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Robust and Fragile Mathematical Identities: A Framework for Exploring Racialized Experiences and High Achievement Among Black College Students

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I introduce the construct of fragile and robust identities for the purpose of exploring the experiences that influenced the mathematical and racial identities of high-achieving Black college students in mathematics and engineering. These students maintained high levels of academic achievement in these fields while enduring marginalization, stereotyping, and other forms of racialization. Their fragile mathematical identities were manifested in the way they were motivated to achieve in order to prove false the negative expectations of others. Their robust mathematical identities were characterized by an evolving sense of self-efficacy and discovery, a growing affinity and passion for mathematics, and a desire to be a mathematically inspiring role model. Extending the work on identity development, I recommend more nuanced interpretations of the interplay of human development, racialized experiences, and distinctly race-related risk and protective factors that complicate mathematical identity formation for Black college students in mathematics and engineering fields.

Key words: Black college students; High achievement; Mathematical identity; Racial identity; Racial stereotypes

Although the research community frequently discusses the achievement, or lack thereof, of African Americans[1] in mathematics, traditional reports often fail to acknowledge that educational spaces too readily become breeding grounds for the systematic marginalization of Black students. Over the past 20 years, a growing group of mathematics education scholars have been challenging the narrow focus on traditional quantitative standards of measuring academic success and have

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[1]The terms *African American* and *Black* are used interchangeably throughout this article.

suggested a more expansive perspective that includes learning and involvement negotiated inside and outside of the mathematics classroom (e.g., Gutiérrez, 2008; Lubienski, 2008; Martin, 2000; Stinson, 2011). Rather than focusing simply on student achievement measures, these researchers have critically examined the experiences of marginalized students, their families, and their communities. They have substantiated the need to understand the racialized mathematical experiences of Black students, including the experiences of those who have maintained high achievement in spite of encountering frequent marginalization (Ellington, 2006; McGee, 2013b, 2013c, 2014).

Implying that failure is a predictable outcome for Black students studying mathematics leaves little room to explore Black students' success, agency, and resilience in the field. The lack of research on African Americans' success in mathematics leads to the mistaken conclusion—and widespread stereotype—that above-average achievement in this area is somehow nonexistent among Black students. Inattention to intragroup differences, including the fact that some mathematically talented Black students endure racial bias within and beyond the classroom, fuels the perception of racial disparities in mathematics achievement (Martin, 2012; McGee, 2013a).

Although the overall percentage of African Americans earning mathematics-related degrees has decreased over the past 15 years (Chen, 2009), a significant number of African Americans continue to excel in these fields at every stage of the academic pipeline (Berry, 2008; Berry, Ellis, & Hughes, 2014; Martin, 2000; Mutegi, 2013; Stinson, 2013; Thompson & Lewis, 2005; Walker, 2011). However, the question remains: Who tells the stories of successful Black students—those who score at or above proficiency levels, maintain high GPAs in mathematics-intensive fields, and obtain the traditionally accepted metrics of academic success—and explains why those stories matter?

My attempts to answer this question led to a study in which I analyzed the experiences of 23 high-achieving African American college students who were mathematics and engineering majors at the junior, senior, and graduate levels (McGee, 2009). I explored the students' racial and mathematical identities as a window into characterizing the factors that accounted for their academic resilience. These students' personal histories revealed their experiences in the home, school, neighborhood, and workforce with a particular focus on negotiating racial incidents in school contexts. Although all of the students in that study had encountered significant obstacles, both in school and in out-of-school contexts, they exhibited resilience in navigating through the difficulties in their lives. They universally believed in the power of their resilience to positively affect their academic achievement and life outcomes. The study accounted for the variation in how African Americans not only interpret but also react to the opportunity structure in mathematics and engineering, given their interactions. The meanings that arose from that work became indispensable for understanding the diverse strategies by which high-achieving Black college students interpret and respond to their experiences.

As a result of my analyses, I constructed a Model for Trajectories of Resilience

Among Successful Black Mathematics and Engineering Students, which highlights the interplay between defining oneself with race-based expectations (fragile resiliency) and defining oneself through self-generated criteria (robust resiliency). This model integrates identity, meaning making, and racial experiences in understanding the mathematical outcomes of Black college students (McGee, 2009).

I have continued to build on these theoretical perspectives by considering the fragmented and continuously negotiated aspects of mathematical identity development for Black students. I reexamined my findings about fragile and robust resiliency through the lens of identity, merging certain parts of the resiliency model and refining and redefining other parts. The result is presented here as the Fragile and Robust Mathematical Identity Framework. This framework more holistically explores the interplay of mathematical and racial identity in the experiences of Black college students.

