current study are the incidents experienced by participants that led them to need strategies to manage the hostile campus.

Racialized experiences have deleterious effects on students' health and overall wellness and negatively influence students' sense of belonging on campus and their persistence (Johnson-Bailey et al., 2009; McGee & Stovall, 2015; Truong & Museus, 2012; Uqdah, Tyler, & DeLoach, 2009). When students of color face racialized experiences, they describe feeling isolated, unsupported, and on the margins on campus and within their academic departments (DeFour & Hirsch, 1990; Gay, 2004; Herzig, 2004; Johnson-Bailey et al., 2009; Milner, 2004; M. R. Williams, Brewley, Reed, White, & Davis-Haley, 2005). It is clear from the extant literature that students of color continue describing feelings of isolation because they are often the only students of color in their classrooms or constitute a small proportion on campus. Being the "only one" or "token [person of color]" expected to represent a race is exhausting and further promotes the trauma and stereotype management mentioned previously. Furthermore, scholars have shown that when students of color experience isolation, they also feel obligated to prove they are smart enough and belong at their institution and in their graduate program (Fries-Britt & Turner, 2005; McGee, 2016) and are not there due to affirmative action decisions to increase diversity (McGee & Martin, 2011b). Isolation for graduate students does not take place only on one's own campus. Students of color are often also marginalized within their broader field of study, as is the case in engineering, where out of 156,857 students enrolled in engineering graduate programs at both the master's and doctoral levels, Black males make up only 1% (or 1,574) of enrolled students (Yoder, 2015). It can be imagined that to feel isolated at all levels (field of study, institution, college, department, research group) can make Black males, and underrepresented students of color broadly, desire to escape to other majors or fields of study where there are more people who look like them.

Sociological Factors: Racialized Experiences Within Critical Relationships

In addition to ecological factors, several sociological factors also influence Black males' graduate experiences. The academic advisor, for instance, is widely considered to be the primary agent of student socialization during graduate school (Barker, 2011, 2016; Felder, Stevenson, & Gasman, 2014; Gardner, 2007; Graham, 2013; Nettles & Millett, 2006; Tinto, 1993; Twale, Weidman, & Bethea, 2016; Weidman & Stein, 2003; Weidman, Twale, & Stein, 2001). Not surprisingly, then, the faculty advisor "can make or break

a Ph.D. student" (Lee, 2008, p. 1). The relationship with one's advisor is central to doctoral students' progress and completion in part because advisors work intensely with students to help them develop a research agenda (e.g., dissertation); this research agenda is often a necessary component to demonstrate students' capacity to produce independent scholarship. Advisors also help integrate students into the campus, department, and field of study. Integration within these intellectual communities is necessary for academic and professional growth as well as critical to helping students feel connected to their field of study.

The advising relationship can become strained for a host of reasons. Most common in the experiences of graduate students of color are racial microaggressions. Sue et al. (2007) define racial microaggressions as "brief and commonplace daily verbal, behavioral, or environmental indignities, whether intentional or unintentional, that communicate hostile, derogatory, or negative racial slights and insults toward people of color" (p. 271). As described by Harper and Palmer (2016), racial microaggressions are like "death by a thousand cuts—an individual one stings, but the cumulative sum of them is quite injurious" (p. 150). The effects of racial microaggressions make individuals feel "othered" and often cause psychological stress (Burt, McKen, Burkhart, Hormell, & Knight, 2016; Pierce, 1970; Smith, Yosso, et al., 2007).

Issues with advising are often exacerbated in fields where one's advisor also serves as one's research supervisor, as in science and engineering (Graham, 2013). In these fields, the advisor's role is heightened because students tend to be involved in their advisor's research group and the work that they do in the research lab often becomes their dissertation work (Burt, 2014). In this regard, one's capacity to demonstrate research growth is tied to work done in the research lab. In these circumstances, the line between receiving advising and receiving feedback on one's research performance can become blurred. If an advisor commits microaggressions against a student, the student likely will not discern the offense as coming from either the advisor *or* research supervisor but rather from the faculty member holding both roles. Such experiences can leave students feeling inadequate about their academic progress and growth (Felder & Barker, 2013).

While much emphasis has been placed on the myriad ways faculty advisors mediate students' experiences, peers also shape students' overall doctoral experience. A relatively small body of literature shows that students learn through interactions with their peers (Fries-Britt, Burt, & Franklin, 2012; Gasman, Hirschfeld, & Vultaggio, 2008; Gatson-Gayles & Kelly, 2004; Holmes & Rivera, 2004; Marbley, Bonner, & McKisick, 2004; Patton, 2009). For instance, when it comes to research experiences, some newcomers turn to their peers for help (Baker & Pifer, 2011). Some feel more comfortable asking questions of their peers than of their advisors; with peers, there is a feeling of safety instead of shame if the student does not know

something the advisor thinks they should know (Fries-Britt et al., 2012). As evidenced in this body of scholarship, peers play an important role in the retention of students in graduate school. However, peers can and often do tend to be sources of stress and trauma for students of color in graduate school. In the classroom, peers tend to be co-conspirators with faculty in asking students of color to speak for their entire race or ethnicity, making students of color feel isolated and othered (Harper & Palmer, 2016). Racialized experiences are especially harmful when the offense makes students of color question whether an incident is racially motivated or not and when it forces students to psychologically manage the harm (McGee, 2016; McGee & Martin, 2011b). For instance, Fries-Britt, George Mwangi, and Peralta (2014) explored the racialized experiences of Black graduate and undergraduate students in physics. In one example, they describe the experiences of Manuel, who upon entering class found a copy of the book *The Bell Curve*, which offers a perspective that people of color are inherently intellectually inferior to White individuals, on his desk. Upon seeing the book, Manuel went to the college dean, who suggested that the incident was not a big deal and likely a "mistake." While the article specifically focused on experiences of foreign-born students of color, the experiences described by Manuel and others are not uncommon for students of color in general. Not only do students of color have to navigate hostile institutions and consistently prove their intellectual capacity, when they report racialized experiences or seek help, they are often told these experiences are just in their heads.

The literature on students of color in graduate education is scant relative to that on students of color at the undergraduate level. Yet across that extant literature, there appear to be patterns in the types of racialized experiences these students face. However, more nuanced examinations of students' experiences are needed. This study adds richness to the higher education and STEM education literature bases due to its focus on Black males in engineering graduate programs at one institution. This approach within a particular field of study is important, especially for a field like engineering, where the field is committed to broadening the participation of underrepresented populations but where most scholarship focuses on undergraduate students and where there is a dearth of research on Black males at the graduate level.

Conceptual Model

While some research has employed an anti-deficit approach that focuses on Black males who defied the odds and the enablers of their success (Harper, 2010), it is also important to better understand the underlying structural processes and experiences that make success a challenge. The Bowman role strain and adaptation model (BRSAM) emphasizes the social and psychological (i.e., psychosocial) resources that individuals often

draw from to succeed, including community and family support as well as individual or personal attributes such as resilience and self-efficacy (Bowman, 2006). Applied to Black individuals and other marginalized populations in various contexts such as education, family life, and health (Bowman, 1989; D. M. Griffith, Gunter, & Allen, 2011; Rowley & Bowman, 2009; K. L. Williams, 2014a, 2014b), the BRSAM underscores the importance of understanding these attributes in the context of the actual *challenges* individuals encounter. The aspect of the model most germane to this study is its emphasis on explicating the challenges students encounter due to structural gendered racism.

A key concept within the BRSAM is *role strain*. *Role strain* is defined as the challenges individuals face in highly valued life roles and their responses to such difficulties (Bowman, 2006). As applied to students in this study, student role strain represents the challenges and barriers individuals encounter in their roles as gendered and racialized students (K. L. Williams, 2014b; K. L. Williams, Burt, & Hilton, 2016). The BRSAM acknowledges that student role strain can result due to normative and non-normative obstacles. Some forms of role strain may be a function of the normative challenges that all students are likely to experience. For example, graduate students may experience strain because of the psychological stress of transitioning from undergraduate-level to more rigorous graduate-level coursework, cognitive difficulties with learning how to conduct research, or challenges navigating departmental social norms and expectations (Austin & McDaniels, 2006; V. L. Baker & Pifer, 2011; Burt, 2017; Gardner, 2007). While all students may confront strain-inducing challenges of some sort, Black males in graduate school must also tackle non-normative obstacles related specifically to their race and gender. Examples of such obstacles for Black male graduate students might include the psychological stress of feeling obligated to represent other Black students in courses, feeling isolated because of their underrepresentation on a given campus, or perceptions that professors have lower expectations of them because of their race (Barker, 2011; Felder & Barker, 2013; Felder et al., 2014; McGee & Martin, 2011b).