The purpose of this article is to illustrate the utility and explanatory power of the framework in narrating and problematizing stories of Black college students in the fields of mathematics and engineering who have excelled academically through racially tumultuous terrain. I present a brief review of the literature related to identity, describe the Fragile and Robust Mathematical Identity Framework, and present two cases to illustrate its explanatory power using student-based accounts that capture the structure of fragile and robust mathematical identity.

Review of Literature on Identity Development

Researchers focusing on identity development (e.g., racial, gender, mathematical) have advanced interpretations of the student experience—how power relationships are enacted in learning spaces as well as how students interpret, internalize, and negotiate their experiences (e.g., Martin, 2013; Smith, 1998; Stewart, 2015). Many researchers studying identity subscribe to the idea that people negotiate different identities within different contexts, and some of these researchers have provided powerful examples of the expectations surrounding racialized and marginalized identities (e.g., Steele, 1997; Tatum, 1997). Such research offers detailed perspectives about how teachers' and learners' identities can be enacted and shaped by participation in socially situated practices.

Mathematical Identity

Within the past 15 years, the mathematics education literature has established the relevance of identity construction for mathematics learning and with regard to learning outcomes (e.g., Boaler & Greeno, 2000; Cobb & Hodge, 2002; Gutierrez & Rogoff, 2003). Some researchers have taken up the notion of identity as critical to understanding students' attitudes and responses toward mathematics (Boaler, Wiliam, & Zevenbergen, 2000). The discourse in the recent mathematics education literature addresses a number of conceptual issues, the most salient being the notion that identity and its development cannot be understood without examining the larger social context (Nasir & Cobb, 2002; Walker, 2012). Furthermore, there is a recognition that identity is dynamic across situations and can be transformed from

one moment to the next (Boaler & Greeno, 2000; Wood, 2013).

Although this research has clarified the significance of identity-related processes that are just as central to mathematical development as content learning, only a small number of researchers have conducted studies on mathematical identity as it relates to African Americans (e.g., Berry, 2005; Martin, 2000, 2007; Nasir, 2000, 2002; J. A. Spencer, 2009). The number is even smaller for exploring mathematical identity in African American college students, who can reflect on their mathematics learning and participation within different academic time periods and across crucial stages of their development (Ellington & Frederick, 2010; Jett, 2011; Noble, 2011; Stinson, 2013).

Racial Identity

Blacks in America have a history characterized by oppression and discrimination that has contributed to a unique racial and racialized identity. The role of racial identity—that is, the extent to which societal and personal meanings of race influence a person's self-concept and consequent behavior (Sellers, Caldwell, Schmeelk-Cone, & Zimmerman, 2003)—in the lives of Black students is a complex phenomenon. For example, Black students often face additional sources of stress inside and outside the classroom because they often receive negative or mixed messages about appropriate belief systems and cultural capital (Lee, Spencer, & Harpalani, 2003).

Racial identity is conceptualized differently for different racial and cultural groups according to their individual beliefs (Nasir & Saxe, 2003). The Phenomenological Variant of Ecological Systems Theory (PVEST; M. B. Spencer, 2006, 2008) contributes to understanding about the diverse ways that Black students and families cope with challenges. The PVEST model examines the interaction between environmental context and identity development and presumes that an individual's perceptions of his or her environment and experiences are crucial to gaining an understanding of the experiences and responses of Black students (M. B. Spencer, 2006).

African American Students' Mathematical Identity

Recently, considerable progress has been made in understanding the mathematical identity of African American students, adding racial and cultural constructs for analyzing students' educational and mathematical learning experiences. Mathematics education research has benefited from culturally and racially relevant definitions of mathematical identity in unpacking the complexities of African American students' participation in mathematics. Martin (2000, 2006, 2009, 2013) has published extensively on issues related to African American learners (children, adolescents, college students) and parents, exploring the role of what it means to be Black and a doer of mathematics and the intersectionality of mathematics and racial identities. His work has taken into account the historical legacy of racism and the continuing segregation and discrimination of African Americans and how these experiences contribute to a collective identity of what it means to be Black.

Martin (e.g., Martin, 2006; Martin & McGee, 2009) and others (e.g., Gutiérrez, 2008; McGee, 2009; Stinson, 2013) have advanced the assertion that mathematics learning and participation can be conceptualized as racialized forms of experience. This perspective suggests that the meanings for race are very salient in structuring mathematical experiences and opportunities and just as relevant in shaping common-sense beliefs and official knowledge about who is competent (or not) in mathematics. Although negative outcomes in mathematics education among Black students are sometimes incorrectly attributed to race (as biology), Martin's work discussed above demonstrates the racialized nature of students' mathematical experiences that most profoundly influences these outcomes.