In addition to normative and non-normative obstacles, the BRSAM suggests that student role strain can also manifest because of structured inequalities due to race and/or gender. These inequalities can promote ecological barriers, social stressors, and personal stress—all of which have the potential to hinder student success. It is essential that research explore difficulties due to structural inequalities that many Black males experience in their pursuit of graduate STEM degrees. The difficulties described previously serve as a contextual backdrop for understanding how these students employ strengths to overcome anti-Black obstacles (i.e., policies and practices that are counterproductive to Black males' progress and achievement) (Dumas & Ross, 2016). From this vantage point, the BRSAM offers a lens that acknowledges the role of structural and institutional barriers in students' experiences, as

opposed to suggesting that students' social and psychological challenges are internally initiated. Hence, this model suggests that the "deficit" lies in the inequitable dynamics of the environment, not the students. Accordingly, our use of the BRSAM expands existing research by critiquing the structural inequalities that create strain-inducing environments and can obstruct successful outcomes for students from marginalized groups. By acknowledging the structurally rooted challenges that students encounter, we can more fully appreciate the resilience required to be successful in a particular context.

Considering the gendered racism that Black male graduate students in engineering experience at the social and institutional levels, the following research questions guide this study:

Research Question 1: What ecological and sociological barriers within a college of engineering promote non-normative student role strain for Black male students pursuing graduate engineering degrees?

Research Question 2: How do these ecological and sociological barriers influence Black males' persistence in engineering graduate programs?

Methods

This article derives from a larger exploratory study of the experiences of 32 Black males in engineering graduate studies across three predominantly White institutions during the 2010–2016 academic years. The participants in this study represent the critical mass of Black males in their respective engineering graduate programs. Questions in the broader study attended to pre–graduate school background and early formative experiences in STEM, reasons for pursuing and staying in graduate school, learning and professional development experiences in graduate school, critical contexts and interactions in graduate school, and being a Black male in an engineering graduate program. This article focuses on 21 Black males at one institution to highlight participants' experiences within their college of engineering, specifically focusing on the contextual factors within the college and the critical relationships that served as barriers to their persistence. By focusing on participants at one institution, we were able to identify college-specific policies, practices, and interactions affecting students' experiences in engineering, an opportunity that may be lost when comparing students across fields of study that do not enable a domain-specific account. Further, it was assumed that focusing this study on one population within the same cultural and political context, studying Black males in a college of engineering versus studying Black males across the STEM spectrum, would reduce the number of potential explanatory factors.

Table 1
Graduate Enrollment by Race and Gender at Midwestern University (Academic Year 2009–2010)

	White	Asian	Black (%)	Hispanic
Male	2,810	531	169 (1.4)	198
Female	2,800	503	325	195

Note. Total enrollment was approximately 11,800 (including international students but not including graduate students from professional schools like medicine, dentistry, business, etc.).

Table 2
Graduate Enrollment by Race and Gender at Midwestern University (Academic Year 2016–2017)

	White	Asian	Black (%)	Hispanic
Male	2,712	489	199 (1.5)	333
Female	2,725	493	317	359

Note. Total enrollment was approximately 13,000 (including international students but not including graduate students from professional schools like medicine, dentistry, business, etc.).

Research Site

The 21 study participants were graduate students (master's and doctoral) at a prestigious university. In fact, the College of Engineering at "Midwestern University" (pseudonym for the institution) was home to top engineering majors at both the undergraduate and graduate levels, warranting respect as a leader in the preparation of engineers. Tables 1 and 2 show graduate enrollment university-wide at the time of data collection. Of note, Black male enrollment at the graduate level remained under 2% (1.4% in 2010 and 1.5% in 2016) for the duration of data collection. These figures represent graduate enrollment across all of Midwestern University (not including enrollment in professional schools); the numbers of Black males in engineering graduate programs, thus, are miniscule. The engineering-specific enrollment numbers are not presented in this article to maintain the anonymity of the institution and the participants in this study.

Meet the Participants

The profiles of the participants in this study provide some information about the educational experiences and caliber of students included in the study, the kinds of high-achieving Black males attending Midwestern University's College of Engineering. See Table 3 for participants' demographic information. A majority of the participants self-reported coming

Table 3
Demographic Data for Study Participants

Pseudonym[a]	Class Level	Engineering Specialization	Ethnicity	Citizenship Status	Undergraduate Origin	Postgraduate Career Intention
Alphonso[a]	Fifth	Electrical	AA	FB	PWI	Industry
Chris[a]	Fifth	Chemical	Nigerian	NB	PWI	Industry
Christian	Third	Civil	AA	NB	PWI	Faculty
Daniel	First	Industrial	Nigerian	FB	PWI	Unsure
David	First	Design	AA	NB	PWI	Unsure
Jackson[a]	Third	Mechanical	AA	NB	PWI	Unsure
Jacob	Third	Chemical	AA	NB	PWI	Policy
Jaden[a]	Second	Electrical	AA	NB	HBCU	Industry
Jalen	First	Mechanical	Jamaican	FB	PWI	Faculty
James[a]	Fourth	Biomedical	West African	FB	PWI	Faculty
Jesse	Fifth	Electrical	AA	NB	PWI	Faculty
Joseph	Fourth	Material	AA	NB	PWI	Unsure
Marcus[a]	Third	Mechanical	Caribbean	FB	PWI	Unsure
Paul[a]	Fourth	Electrical	Ethiopian	FB	PWI	Unsure
Quentin[a]	Fifth	Electrical	Nigerian	FB	PWI	Unsure
Shawn	Fourth	Material	AA	NB	HBCU	Industry
Terrence[a]	Second	Material	Ghanaian	FB	International	Unsure
Titus	Second	Civil	AA	NB	PWI	Unsure
Trai[a]	Fourth	Mechanical	AA	NB	PWI	Industry
Tristan	First	Aerospace	AA	NB	PWI	Unsure
Victor[a]	Fifth	Chemical	AA	NB	PWI	Industry

Note. Class level refers to the number of years a student has been in graduate school. Citizenship status refers to students who are foreign born (FB) or native born (NB). Undergraduate origin refers to the designation of students' undergraduate institution: Predominantly White Institution (PWI), Historically Black College or University (HBCU), or an international institution. AA = African American.
[a]Denotes that a student has graduated since data collection.

from middle-class families (1 participant described coming from a poor and working-class family) and two-parent homes (4 participants described being raised primarily by their mothers). Of the 21 participants, 16 had mothers with postsecondary education, including 4 who held doctorates. Similarly, 18 had fathers with postsecondary education, including 3 who held doctorates.

Most participants (19) attended public high schools; 2 attended private high schools. Eight attended high schools described as majority White, 7 attended high schools where a majority of the students were classified as Black, and 6 attended high schools with racially and ethnically mixed populations. Collectively, their high school grade point average (GPA) was

approximately 3.66. Participants' collective GPA at the collegiate level was equally impressive at 3.58. Most participants (19) had attended Predominantly White Institutions (PWIs); 2 had attended a Historically Black College or University (HBCU).

In their engineering graduate studies, participants' specializations varied: electrical (5), mechanical (4), material (3), chemical (3), civil (2), aerospace (1), biomedical (1), design (1), and industrial (1). They also ranged in class level, their year in school during the time of data collection: first year (4), second year (3), third year (4), fourth year (5), fifth year (5). At the time of this writing, 11 of the 21 participants in this study have earned their doctorates from Midwestern University (this information was ascertained through personal contact, a benefit of the rapport building that will be described more in the following). It is important to note that in this article, *Black* is not synonymous with *African American*. Rather, we use *Black* to denote the more global diaspora of race. Thus, eight foreign-born students considered themselves Black but not necessarily African American. Some students considered themselves Nigerian, West African, Caribbean, Ethiopian, and Ghanaian. Finally, at the time of data collection, 6 students were interested in obtaining industry positions upon graduating, 4 were interested in a faculty career, 1 was interested in a policy career, and 10 were unsure of their postgraduate plans.

Both their high school and their college GPAs suggest that these students had historically been academically strong. As reflected in these demographic data, almost all of the participants in this study had experience interacting with and thriving in postsecondary academic spaces where they were not in the racial majority. Participants' family backgrounds, grades, involvement, and proven records of performing at high levels over extended periods of time indicate that these Black males had profiles of individuals likely to succeed in graduate school. Thus, it is reasonable to hypothesize that academic troubles they confronted were caused by institutional factors and not academic deficiencies (as existing scholarship on underrepresented students in STEM might suggest).

Data Collection

During the first wave of data collection (2010), a student leader in a student-run organization that caters to students of color in STEM fields, Really Intelligent Student Engineers (RISE), provided names of Black males in engineering who met the study's criteria: Black male master's or doctoral students in engineering. This assistance led to the initial 5 participants. After each interview concluded, participants were asked to provide names of other Black males enrolled in an engineering doctoral program at Midwestern University. This snowball sampling procedure (allowing participants who met the study criteria to help identify other potential participants

who also met the criteria) (Merriam & Tisdell, 2013) helped identify 6 additional participants. For the second wave of data collection (2016), an engineering administrator contacted eligible participants, which yielded 10 additional participants. To maintain consistency, the interview processes during both waves of data collection were nearly the same. Specifically, after granting consent, participants completed an eight-item demographic form. Then, one-on-one, semi-structured interviews were conducted (Merriam & Tisdell, 2013), guided by an interview protocol that allowed participants to describe their collegiate backgrounds, graduate school experiences, and identification with and intentions to remain in engineering (interview protocols were nearly the same across both waves of data collection except that questions that elicited redundancy were removed). Because the interviews were semi-structured, follow-up questions were asked to clarify or gain deeper understandings. Although participants were only asked for one hour of their time, several interviews approached two hours. Many of the participants acknowledged the interview as the first time they had been asked to reflect on their experiences in graduate school. As such, they felt the need to share their stories. In addition, many felt as though their participation in this study was necessary to make the experiences of future Black males in engineering better than their own.

Data Analysis

Adapted techniques from grounded theory were utilized to analyze data. Data analysis included two waves (2010 and 2016) and multiple rounds and was conducted by the principal investigator, the first author. In the first wave and first round of data analysis (2010), an inductive approach was used. Small segments of interview text were selected (coded) and defined in a codebook when they shed light on students' graduate experiences at Midwestern University, experiences that led them to graduate school, and/or experiences while in graduate school (Merriam & Tisdell, 2013). This process of coding was completed for each of the 11 transcripts in the initial wave of data collection. The goal was to be open to all possible accounts. Codes were constantly scrutinized to make sure their properties were distinct from other codes (i.e., constant comparison) (Corbin & Strauss, 2008). This process was iterative and ongoing. When one code could not be easily distinguished from another, it was reanalyzed and assigned a more appropriate label and definition. Confidence that saturation had been reached occurred when no new codes were identified. After the coding process, like codes were combined into categories. Examples of categories and their codes include: journey to the PhD (influence of others, personal aspirations, family expectations and encouragement, cultural pressure), pushing past obstacles (transitioning to graduate school, advisor relationships, experiences with qualifying exams, research experiences), and

sources of support (family, peers, undergraduate advisor/mentors, campus student organization, university).

A second round of data analysis specifically focused on participants' perspectives on being Black and male in an engineering graduate program. The aim of this intersectional analysis was to ensure that participants' racialized and gendered experiences were accounted for. Codes were emergent in that no preexisting codes based on a priori findings were used to generate the codes in this study. This does not suggest that the literature did not inform the process of analysis. For example, we were familiar with concepts such as racial microaggressions, racial battle fatigue, stereotype management, and resilience prior to analysis. However, those concepts and others served as sensitizing concepts; we were not searching for confirmatory data to validate hunches. Rather, we used the data, the voices of student participants, to determine the patterns of gendered racialized experiences they were reporting. To this end, we coded all instances where students described experiences based on their Black and/or Black and male identities. Examples of categories and their codes include dealing with tokenism (perceptions of prejudice, Black achiever isolation), unwavering optimism about completing the PhD (understanding the magnitude of undertaking the PhD as a Black man, committing to completing the PhD, excelling in small academic tasks), and rationales for and agency in engineering persistence (individual responsibility, opportunity to impact the engineering pathways for future generations of Black students).

During the final round of data analysis in the first wave, a deductive approach was used to consider the ecology, or contexts, in which participants' experiences were nested (e.g., college of engineering, department, research group); sociological interactions with various actors who mediated students' experiences within the college of engineering (e.g., advisors, research supervisors, non-Black peers, Black peers); and ways in which students communicated identification with engineering and long-term persistence in engineering (e.g., excitement to remain in academe or engineering industry after graduating, pursuing professional opportunities that do not relate to one's engineering training, dropping out of the PhD program). We remained attuned to the ways in which participants' experiences were gendered and racialized in efforts to help make sense of their nested contexts.

In the second wave of data collection (2016), a selective coding process was used for the additional 10 participants. The purpose of selective coding is to focus on particular codes to help with hypothesis testing (Corbin & Strauss, 2008; Merriam & Tisdell, 2013). For example, in the first wave of analysis, we identified a relationship between students' persistence and four factors: gendered racialized experiences in engineering, contexts in which participants' experiences were nested, who mediated students' experiences, and communication of engineering persistence. We tested these core categories through analyses of participant data in the second wave of

data collection. Constant comparison was also used to make sure that codes from the second wave of participants fit with the initial coding criteria in the codebook.

Because of the adapted grounded theory techniques employed (Corbin & Strauss, 2008), we did not begin analysis with a theoretical model to guide our analyses. Rather, after data collection and multiple rounds of analyses (both inductive and deductive), we drew on the BRSAM to offer a theoretically based interpretation of participants' experiences. That is, we maintained the core categories identified in previous analyses (i.e., gendered racialized experiences in engineering, contexts in which participants' experiences were nested, who mediated students' experiences, and communication of engineering persistence) but then turned to the BRSAM for conceptual guidance concerning participants' gendered and racialized experiences and how those experiences demonstrated non-normative student role strain in their nested contexts.

Role of the Researchers

In qualitative research, a practice of reflexivity encourages researchers to be aware of how their positionalities and worldviews shape all aspects of a study (Green, Creswell, Shope, & Clark, 2007; Merriam & Tisdell, 2013; Milner, 2007; Peshkin, 1988). We were reflexive with regard to how potential biases may have affected our interpretations of data (Bernal, 1998; Cooper, Jackson, Azmita, & Lopez, 1998; Warren & Vincent, 2001). Specifically, the principal investigator is a Black man who at the time of the first wave of data collection was a doctoral student in the social sciences (not engineering) and a faculty member during the second wave of data collection. Being a Black male doctoral student was beneficial in building rapport with participants in the first wave of data collection; participants felt as if they were sharing valuable information with a peer. The ease with which participants openly shared their experiences with the principal investigator was likely due to the researcher's social identity as a Black man, regardless of differences in academic fields of study. This ease of communication became apparent through the exchange of culture-specific terminology and nonverbal cues (e.g., head nods, fist bumps, Black-diaspora slang). Reflecting on his new professional positionality as a faculty member during data collection in the second wave, the principal investigator proactively considered strategies to make participants feel at ease candidly sharing their experiences with a faculty member who would not report their responses back to administrators and their faculty advisor. One such strategy included dressing casually in jeans and a college t-shirt like most participants and intentionally not dressing "like a professor" in a blazer or business casual attire. The second author, a Black woman, has an undergraduate background in STEM but holds a doctorate in a social science field. The third

author, a Black man, holds degrees in psychology and counseling. They too are professors. In whole, our intersecting identities, ideologies, and perspectives shape who we are as researchers, the nature of the interview protocol and research design, interactions with participants (including but not limited to how they interacted with the principal investigator, thus influencing the quality of the data collected), and the ways in which the data were interpreted (Bernal, 1998). Collectively, based on our aligned research interests and bodies of scholarly work, we agreed that Black male students (and underrepresented students in whole) hold unique and nuanced experiences. We also agreed that Black males' experiences vary based on a host of factors (e.g., ethnicity, socioeconomic status, family influences, perspectives on education). While we were careful not to assume that being Black (and/or male) made us experts on our participants' experience, we believe that our racial (and for the first and third authors, our racial and gender intersectional) identities are strengths in this study as we shared some similar experiences as our study's participants. Sharing these multiple identities with participants allowed for more nuanced cultural interpretations of the interview data that might be lost on researchers with different identities (Bernal, 1998; Green et al., 2007; Warren & Vincent, 2001).