Much has been gained from research and theoretical frameworks geared toward better understanding of the mathematical identity development of African American students. The intricate ways that mathematical identity intersects with racialized experiences can serve as a guide for interpreting the mathematical and racial experiences of Black students. However, the current framings of mathematical identity and its development do not present a comprehensive conceptualization of the ways in which the racialized experiences of Black students may have an impact on the development of their mathematical identities. Moreover, current frameworks do not capture how high-achieving students' may react to racial threats on their mathematical identities. The duality of mathematical experiences for African Americans is important because it offers insights into the subtle mechanisms of how being raced and stereotyped cause added stress for many high-achieving Black students who must expend extra emotional energy in order to succeed in the spaces they inhabit. Understanding the developmentally and racially sensitive nature of mathematical identity is crucial to unpacking critical turning points in African American students' mathematical academic and career trajectories. The framework presented in this article is an attempt to operationalize these constructs with regard to the mathematical identity development of Black students.

Fragile and Robust Mathematical Identity Framework

The racialized experiences that high-achieving Black college students face in the mathematics classroom can be described through the lens of fragile and robust mathematical identity. Mathematical identities are coconstructed and renegotiated around a number of factors, including the frequency of racialized events within and beyond the mathematics classroom and the intensity of these events across a wide set of situations. Thus, mathematical identity is fluid, continuous, dynamic, and at times situationally dependent. How students make meaning of their environments is critically important in addressing the experiences that they endure, which adds another layer of description and understanding to their decision-making. Motivations to succeed in mathematics within this framing include proving one's mathematical talents, and these motivations can be operationalized by negotiating racialized experiences, which affect one's dispositions connected with mathematics accomplishment. However, repeated negative racialized experiences can produce unhealthy consequences, even while academic scores remain high.

The Fragile and Robust Mathematical Identity Framework attempts to explain the complex experiences many African American students undergo, including intersections with racial stereotyping, mathematics interactions, agency, resilience, and passion for mathematics as well as learning how to play the game and feeling heavily conflicted about it. In this framework, the term *fragile* is defined as the delicate and vulnerable relationship between Black students' mathematics success and the persistent racialization they endure in their discipline. The term *robust* is defined as the strength and agency that students develop in spite of their racialization to maintain self-motivated mathematics success. The three components of fragile and robust mathematical identity are (a) central motivations to succeed in mathematics, (b) the use of coping strategies in response to students' racialized mathematical experiences, and (c) dispositions associated with one's successful outcomes in mathematics. During specific time periods, mathematical identities are either mostly fragile or mostly robust, and those labels became useful in unpacking the actions and motivations behind the mathematical experiences. Below, I describe each component in more depth.

Motivations to Succeed: Defending Versus Defining Oneself

The first component of the framework captures the shift between defending oneself against stereotypes and other forms of bias and defining oneself according to criteria that are purposefully self-generated (see Figure 1). In some cases, mathematics achievement is framed as a preemptive defense strategy against potential and realized racial bias (McGee & Martin, 2011a). As a result of being frequently stereotyped,

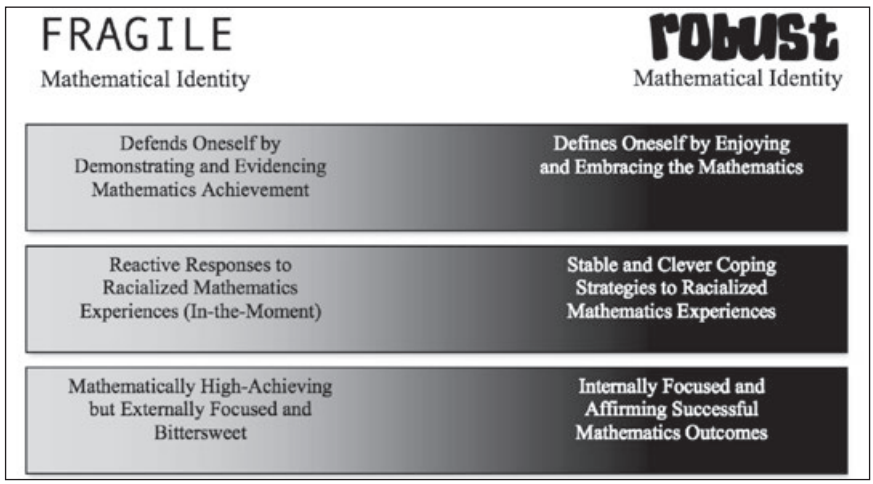

Figure 1. The three components of the Fragile and Robust Mathematical Identity Framework: (a) motivations to succeed: defending versus defining oneself, (b) coping strategies: reactive versus stable responses, and (c) dispositions associated with success: external versus internal focus.

subtly ridiculed, and racially discriminated against, some individuals express an unyielding desire to excel in mathematics in order to disprove those who doubt their mathematical abilities or hold a deficit perspective of Black students. Others harbor a sense of obligation to meet the expectations of parents who want to substantiate the mathematical and intellectual worth of their children through mathematics success.