Limitations

Several limitations to this study should be considered. First, the sample of 21 Black males in engineering graduate programs is not, nor should it be, considered representative of all Black males in engineering graduate programs as this study's goal was not to generalize to a broader population. Rather, the focus on 21 participants who were all Black males in engineering at the same institution provides more depth for understanding participants' lived experiences. Focusing on these 21 students allowed for consideration of their unique contextual (institutional and departmental) experiences, which might be lost or overlooked in a larger sample that included students across academic disciplines or institutions.

Second, the two times at which data were collected should be considered. It is possible that the two time contexts in which participants navigated Midwestern University were qualitatively different. However, the researchers remain confident that the lived experiences participants described mirror one another, irrespective of the years in which the data were collected. For example, several participants across waves of data collection referenced similar faculty advisors, administrators, College of Engineering policies and practices, and patterns related to peers. This gives us confidence that even though the years in which data were collected differ, the experiences had by Black males in engineering at Midwestern University between 2010 and 2016 remained relatively unchanged.

Third, the initial participants in the first wave of data collection were identified through their involvement and/or connection to other student leaders in RISE. However, participation in RISE was not a criterion for participation in this study. The goal of this exploratory study was to gain an initial understanding of the full range of experiences had by Black males in engineering doctoral programs. Because of the small number of Black males who met the study's criteria, access to any and all Black males was most important. Use of students who participated in RISE was merely convenient. Nonetheless, it is possible that the nature of the RISE student organization, an affinity group with the goal of discussing challenges and overcoming obstacles in STEM, might have encouraged certain types of student leaders—those who are outspoken about these kinds of social justice issues—to agree to participate in this study.

Finally, the social identities and individual experiences of most of the participants should be considered. Specifically, most participants came from U.S., White-dominated or mixed-race educational environments and self-reported middle-income families in which most parents had postsecondary education, and most participants were student leaders during their undergraduate years. It is possible that the participants in this study were specific types of students who were attracted to and/or recruited by the institutional prestige of Midwestern University. As such, their motivations for attending, surviving, and thriving at Midwestern University could have overshadowed how they made sense of their racialized experiences in engineering. In other words, because of being successful based on their background characteristics and perhaps family expectations, some may have felt the need to underplay their challenges during the interview, a learned behavior among students of color in STEM for coping with isolation and racial hostility (McGee, 2016; Truong & Museus, 2012).

Ensuring Quality

The trustworthiness and credibility of the findings were enhanced by a number of steps. First, even though data were collected in two separate waves six years apart, the same interview protocol was used, and it elicited similar results. This suggests that despite the difference in the years data were collected, the cultural context of the College of Engineering at Midwestern University remained relatively unchanged. It also suggests that the interview protocol is not time-specific and can be a valuable instrument in the future. Second, the principal investigator intentionally aimed to build trust and rapport. To establish feelings of trust, the interview protocol was purposefully designed to be general at first before probing into deeper, more sensitive questions related to graduate experience within the College of Engineering. This strategy allowed participants to ease into sharing their experiences and view the exchange as a conversation (rather than an

interview). The conversational nature of the interviews resulted in interviews that were longer and data that were more descriptively rich than anticipated. Because interviews were not abruptly concluded at the end of one hour, as per participants' requests, rapport was built, which allowed for an ample number of clarifying and probing questions. Third, actively searching for evidence that challenged the emerging findings (Merriam & Tisdell, 2013) provided depth to the understanding of Black males' experiences in engineering doctoral programs. Further, the principal investigator allowed himself to be vulnerable and answer personal questions *at the conclusion of the interview* about his doctoral experience, what he was preliminarily learning from other conversations with Black males in engineering, and future uses of the research study (Dunbar, 2008). While these informal conversations were not a part of the planned interview protocol, almost all participants asked these broader questions to ascertain how they fit into the larger scope of the project. Engaging in these conversations built trust between the researcher and participants.

Fourth, qualitatively trained colleagues were consulted throughout the entire research study, from research design to data collection to analysis (Creswell, 2012; Merriam & Tisdell, 2013). Additionally, the second and third authors further scrutinized the data in a final round of peer debriefing. All researchers engaged in conversation until reaching consensus that student quotations were accurately analyzed and explained. Engaging in a process of peer debriefing during the development of interview questions helped focus the interview questions on the engineering context. During data analysis, peer debriefing provided checks to early and ongoing interpretations of the data. The second author's background in STEM and social science also provided valuable peer review of the data. Fifth, after transcripts were checked against the audio recordings to ensure accuracy, all transcripts were sent to participants to ensure that what they said was captured in the ways they intended; no participants responded with comments. Finally, throughout the research process, memo-ing allowed for tracking of procedural decisions and potential relationships between the interviews, research questions, and prior research to arise. Discrepant evidence was noted whenever participants articulated disparate experiences. This audit trail helps make the study procedures transparent (Merriam & Tisdell, 2013). It also allows for replication of this research; researchers can learn from the decisions made in this study and bypass any mistakes.

Findings

Despite the resilience displayed by each of the Black males participating in this study, analyses revealed several ecological and social barriers that induced student role strain. These impediments, along with the non-normative student role strain shared by Black males in this study, describe

the storm and turbulence they were forced to navigate during their graduate work in engineering. We cluster these barriers based according to *where* the offense originated, centering on policies and practices within the College of Engineering. Furthermore, we then discuss the primary populations *who* commit offenses that threaten participants' persistence. In the following sections, we discuss Black male participants' racialized interactions with White and Asian engineering peers and their perceived hostile interactions with faculty advisors as sources of student role strain.

The Ecological Impediments of Underrepresentation: Institutional Practices, Non-Normative Student Role Strain, and Challenges to Black Males' Persistence

The underrepresentation of Black males within the College of Engineering was a source of non-normative student role strain for many of these students. Changes in institutional practices created an environment in which Black male students felt isolated and lacked the support needed to promote persistence, an ecology detrimental to student success. Throughout data collection, the institution was testing out new recruitment strategies while simultaneously adapting to federal policies to avoid further attacks on affirmative action. As indicated by M. R. Williams et al. (2005), the impacts of the ongoing affirmative action discourse on Black graduate students had yet to be fully realized. Still, they provided evidence that stereotypes and perceptions of affirmative action policies negatively contributed to some students' identity and psychological well-being, a finding similar to that of McGee and Martin (2011b). The challenges to students' identity and the reduction of their well-being represent forms of non-normative student role strain that students of color had to combat in hostile and racially charged academic environments.

Several other environmental factors influenced the non-normative educational challenges or strains Black males experienced. Changes in student recruitment led to lower Black male enrollment, which had impacts on the educational experiences of the Black male participants in this study. For example, the advanced students in this study, the third-, fourth-, and fifth-year students witnessed the impacts of changing recruitment policies. Of most concern to them was the College of Engineering's inability to explicitly recruit students of color via targeted recruitment weekends and other race- and ethnicity-focused strategies. In fact, several advanced students shared that they had chosen Midwestern University in part because of the efforts made to recruit them and other students who looked like them. These institutional efforts were an attempt to address structural racism (Bonilla-Silva, 1997) that exists within higher education and consistently creates barriers to opportunities for students of color in engineering fields. During the period in which such recruitment efforts ceased, older Black peers graduated,

leaving current students feeling isolated. Several participants noted the changing cultural climate of the College of Engineering that created barriers to their success. Trai, a fourth-year candidate in mechanical engineering, shared how the racial isolation he experienced resulted in increased non-normative student role strain: "I'm here 'cause I care about my craft. But it still makes it tough when you don't have a face that's familiar in a class." He further explained that before affirmative action legislation was passed, minority students had been specifically recruited for graduate studies in STEM fields, which made him feel empowered and understood:

> Seeing some of the people that were there . . . kind of powers me through. . . . It also helps you vocalize any other issues, that, you know, "Oh, professor x here looked at me kind of weird today," and kind of, you get the impression that a professor, he or she, might be treating you a little differently because you're Black or this and that. Another Black male can relate to that. A White male cannot. As hard as he may try, they can't. So that's very helpful I think when you are going through that kind of experience.