Some students report a weariness that comes from having to constantly prove oneself as worthy and competent. This emotion is often coupled with a deeper appreciation of mathematics that fuels different incentives, prompting one to seek out people, events, and organizations in which mathematical identities are affirming and encouraging. This is an intentional shift in one's energies from proving oneself to teachers, professors, peers, and important others (e.g., internship employers, lab instructors, school administrators) to honoring one's mathematical identities in ways that bring happiness and fulfillment. This shift encompasses self-discovery and self-definition based on like-minded people, spaces, and places and often includes the presence of mentors, other academically talented students, and community and college organizations.

Coping Strategies: Reactive Versus Stable Responses

The second component of fragile and robust mathematical identity involves coping with racially unsettling situations within one's mathematical experiences. These situations produce two central ways of coping: reacting in the moment or using clever and well-developed responses. Reactive coping responses happen mainly after a jarringly or surprisingly negative incident in the mathematics classroom. For example, a mathematics professor tells a student on the first day of class that his office hours were "made for students like you," and the student temporarily stops attending classes. Racial stereotypes and other forms of bias can be unpredictable and are often met with reactions that range from contempt to sadness and depression. Responding to subtle and overt forms of racism with anger sometimes exacerbates already tense situations, can lead to unhealthy outcomes, and may increase personal trauma (Chao, Mallinckrodt, & Wei, 2012; McGee & Martin, 2011a; McGee & Spencer, 2014). Feeling hurt by stereotypes without having adequate outlets for relief and understanding may produce temporary and volatile responses.

With time and maturity, one's mathematical identity can become more robust as more stable coping strategies are developed—strategies that do not entail simply reacting to negative situations but instead involve clever, more sophisticated retorts to counter racist assumptions. Unsatisfied with reacting in the moment, students learn how to adapt in negative environments, which drives the formation of a strategic set of skills that offer some protection against instances of overt and subtle forms of racism. This strategic skill set allows students to sustain greater emotional stability while minimizing the anxiety and drain associated with their previous in-the-moment responses. After testing, fine-tuning, and refining these response effects, students decide that their time and energy could be better used working in positive and proactive spaces in which emotional safety and solace is commonplace. Such coping strategies help minimize the impact of racism, sexism,

and other forms of marginalization in racialized classrooms. These stable reactions assist in sustaining mathematics achievements and appear to lessen the injury to one's racial and mathematical identities.

Dispositions Associated with Success: External Versus Internal Focus

The third component of the framework characterizes success in mathematics as shifting from bittersweet and externally driven to affirming and internally fulfilling. One's initial mathematics successes are frequently defined as bittersweet because the drive to excel in the standard forms of mathematics achievement (e.g., teacher and peer acceptance, test scores, correct mathematics homework and in-class paperwork, or other mainstream measures of achievement) is motivated by proving one's intellectual capacities but not necessarily because of a strong affinity for the subject itself. External proof from peers, teachers, school administration, and significant others is often the primary reason for sustaining high achievement in mathematics. Being perceived as smart and capable of learning and doing well in mathematics is an unrelenting promoter, causing students to strive to achieve, almost to the point of obsession. One does not have to believe the negative expectations that are presented and may even adamantly reject them, but at the same time, one is driven to dispel stereotypes that situate one's expectations of success as minimal.

When shifting from an external to internal affirmation for learning, one's decisions to succeed in mathematics are based on reasons associated with one's affinity with the discipline and one's own self-satisfaction. Becoming more aware of racial stereotypes, racism, and other forms of discrimination may lead one to recognize the futility of attempting to rid society of low expectations for African American students and to choose instead to serve as a role model for younger students, who are likely to face the same racialized challenges in future mathematics classrooms. A robust mathematical identity partially shields one from other people's judgments, thereby allowing one to maintain positive attitudes and behaviors. This form of mathematical identity is framed as robust because mathematics achievement that is internally motivated and supplemented by emotionally healthy networks is self-affirming and sustainable.