Marcus, a third-year candidate also in mechanical engineering, offered similar sentiments regarding the non-normative student role strain he experienced because of the low number of Black males in the College of Engineering:

> I would ideally love for there to be more African American men in my classes, for me. People are naturally going to want to be around people who look like them. I look at the Asians and when they come here, they have their own niche right away. Even though they are [from] a foreign country, they are completely comfortable. . . . As a Black man in engineering, I don't have that camaraderie. So, I am forced to immediately look outside of my comfort zone in order to find people who I can study with, talk with, and have overall support. . . . There is not that support there for me to succeed.

Marcus's comments reflect the non-normative challenges that many Black males report on predominantly White campuses. Black males cannot assume that other students will be free of gendered-racial stereotypes that their presence will not be a source of discomfort for non-Black students. This environmental context can potentially increase the strains that Black males develop because of the racial biases they are forced to navigate. It was risky for Marcus to step outside of his racial "comfort zone" and participate in cross-racial study groups. Because of the limited number of Black males (and females) in the College of Engineering, being in a racially homogenous study group was not an opportunity afforded to Marcus and his limited number of Black male peers. Marcus's apprehension is consistent with Fries-Britt and Griffin's (2007) findings that high-achieving Black students, described as "the best and the brightest," were judged based on the larger society's social

stereotypes regarding the academic abilities of Black students. These pressures made Black students respond with self-protective measures (i.e., coping strategies).

Earlier, Marcus referenced Asian students as having an easier adjustment to campus, especially when it comes to the ecological and social advantages of having a critical mass of Asian peers for support. Marcus was not the only participant to acknowledge the presence of Asian students in the College of Engineering. Quentin, a fifth-year doctoral candidate in electrical engineering, noted an increase in the numbers of Asian students in his lab and across the college:

> With my professor, I think I'm his first Black student. At least from the names of his students from the past, most of them are Asian or Chinese. So, he usually recruits Indians and Chinese. So, that's something he does consciously, and I am guessing other professors do that too. So, maybe it's Midwestern University some sort of predisposed preference that they [faculty] have coming in, and that's something that is seen in grad school.

Here, Quentin and other Black male students were trying to make sense of the racial composition of those in the College of Engineering. One way to make sense of the lack of presence of other Black males is to assume that the—predominantly White and Asian—professors prefer Asian students. Not only did Quentin assume that his advisor and other professors throughout the college actively recruited Asian students, he also suggested that embedded within the practices of recruiting students, faculty had preconceived biases regarding students and students' abilities based on their racial identity. Although Asian students outnumber Black students in the College of Engineering (specific numbers are masked to maintain institutional anonymity), we are not suggesting that Asian students are free from the burdens of racial stereotypes. For example, existing research reports on how Asian students—across a wide diaspora—deal with the "model minority" stereotype (Poon et al., 2016). Yet it is this same stereotype about Asian students that influences their participation and acceptance in STEM spaces. Similarly, the Black males in engineering experienced a particular form of non-normative student role strain unique to their racial identity and due to their limited representation. However, their gendered racialized stereotypes did not hold the same positive connotations as those of their Asian peers.

As evidenced by some of the quotations shared in this section, Black male students report non-normative role strain due to low representation of other Black male engineering students, being unsure that they are valued by their professors, and being unconvinced that there is a true commitment to their academic, social, and personal success. Feeling uncertain, lacking a perceived genuine interpersonal commitment to one's success, and missing a social/racial sense of belonging are conditions that lead to racial battle

fatigue (Smith, Mustaffa, Jones, Curry, & Allen, 2016). Still, Black males constantly debate why there are not more males who look like them on their campuses and in their academic majors. Alphonso, a fifth-year doctoral candidate in electrical engineering, shared the following insights about the lack of cultural representation and the resulting non-normative strain that he and his Black male peers encountered:

> You have to be comfortable with, I guess, being in the minority role—you know what I mean—in terms of the people here. Like if you're used to, like growing up, and let's say everyone you talk to, everyone in your school, is Black. And you go to, you know, college, and everyone you know, everyone you're used to dealing with, is Black. The environment is kind of set up to that culture, and promoting [and] building up that culture. And then you come to some place like [Midwestern University]. There's like White and Asian . . . grad students and professors. . . . There's definitely a lack of like Black professors and Black colleagues. So, if you're not used to that environment, not comfortable working in that environment, interacting with people in that environment, it's going to be tough for you to be at [Midwestern University] and to be successful.

In the previous quotation, Alphonso expressed arguments representative of those of his Black male peers in the study. First, embedded within Alphonso's quotation is the commentary that Asian students were not underrepresented at Midwestern's engineering college—nor in the field of engineering. Second, he argued that certain types of Black students are likely to survive the predominantly White environment of Midwestern University: those who have previous experiences being racially minoritized. This notion that only those accustomed to predominantly White environments can weather the storm is troubling and provides a glimpse into the challenges with recruitment efforts to deal with the underrepresentation of Black males. If current students are not having positive academic experiences because they feel undervalued due to their race, they may be unlikely to promote the graduate program to talented prospective students who could add to the diversity of the program. As evidenced in the previous quotation and throughout this section as a whole, the structural racism within the institution and the engineering college resulted in unfair treatment, unwelcoming environments, and racially induced non-normative student role strain.

Peer Prejudice as a Social Impediment: Gendered Racialized Experiences, Non-Normative Student Role Strain, and Barriers to Black Males' Persistence

The negative racialized social interactions that Black males had with their non-Black peers created non-normative strains that challenged their persistence. McGee (2016) reported that Black and Latinx STEM students often face "negative assumptions, biases, and derogatory, often toxic, stereotypes and microaggressions about their intellectual aptitude and STEM

identity" (p.1652) from their non-Black and non-Latinx peers (and faculty). In the current study, prejudiced attitudes among non-Black peers often led to discriminatory practices of exclusion, which many of the Black males noted, particularly in the context of academic interactions such as study groups. Several participants discussed the importance of study groups in the College of Engineering. Study groups appeared to serve not only as academic support but also as structures to aid the transition into doctoral-level work and acclimation to the engineering community. In fact, joining study groups was described as an essential activity for survival; participants suggested that their White and international Asian peers were successful in classes in large part due to the study groups they formed. Despite the value of study groups and the positive peer interactions that they can foster, Black male doctoral students in engineering described the non-normative student role strain they experienced because of racial biases from other students and within their departments. This strain often manifested as a feeling of isolation. Chris, a fifth-year doctoral candidate in chemical engineering, remarked:

> Asians, you know, they have a study group, they have a purpose coming here. They get together, they have support networks, such as these tests that they pass down. Whereas, a Black man . . . there's very, very few African-Americans in these different departments. For example, my department, I might be the only one. I'm the only one in my department. . . . So, the experiences to me are very, very much different. I'm looked at differently. I think I'm scrutinized even a little bit more.

In study groups, students learn course material from each other, perhaps in ways they might not otherwise learn it if studying on their own. One's attempts to join a study group are an indication of the desire to participate in the practices of that community (Lave & Wenger, 1991; Wenger, 2010; Wertsch, del Rio, & Alvarez, 1995). Harper (2015) reports that high-achieving Black males are not afforded the opportunities to benefit from a critical mass of Black male students in their respective majors. As Harper explains, and according to the assessment of students in this study, study groups—like those formed by the international Asian students they observed—provide mutually supportive learning environments, produce empathy among fellow learners, diminish social isolation, and create a social support network that provides a sense of belonging. As a result of the incredibly small numbers of Black males, Black male study groups are almost unheard of for most academic majors, including engineering. Instead, most Black males rely on community-based organizations, fraternities, and mentoring groups. As Chris reports, when non-Black study groups base their participation on whom they feel comfortable with and around or scrutinize membership based on a person's race, it is hard for Black males to break through artificial

racial barriers to join these knowledge-sharing networks. Because of the aforementioned reasons, Black affinity groups, like Midwestern's RISE, then become a necessary space for racial and gendered affirmation for Black males in STEM.