Descriptive Illustration of the Fragile and Robust Mathematical Identity Framework

To illustrate the explanatory power of the Fragile and Robust Mathematical Identity Framework, I share the stories of two African American students, participants in the McGee (2009) study, who characterized their learning experiences as racialized. My goal is to present a nuanced understanding of mathematics success in racially discriminatory spaces. Through the lens of this framework, I sought to examine the development of mathematical identity for these high-achieving students and to identify the approaches they adopted, created, or negotiated to maintain their high achievement outcomes despite their racialized experiences. Also, I wanted to

understand how these students made meaning of the racial bias in their mathematics participation over the course of their schooling, including the K–12 years.

Method

Using extant data from McGee (2009), I conducted a comprehensive examination of the 23 African American college students who participated in that study. Data had been collected within the students' personal contexts, which included their own language and cultural niches (Rubin & Rubin, 2012). I used McAdams's (2008) life-story interview process as a way of gathering details about the influences at various stages of their lives and mathematical development. For example, each student provided an overview of the main "chapters" of his or her life as a mathematics learner, including a summary and title for each chapter. Students described particular and significant mathematics events, including a high point, a low point, and a turning point. They interpreted racialized experiences and explained where these experiences fit into the context of their overall life story. Finally, they described where their story might be going (i.e., future chapters). The students also provided details about their personal ideologies, including self-description, religious beliefs, political values, and the tenets that guide their life. A phenomenological interpretation of those data allowed me to paint a broad picture of the students' lives and experiences in their homes, schools, neighborhoods, and college settings. Findings from these analyses are reported elsewhere (McGee, 2013a; McGee & Martin, 2011a, 2011b; McGee & Spencer, 2012, 2014).

Participants

In this article, I showcase the experiences of only two students, Tinesha and Rob. The choice for focusing on Tinesha and Rob was largely due to the encompassing ways in which their interviews most poignantly captured the findings of the other 21 interviewees. Tinesha attended Medium University,[2] a public institution located in a large city in the Midwest that serves the local population. It is primarily a commuter campus and has about 25,000 students. About 90% of Medium's students are residents of the state. Tinesha completed her Master's degree in bioengineering and completed her first year as a graduate student in mathematics education at a Midwestern university. Tinesha narrated many of the gender issues that the other females in the study endured. Rob attended Soho University, which is also located in a large Midwestern city. It serves a large international student and faculty population and caters to science, technology, engineering, and mathematics (STEM) students. Rob graduated with his PhD in applied mathematics and joined the faculty of a predominantly Black university in a Midwestern city. Rob was raised in two different types of neighborhoods, one racially mixed and the other predominantly Black, and he provided in-depth counterstories of these two starkly dissimilar environments. Both students had accumulated significant life experience as African American adults, which

[2] Pseudonyms are used for institutions and participants.

allowed them to articulate and challenge conventional stereotypes about African American students in mathematics and engineering.

Additionally, the quality and extent of the interview data collected for Tinesha and Rob increased the trustworthiness of my interpretations of their mathematical identities, including a thorough account of crucial time periods during their academic lives. Tinesha and Rob were interviewed for a total of 259 minutes (over the span of 21 months) and 220 minutes (over the span of 17 months), respectively. They performed member checks on two of their three interviews, which allowed them to check their statements for accuracy and intended meaning (both declined the offer to review their final interview).

Data and Analysis

I analyzed the accounts of Rob and Tinesha through the lens of the three components of the Fragile and Robust Mathematical Identity Framework. I identified incidents (which I refer to as scenes) in the written transcripts of the interviews that described important life experiences related to "being Black" and being a high achiever in mathematics or engineering, that referred to the positive and negative experiences in their stories, that revealed the host of challenges they faced, or that indicated how they managed the various and complex forms of racialization they had encountered. Multiple scenes pertained to each component of the framework, and some scenes related to more than one component.

I drew on the PVEST model during my analysis by coding data with the particular goal of unpacking the participants' risk and protective factors. For example, I identified patterns of coping and resiliency (or lack thereof) that students developed over time (M. B. Spencer, 2008). I highlighted the students' vulnerabilities, pliability, and challenges (as identified by risk factors) as well as supports (as identified by protective factors) in their social and academic lives. The students themselves had identified these risk and protective factors based on their individual perceptions and meaning making (cf. M. B. Spencer, 2006).

All data were analyzed using a constant comparative method from an interpretivist stance (Suddaby, 2006). An interpretivist framework emphasizes the significance of context and the multiple ways in which students form meanings. The initial coding step involved open coding of words that appeared numerous times in the transcripts. Next, open codes were grouped into axial codes. Axial coding involved linking the open codes together. In the final step, selective coding, explicated themes were developed and compared. Table 1 presents a sample of the coding architecture for Tinesha and Rob at two distinct time periods, K–12 schooling experiences and college experiences. As a result of this analysis, for each component of the Fragile and Robust Mathematical Identity Framework, I identified a complex pattern of behaviors, characteristics, opportunities, and barriers that supported the development of the students' mathematical identities.

A senior colleague reviewed and critiqued my ongoing analyses in monthly meetings. These interactions prompted multiple iterations of the codes and themes and helped me identify core consistencies and meanings. This same colleague

provided an additional layer of scrutiny and offered perspectives that challenged some of my initial assumptions. The dialogue that arose from our meetings enabled the refinement of my analysis of the fragile and robust mathematical identities for Tinesha and Rob.

Positionality and Subjectivity of the Researcher

In formulating my own perspectives in this study, I juxtaposed my academic and research background with my experience as a teacher of Black and Latino students. Studying those learners requires an acknowledgment and discussion of my own positionality and subjectivity. As Peshkin (1988) proclaimed, "One's subjectivity is like a garment that cannot be removed" (p. 17). With Peshkin's quote in mind, I confess that my research has been influenced by critical race theory, which has helped me recognize that power, privilege, race, class, and sexual oppression are at the root of many of the academic barriers these students face, and the devaluation of humanity based on race. Thus, I made a conscious commitment to perform this research from a race-conscious perspective, to examine how being racialized operates in the mathematics classroom, and to challenge the status quo by giving voice to the participants through their narratives.

I self-identify as a Black woman and a mother. Having endured the challenges associated with being Black, female, and a "doer of mathematics" (Martin, 2006), I have discovered that my experiences are similar to those of the students I research and teach. Thus, I am sensitive to the struggles that are common to the African American experience in U.S. society and to experiences in the mathematics field in particular. However, because I was educated in an undergraduate mathematics-intensive program more than 20 years ago, my experience and achievement in mathematics differ from those of the participants in this study. Therefore, I remained mindful of the participants' more current perspectives and of the ever-changing ways that race is constructed in the mathematics classroom.

Robust and Fragile Mathematical Identity: Illustrated Through the Experiences of Tinesha and Rob

To demonstrate the components of this framework most effectively, I extracted direct quotes from both Rob's and Tinesha's interviews that expressed their thoughts and how they made meaning within each component of the framework.

Brief Background

Tinesha grew up in a low-income, "all-Black community (except for the owners of gas stations and convenience stores)" that she described as a "Blackout," meaning mostly Black residents and culture. She attended predominantly Black elementary and high schools and described her transition to college as turbulent. Tinesha was considered a minority in a number of different but overlapping contexts: She was a racial minority on campus and in her discipline as well as one of the few women in her discipline. In contrast, as a Black student, Tinesha was a racial majority in her first college mathematics class because—despite graduating

Table 1
Tinesha's and Rob's Fragile and Robust Mathematical Identity Codes From Two Broad Developmental Schooling Timeframes

	Fragile Mathematical Identity	Robust Mathematical Identity
Tinesha (K–12 years)	Frequent moving/changing of schools Attended underresourced urban schools Bullied for "always being the new kid" at school Mother's ailing health increased Tinesha's responsibilities to care for her younger brothers and sisters Motivated to learn mathematics to retain the "smart" and "talented" label Being educated in a series of deprived neighborhoods	Being raised in city housing projects (provided close proximity to other family members) Multigenerational Sunday dinners, where all the family gathered in her grandmother's small apartment and celebrated life and family togetherness Being classified as a smart student, especially in mathematics, opened up many scholastic opportunities Self-defined as naturally good in mathematics Close bond with brothers and sisters who supported one another Gained resilience from mother's perseverance in difficult times Negotiated being the teacher's pet Attended predominately Black K–12 schools
Rob (K–12 years)	Motivated to learn mathematics to prove stereotypes wrong Possessed an externally driven determination to prove his intellectual abilities Dark skin tone Heightened sense of class inequities as lower to lower-middle SES in an upper SES community Attending an elementary school with large number of White and Asian students Angered over being rejected as "very smart" in some mathematics classes	Tough love from mother A smart and competitive younger brother A self-determination to prove his intellectual abilities High quality out-of-school mathematics teachers Not looking visibly African American Frequent receiver of praise for mathematics skills Rich mathematics content knowledge from an international home mathematics library