Such barriers perpetuate structural educational inequalities that can exacerbate the normative strain of graduate studies and present non-normative challenges for Black male doctoral students in engineering. Despite knowing that they should be in a study group and having an interest in joining one, the Black males who participated in this study found it difficult to gain access to the study groups dominated by their White and international Asian peers. Alphonso, for example, said, "Especially with the grad students [at Midwestern University] there's a lot of Asian students and they work together. It's not—you can't always get into that group." For these Black males, the isolation that they experienced was a form of student role strain that that was not only non-normative but also unnatural. While expressing his frustration with having to study alone, Trai indicated, "I'm sitting here trying to be superman [and] do it [study by] myself." The challenge with joining study groups, at least for the participants in this study, was that they were not invited and in some cases were rejected. Participants felt as though they had to aggressively seek the validation of their peers to gain access to study groups, and several never secured consistent study groups. Although the culture of competition within the College of Engineering fueled participants' desires to prove their intelligence to others, they perceived their race and the stereotypes associated with being Black males as the reason why they did not participate in study groups with colleagues. These racial biases created barriers to Black males' success; although they were thriving by persisting, they were excluded from fully participating in engineering learning communities. Also worthy of note are the stereotypes that the Black male participants in this study held of their Asian and White peers. Because of their underrepresentation within the College of Engineering, they likely assumed that *all* Asian and White students participated in study groups. Black males' generalizations of and comparisons to their peers were non-normative forms of strain. Furthermore, this finding suggests that even while experiencing barriers caused by race, Black males too can hold stereotypes of other students.

Other research on high-achieving Black collegians further supports the racially motivated non-normative student role strain articulated by the participants in this study (Fries-Britt, 1998; Fries-Britt & Griffin, 2007; McGee & Stovall, 2015; Tuitt, 2012). Specifically, they describe how the structural barriers and social isolation Black students experience at predominantly White institutions cause individuals to feel the need to prove themselves. This "proving process" is unhealthy because it is never-ending. In the present study, not being invited into study groups was a microscopic example of a larger narrative of feeling unaccepted in science and engineering. At times,

participants were made to feel as if they had been admitted to meet quotas. Victor, a fifth-year doctoral candidate in chemical engineering, asked, "Am I just here for numbers' sake, or am I here for what I can offer to this department?" As articulated by Paul, a fourth-year doctoral candidate in electrical engineering, the non-normative strains induced by challenges at the institutional and social levels make leaving an easier option than perseverance:

> It is not just [my] advisor but also the department, the school, and the social scene. I think all of those things. If you don't feel like you have a positive or supportive environment in any of those, they could all be reasons that you wouldn't want to stick around here for a long time.

Chris, a fifth-year doctoral candidate in chemical engineering, expressed a similar sentiment, suggesting some might consider a different life course:

> Well, instead of going through this prejudice in my school [and] in my department, I can go and get a job with my master's degree and make good money, and maybe work my way up. The plan changes, but you . . . [you] get away from the negativity that is in their department.

Both Paul and Chris suggested that the non-normative strains caused by their educational contexts (school, department, and the broader city environment in which Midwestern University was situated) threatened their persistence in engineering. They expressed a desire to fully participate in engineering, yet they also considered leaving engineering to avoid dealing with the "negativity" they faced in their attempts.

Faculty Biases as Social Impediments: Feelings of Otherness, Non-Normative Student Role Strain, and Threats to Black Males' Persistence

The roles of faculty advisors are extensive and vary by field of study and in some cases by department. Despite the nuanced differences in advisor roles, existing literature suggests that advisors should serve as sources of information, liaisons to the department, dissertation supervisors, agents of socialization, role models, mentors, and career coaches (Antony & Taylor, 2001; Austin & McDaniels, 2006; Barnes & Austin, 2009). Jackson, a third-year doctoral student in mechanical engineering, discussed the importance of his relationship with his advisor this way:

> Some people liken the advisor relationship to a marriage and that you are likely to be together four, five, six, seven years depending on how long you are here. Being able to come in and foster that relationship is important.

Most students understood the important role that advisors played prior to becoming engineering students. They knew that advisors had the

responsibility to help them learn content knowledge, transition into graduate school, and learn and prepare for a range of postgraduate careers. These typical roles are forms of mediation whereby advisors and students interact and as a result, graduate students become better able to participate within the graduate community and field of study (Burt, 2014).

Most of the participants in this study perceived their advisors as threats to their success in engineering and saw no organic opportunity to establish stronger relationships with them. In addition to isolation from peers, this form of academic isolation from advisors also has the potential to deter persistence given the critical role of advisors in a graduate program. When arriving at Midwestern University to start a doctoral program, participants expected to be welcomed and guided by their advisor. Alphonso, for instance, described his need for an academic advisor who would validate his academic progress:

> You know, you're looking for [advisors] who are in their positions of academic success or support. So, you're looking for your academic validation. They're the ones grading you and your reports. So, you're looking for them for your academic validation in a way.

Not only were participants denied the academic validation and encouragement they sought, many described receiving explicitly discouraging messages from their advisor that ranged from passive-aggressive to explicit challenges regarding their ability to do doctoral-level work. James, a fourth-year candidate in biomedical engineering, shared examples of how his advisor communicated:

> My advisor—he's—when he tells you stuff, it's kind of—so if you approach him, and he asks you questions, and it was like some fundamentals you don't know, or you were never taught it as far as software stuff—I don't want to say he belittles you, but he'll kind of be like "yeah, you learned this as a junior in undergrad, and the sophomores here are doing it." And I'm like, "ok."

James hesitated to name his advisor's racial microaggressions as belittling, but when James's advisor compared his engineering knowledge to that of Midwestern University sophomores, the implicit message was that James did not have basic, foundational knowledge needed to complete the work of engineers. Racial microaggressions are often described as subtle negative comments or behaviors that are either brief or ongoing (Burt et al., 2016; Pierce, 1970; Smith, Yosso, et al., 2007; Sue et al., 2007). It could be argued that James's advisor meant no harm and that his comment was not related to race at all. Regardless of his advisor's intent, the effects of the comments were harmful to James. Comparing James's ability to that of Midwestern University sophomores, almost all of whom were White, carried a racial implication that was not lost on James.

Other participants reported similar negative interactions with faculty that resulted in non-normative student role strain. Jaden, a third-year electrical engineering doctoral student, for example, described his first interaction with his advisor:

> When I did my initial grad search I only found a few advisors who I considered working with. Um. A lot of them wouldn't respond to email and I thought, "this won't go well." The one who did, I went to his office and he gave me this bizarre look. I'm not sure if he expected me to be Black honestly, that's what I think it was.

Here, Jaden explained how his initial interactions—or lack thereof—with potential engineering advisors caused him trepidation regarding his graduate experience to come with professors who would be too busy, unresponsive, and inattentive. The lack of response from faculty members can be considered normative role strain in that it is not specific to the Black male students in this study. However, Jaden's cumulative interactions with this particular faculty member prompted him to wonder if race played a role in the "bizarre" interactions, an example of non-normative role strain. For instance, the quizzical look Jaden described on the professor's face should not be ignored. From Jaden's perspective, the look was prompted because he was Black in an engineering context where the majority of graduate students seeking advisors are White and Asian. As time went on, Jaden observed similar instances where communication between him and his advisor was minimal. Reflecting back on his first interaction with his advisor, including the "bizarre look," made Jaden question himself: "Is my advisor not talking to me because I am Black?" It could be argued that what Jaden—and his Black male peers—experienced was bad advising. While that too might be true, these participants attributed their experiences to race based on their perspectives in the engineering context at Midwestern University. In Jaden's example, non-normative role strain was exhibited by the cognitive load it took for Jaden to consider whether his experiences were typical or racialized. That extra burden of wondering if gendered racism is the culprit or if one's experiences are somehow a mental fabrication is an added unnecessary stressor (i.e., strain) for underrepresented students of color attending PWIs (Bowman, 2006; Bowman & Howard, 1985).