Tinesha (college years)	Despair associated with being placed in a pre-freshman level remedial mathematics course Racialized stress from lab and classroom situations Temporarily avoided attendance in classes in which racial stereotypes were active and undisputed by faculty and peers Not communicating with friends and family members, after experiencing a racialized incident Experienced racial shock over some African-born students not wanting to associate with Black American-born students—brief disengagement from school activities	Rising confidence in mathematics ability Increased academic capital and savviness in navigating the college environment Motivated to succeed in mathematics college and career trajectories to mentor Black and Brown youths and start business (incorporation of more self-defined strategies) Participation in National Society of Black Engineers and the Black Student Union (incorporation of more self-defined strategies)
Rob (college years)	Feelings of self-doubt associated with his attendance at a prestigious STEM college institution Disturbed by the legacy of racism that persists in many mathematics environments Being mistaken for being "non-Black" exposed heightened experiences with racist ideologies Feelings of helplessness in the plight of teaching mathematics to Black children Adoption of behaviors considered "smart" by mainstream society (e.g., wearing nonprescription glasses, nodding excessively in class), which created identity sacrifices	Great pride in being a mathematical high achiever (self described cockiness) Use of racial comedy to cope with being the victim of racist and colorist stereotypes Motivated to succeed in mathematics college and career trajectories to mentor Black and Brown youths (incorporation of more self-defined strategies) Motivated to learn mathematics to become "that Black math teacher" (incorporation of more self-defined strategies) Provided mathematics teaching and tutoring at a predominantly Black high school Use of news satire as a coping mechanism Marveled over the ridiculousness associated with witnessing racial stereotypes in mathematics contexts

at the top of her high school class and getting all As in mathematics—she tested into a remedial mathematics course in which her classmates were primarily African American and Latino.

Rob lived in a community that was cited as one of the most diverse neighborhoods in the world (Mayfield, Hellwig, & Banks, 1999), although in his words it was "cleverly disguised to perpetuate shrewd racial and even shrewder class divisions." He realized from a very early age that the stereotype that Blacks are less intelligent than Whites prevailed in his school. He made a conscious and deliberate choice to do well in mathematics to prove those stereotypes wrong. Rob sadly remembers feeling intellectually berated and psychologically disempowered the day he came home from third grade and asked his mother, "Why are all the White kids smart and all the Black kids dumb?" The reality of low expectations and racial bias followed him through his high school experiences and did not disappear, even when he won a coveted college scholarship to a prestigious university known for producing world-class mathematicians.

Although Tinesha and Rob were successful in mathematics, their fragile mathematical identity motivations were driven by other people's expectations. These expectations stemmed either from their parents' belief that mathematics achievement was one of the only ways to obtain a career and financial security or from their need to defend themselves against the negative racial stereotype that Blacks could not succeed in mathematics. They handled their stress and anxiety about the perception and reality of lowered expectations by defending themselves against racially biased ideologies through their academic achievements. This resulted in encounters that included constant worry to the point of obsession about negative stereotypes and temporary feelings of helplessness.

Defending Versus Defining Oneself

At first glance, meeting their parents' expectations may appear to have been a positive influence (robust) on the two students' mathematics aspirations. Family leaders—whether they are parents or guardians, married or single, or extended family members—can assist in empowering Black students to be resistant to academic failure and resilient for success (McGee & Spencer, 2015). However, Rob described his mother's motivations as being couched within the deteriorating status of Black males and his probable lack of other options for achieving life security. The message that Tinesha got from her mother was that mathematics was the family's ticket out of her low-income neighborhood in which over 80% of families were living below the federal poverty line. Neither participant mentioned that their parents advised them to establish an affinity for the subject or encouraged them to follow their academic passions. Tinesha and Rob attested to mastering mathematics initially because they felt they lacked other options. In their home communities, there were few Black women and men gainfully employed in jobs requiring a college education, and their parents saw their mathematics achievement as a way out of those desperate conditions.

Rob recalled that soon after his parents divorced, his mother was explicit about the future of her two young male children:

> My parents were divorced, and my mom let me know from day one that we were poor and the only thing that we had going for us—I'm sorry—was our smarts and that we better get smart fast.

Rob credits his mom's candor for his early motivation and subsequent agency to succeed in mathematics, but she also gave Rob the impression that his options were very limited. Rob said that his mother's ideology situated academic attainment as their only way up the economic and social ladders.