Paul, an electrical engineering doctoral student, described interactions with his advisor that threatened his motivation to persist. Paul reported, "I don't know why, I still don't know why he, he basically said, you know, 'why don't you go out and work first for a few years,' that was his opinion." It remained unclear to Paul what his advisor was trying to communicate and whether his advisor was attempting to be helpful or was being condescending. To Paul, his advisor's comment appeared to be the latter. Why would Paul's advisor encourage him to leave the doctoral program—before earning his degree—and immediately get a job in an industry career, other than to

suggest that he was not meeting expectations? Paul did ultimately meet expectations by earning his doctorate from Midwestern's engineering college. This memory of Paul's was significant, however, because it signaled one instance where he could have dropped out based on the encouragement of his advisor. This quotation also represents a common experience across this study's participants: a crossroads experience where they felt challenged about their status as graduate students and their potential as future engineers.

Chris also described not only demoralizing interactions with his faculty advisor but also the weight of the resulting non-normative student role strain as it relates to dropping out:

> I think dropout rates [of Black men at the doctoral level] are definitely influenced by the departments [and] by the interaction with your professor. Now, when those get uncomfortable for the Black male, and especially the advisor relationship gets uncomfortable, coupled with the prejudice people have with you being a minority male, in a field dominated by White men, the pressures can get to you. [You start to] see the fact that you can't do it, and realize that there's another good option—get out with my M.S. [master's of science] and work.

Like Chris, Jackson too shared how he believed his experiences in engineering resulted from his underrepresented status as a Black male. Jackson commented, "And, I guess my feeling is that maybe I'm subject to other judgments that if I were in the majority I wouldn't be necessarily subject to." Jackson's comment advances his belief that underrepresented students at Midwestern University's engineering college have different experiences, in his case, that he received more scrutiny and judgment than his majority peers (i.e., those from White and Asian backgrounds). Both Chris and Paul's quotations provide examples of how racial misandry and gendered racism shape their experiences as Black male graduate students. Specifically, they both explained how their experiences are different than those of the "majority"; in a field dominated by males, they—as Black males—do not benefit from being males because they are minoritized males (Mutua, 2013). As a result, they are excluded from White male privileges in "a field dominated by White men," as expressed by Chris. Also important to recognize is how matter-of-fact Jackson is about his assessment, which almost appears to suggest that his unequal experience in graduate school is part of the normal hidden curriculum for Black males in engineering graduate programs.

The result of receiving discouraging messages from an advisor was that students did not feel comfortable communicating with advisors when they needed help. Accordingly, the students' negative interactions with faculty not only elevated their non-normative student role strain, it also fostered

coping strategies of self-preservation. This finding about students' self-preservation relates to McGee and Martin's (2011b) work on stereotype management. Although the advisor should be the person who assists students when they are having academic trouble, according to some of the participants in this study, acknowledging one's limitations was equivalent to conceding what they were fighting against: the perception that they did not really belong in the engineering doctoral program at the prestigious Midwestern University. This finding relates to the work of Smith and colleagues (Smith et al., 2016; Smith, Yosso, et al., 2007), who discuss the racial battle fatigue of Black males at predominantly (and historically) White institutions. The authors argue that racial microaggressions sometimes come in the form of subtle comments or behaviors that add psychological stress to the recipient. A consequence of racial battle fatigue, according to the authors, is that Black males become exhausted from developing coping strategies to navigate these hostile environments. It can be assumed, then, that if a student no longer wanted to deal with the non-normative student role strain resulting from what was perceived to be a hostile environment, he would drop out. Or equally troubling, the student would choose to no longer participate in engineering.

Discussion and Implications

The Black males in this study pursued graduate education because they enjoyed STEM, thrived academically as undergraduate students, and wanted to continue pursuing their goals in engineering. Many chose Midwestern University because of its stellar reputation in the field of engineering. They all described being excited to start graduate school and having high expectations of what they could achieve during graduate school. Yet the 21 Black males in this study encountered non-normative student role strain resulting from ecological and social barriers within the College of Engineering, including isolating institutional practices, discrimination from non-Black peers, and raced-based faculty biases. These challenges served as reminders of being a gendered racialized "other."

Institutional and social barriers create environments that are counterproductive to successful outcomes for Black males specifically and students of color more generally. Based on the findings from this study, the non-normative student role strain caused by underrepresentation of students of color in STEM poses unique challenges for Black males. It limits opportunities for students to establish community with others from similar backgrounds and fosters self-doubt by perpetuating the belief that people of color lack the intellectual aptitude necessary to succeed in STEM fields. This example of student non-normative role strain is inextricably connected to negative racial biases about people of color within STEM fields and broader racialized social stratification that maintains the underrepresentation of people of color in STEM fields.

In addition to their underrepresentation, the Black males in this study exerted more than considerable energy trying to identify, judge, predict, and discard racially motivated microaggressions (Profit, Mino, & Pierce, 2000). The majority of the gendered racial microaggressions they faced were automatic, indirect, stunning, or seemingly innocuous messages that were both verbal and nonverbal, resulting in a perception that they were both devalued and unwanted (Smith, Yosso, et al., 2007). In totality, racial microaggressions are inescapable and are cumulative expressions of racist views, (dys)conscious ideologies, and institutionalized practices toward people of color (King, 1991). According to King (1991), "dysconsciousness is an uncritical habit of mind (including perceptions, attitudes, assumptions, and beliefs) that justifies inequity and exploitation by accepting the existing order of things as given" (p. 135). Such ideologies are the social psychopollutants that disrupt the lives of Black males and other people of color while at the same time privileging most White individuals (Smith, Hung, & Franklin, 2011). These disruptions are why the cumulative effects of frequent racial microaggressions and racial battle fatigue are important subjects for continued research if we are to understand their impact on the success of Black male graduate students.

Implications for Policy and Practice

The focus of this article was not on the resiliency of Black males. Instead, we discussed the ecological and social factors that were detrimental to their success and made resilience a necessity. Faculty, administrators, and staff who are in positions to inform policy and practice might start by investigating existing policies and practices. No matter how well intentioned, policies such as changing recruitment strategies may have unintended consequences for smaller populations, like Black males, negatively influencing the context needed for these students to thrive academically. Regarding practice, several participants in this study noted the non-normative student role strain they encountered because of negative advising experiences. This highlights an area ripe for much needed institutional investment. An appropriate advisor-advisee match may be critical to students' academic experiences. Faculty advisors are important to students' persistence; this is not a novel revelation. But this study's targeted focus on Black males offers a deeper understanding of the nature of the relationship between Black male students and their advisors. Faculty need to invest in students by helping shape how they view themselves as individuals, members of the graduate community, and within engineering. Some of this can be done through the research experience. Taking more time to help students work through challenges in research and reaffirming students' belief in their abilities and potential contributions to engineering would be beneficial for students' progress.

In addition to creating the infrastructure to support Black males once they have been admitted into a doctoral program, through appropriate advisor-advisee matches for example, attention should be aimed at increasing their representation at all levels (i.e., faculty, administration, students) to help reduce the non-normative student role strain reflected by their feeling that they are anomalies in the college of engineering context. This may be a challenge, especially as affirmative action policies are being attacked and reduced. However, if broadening participation in engineering is truly a goal, creative efforts to achieve diversity must include a committed strategic plan that is inclusive and involves other university partners. Institutional policymakers could establish a task force, hire a college-level diversity officer, and/or hire diversity recruitment specialists in each department who are tasked with developing partnerships and creating other strategies that might help with recruitment. Such efforts would require appropriate funding to succeed. It is necessary to acknowledge that having a full-time individual or team designated to tackle diversity should not excuse faculty serving as advisors from understanding the significance of their roles in facilitating the progress of Black males. There also must be an internal change that welcomes diverse students, especially Black males. This structural change and commitment must include the dean of the college, department chairs, and faculty. Failure to address this important factor will render meaningless any attempt to foster diversity.

Black males would also benefit from institutionalized support programs that connect them across engineering fields. Implementing programmatic efforts or establishing graduate organizations like Midwestern University's RISE, where Black males can interact with other academically talented peers in science and engineering, would aid in students' persistence. This type of intentional support structure would strengthen students' academic sense of self and help to buffer, at least in part, the non-normative strains fostered by isolating (and oftentimes hostile) engineering educational environments. However, if this strategy is chosen, it needs to be supported by the institution financially and have support from administrators. While such a student organization can be helpful, creating an organization cannot and will not, alone, fix or alleviate an unhealthy college climate.

Implications for Future Research and Theory

This study illuminates several opportunities for future research. First, there are alternative sampling strategies that could either more narrowly or widely scale the sample. Both strategies would extend the existing knowledge base concerning the experiences of Black males in engineering graduate studies. For example, the participants in this study represented various departments within the engineering college. As a result, there may have been differences in policies (e.g., how students acquire advisors), funding

structures, and recruitment strategies by department and thus different student experiences. To limit the potential variation caused by participants' engineering specializations, participants were asked general questions about their experiences to elicit broader information about being a Black man in an engineering doctoral program. Researchers interested in more narrowly investigating students' experiences by specialization could pursue a more nuanced exploration.

Second, while this paper suggests the importance of a domain-specific focus, there is merit to examining students from various fields of study across an institution; there could be contextual factors related to institutional policies and practices that shape students' experiences. Future research investigating students' experiences at both field-specific and institution-wide levels may help identify systematic structures and policies influencing students' experiences. Additionally, future research that includes participants' experiences from an array of institutions and institution types would help further characterize the prevalence of Black males' experiences in engineering, illuminating whether their issues are institution-specific or more broadly related to counterproductive legacies and traditions of STEM. Additionally, by widely exploring the experiences of Black males in engineering, the educational scholarship on Black males will become rich with suggestions for negotiation and navigation strategies for Black males successfully persisting in engineering graduate education.

Third, this article utilized the BRSAM, a framework that provides a useful analytic tool for understanding how ecological and sociological barriers can create challenging circumstances or strains for Black males in graduate engineering programs. In addition to noting the strains that Black males experience, which may be similar to those of other students (i.e., normative), the model allows an examination of non-normative strains reflective of racialized and structured inequalities. It should be noted that by using the BRSAM, we employed a different approach for thinking about anti-deficit research. Specifically, our analysis centered on the ecological and sociological factors that served as barriers for students. With this different approach, our analysis shifted the focus from students' deficits to the deficient systems and structures that served as barriers to students' success. This shift of focus was possible because the BRSAM contextualizes students' challenges and acknowledges how their challenges are rooted in race-based and gender-based structural inequalities.

The BRSAM was not without its limitations. Although the model acknowledges structural inequalities of marginalized populations in general, it was not designed to explicate the experiences of high-achieving students who are also racially underrepresented. A conceptual framework that specifically focuses on high-achieving students of color would capture the unique experiences of students who have excelled academically yet have to navigate gendered and racially motivated biases despite their records of

exceptional scholastic performance and potential. In addition, the BRSAM was not designed to specifically address students' experiences in STEM. Given that different disciplines often have different norms, expectations, and socialization processes, it is feasible that a model specific to these fields may unearth some of the unique experiences of marginalized students therein. Future research should create new models that speak to the experiences of students who are marginalized, high achieving, and in STEM fields, including intersections of these categories. Future research that captures these intersections, while also identifying the structural barriers to succeeding in STEM, would help address calls for broadening participation in these fields.

Also with regard to theory, this study illuminates a need for more theoretical insights about the unique gendered racism and microaggressions that Black males experience in engineering. Existing STEM research concerning gender focuses, primarily, on the experiences of women in these fields (Cohen & Deterding, 2009). Existing research also notes that Black males often face stereotypes, subordination, and oppression as a result of their race and gender (Curry, 2016; Essed, 1991). Accordingly, future studies should seek to better understand and theorize the complexities of these intersections for Black males within the context of engineering fields (e.g., a theory on "Black male gendered racism in engineering"). This is especially pertinent as Black males battle challenges of underrepresentation (despite the male-dominated nature of STEM fields).

Finally, despite the odds stacked against them, at the time of this writing, more than half of the 21 participants in this study have earned their doctorates from Midwestern University; those remaining continue persisting in their efforts to earn a PhD. This statistic is offered only to suggest that these high-achieving Black males are accustomed to overcoming barriers in science and engineering. Their realities are consistent with existing research that suggests academically successful Black students implement race-related socialization practices shared across generations for dealing with racism and surviving and thriving in a "White world" (Bowman & Howard, 1985). Understanding the important roles of race, gender, and other social identities in students' development is a strength of newer conceptualizations of graduate student socialization (Barker, 2011, 2016; Felder et al., 2014; Twale et al., 2016). Further examinations of graduate students of color utilizing these newer models of graduate student socialization will provide clues to the wide range of race- and gender-specific socialization practices needed for successful navigation in the academy.

Concluding Thoughts

Focused scholarship on underrepresented groups, for example Black males in engineering graduate programs, is limited. This study adds to the existing STEM education research by identifying pervasive challenges of

Black males pursuing graduate-level engineering degrees. As such, this article was not intended to be a fairy tale with a rosy ending. Rather, this article intends to highlight the often unheard voices of Black males in graduate education, namely, graduate engineering education. The voices of Black males in this study highlight students trying to strive and survive in the turbulent conditions of graduate engineering education. Their stories illuminate a hidden curriculum of traversing the storms of academia and succeeding in science; to succeed, one must be prepared to negotiate and navigate a field—and the people within the field—that makes them feel unwanted and unqualified. Their stories provide further clues to the kinds of barriers some students must overcome to successfully persist in engineering as well as clues to how students' perceptions of engineering pathways are formed and solidified. This article also serves as a call to action for those in positions of power genuinely committed to improving the educational experiences of current Black males in graduate engineering programs and helping to forge a path for broadening participation in STEM for future generations of Black males in engineering. Based on the findings in this article on the gendered racialized experiences of Black males in graduate engineering studies, persistence in engineering at the graduate level may begin to be better understood. Using this new knowledge, institutions of higher education can better address calls to recruit and retain more Black males to graduate programs in engineering.

Consistent calls to action for the broadening of participation in engineering pathways have been extended over the years. However, the policies, practices, and activities of institutions still have the potential to threaten students' progress. The additional non-normative strain this places on Black male students then becomes a deterrent to their success and leads administrators and faculty members to make the excuse that Black males are not equipped to successfully complete a rigorous program. We should be asking how institutions create the barriers that force students to unnecessarily have to cope and survive. When responsibility for students' negative experiences is placed on institutions rather than students, we can then more productively ask how institutions can help alleviate these barriers for students.

While it is clear that institutions need to be more accountable for the practices and other campus environmental factors that pose a threat to Black males' educational success, we also recognize that the delicate intricacies of structural racism may obstruct progress toward inclusion. As Carter G. Woodson (1933) articulated,

> The same educational process which inspires and stimulates the oppressor with the thought that he [and she] is everything and has accomplished everything worthwhile, depresses and crushes at the same time the spark of genius in the Negro by making him [and her] feel that his [and her] race does not amount to much and never will measure up to the standards of other people. (p. xiii)

The oppressive nature of these institutions for Black males is what helps maintain the status quo and the nature of elitism within competitive colleges and universities as well as highly prized STEM fields like engineering. It would be misguided to overlook this connection and passively wait for institutions to change their course of action. Neither Black males nor the Black community writ large can wait for institutions to address their race-related issues. We cannot afford to allow another Black man or woman's genius get depressed or crushed. Accordingly, future research must also tap into the race-related socialization and adaptive role strain practices that have helped Black students to be successful despite institutions' preservation of learning conditions that are oppressive for these students. These problems are not new; this is old wine packaged in new bottles. Yet there is enough brilliance within Black communities that the existence of efforts to nurture and bolster Black boys' and girls' "spark of genius" should never be in question. It is our goal to address these efforts in our future studies.

Note

This work was supported by the National Academy of Education/Spencer Postdoctoral Fellowship Program and the National Science Foundation-Iowa EPSCOR (under grant EPS-1101284).

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Manuscript received August 31, 2015
Final revision received January 11, 2018
Accepted January 12, 2018