For Tinesha, growing up in a predominantly Black neighborhood and being a high achiever granted many extrinsic benefits, such as being assumed smart by teachers, increased school leadership, and summer job opportunities. However, her reasons to succeed in mathematics were fueled by fear that the high expectations of her teachers could diminish with one "bad" grade. Tinesha's narrative illuminates the fragility of her success against the fear of potentially being perceived as a failure. The transition to college produced new forms of racial insecurity. Tinesha felt a sense of obligation to prove that she was worthy to teachers, peers, parents, and school personnel of "just being there." She explained further:

> I came to realize, like, these people [college administrators, teachers, and her peers] don't expect too much of me in this class and so I've always had kind of like this idea, even when I was younger, like elementary school, like if you tell me that I can't do something then I want to prove to you that I can.

As illustrated above, Tinesha and Rob were initially motivated by other people's expectations in their drive to be successful in mathematics, which is characteristic of a fragile mathematical identity. Whether their parents expected them to gain mathematical competencies as a way out of financial despair or to prove lowered expectations wrong, their ambitions were not built or persevered from within. However, over the course of their K–12 years, their mathematical identities became more robust and appeared to align with intrinsic motivation and realistic self-appraisal, which guided their behaviors and reflections on their mathematical experiences. This was accompanied by a healthier understanding and appreciation of their racial or ethnic identities. These factors seemed to create new forms of protection.

Rob's reasons for seeking success in mathematics shifted from proving his intelligence to "doing mathematics 'cause it makes me happy." He attested to performing mathematical tasks "just for the fun of it." Rob admitted that over time his peers and professors did not really question his mathematical astuteness, but "jokes" that were denigrating and discriminatory comments plagued his graduate school experiences. For example, his applied mathematics professor asked him if he knew any "good cleaning ladies or maybe one of your relatives might be in a need of a job," and Rob responded, "All my family members have master degrees and know how to clean their own houses." Rob expressed a sense of despair that

his mathematics professor, whom he worked with extensively, would reduce the women in his family to stereotypical roles of Black womanhood. Rob concluded that as long as his intellectual competence was not questioned, he could "put up with smart fools making racially stupid assumptions."

Tinesha's determination for continuing to pursue engineering and mathematics education shifted from her fear of potential failure to her commitment to teaching and the love she has for herself as a Black person. Her keen awareness of the realities of the racism and racial discrimination that exist for aspiring Black mathematics students comes from her own experience as well as the continuing struggle that she witnesses in teaching mathematics to Black and Latino youths. Tinesha is committed to using her engineering and mathematical abilities toward the improvement of her family, neighborhood, and the Black community at large.

At different points during their undergraduate programs, Tinesha and Rob decided that using their energy to try to rid the education system of stereotypes and other forms of bias was not the best use of their time, and they opted for more affirming conditions for achieving success. They gravitated toward friendships and faculty associations that supported a more robust mathematical identity and validated their high achievement, as well as other important facets of their identities (e.g., race, gender). Both students became learners of Black history and acquired a broad grasp of the African diaspora. For Rob, this translated into healthier strategies to endure racism and color bias. For Tinesha, through learning about the mathematics and science achievements of her ancestors, she developed a sense of pride that bolstered her determination to complete her engineering and entrepreneurship career trajectory.

Reactive Versus Stable Responses

Although Tinesha and Rob negotiated spaces that assaulted their identities, their reactions to the biases they experienced in those spaces oscillated between unstable, in-the-moment reactions to more stable and confident reactions. When their mathematical identities were more fragile, they responded to the shock of being perceived as inferior with in-the-moment and emotionally draining reactions. These experiences and situations challenged their academic well-being, resulting in emotionally charged coping reactions that sometimes led to academically hurtful but impermanent responses. When Rob was in the sixth grade, his mathematics teacher always placed him at the second highest mathematics table (she tracked her students within the classroom by students who sat at one of five tables), and when Rob complained that he more than deserved to be at the highest table (occupied by White and Asian students), she refused. When Rob continued to complain, his mathematics teacher sent him to the principal's office because he had been, in the teacher's words, "pissed about it." Rob was "pissed" that this teacher assumed that he was not capable of being at the highest mathematics table in spite of his persistently high mathematics grades. Rob eventually got so mad that he walked out of the classroom with a purposeful male bravado, flinging his arms and stomping his feet, in hopes that he would scare his teacher. He did just

that, and Rob was banned from his mathematics teachers' classroom for several days until his mother threatened the principal with legal action. Rob reported that he felt conflicted about the outcome: He missed out on having almost perfect test and homework scores, but he was somewhat proud of himself for standing up to his racist, White mathematics teacher. He recalled several other early school experiences in which he reacted in ways that protected his mathematical identity from being a target of threat but ultimately resulted in temporary academic setbacks or harm to his psyche. As Rob's understanding of bias and discrimination increased, he learned to respond more cleverly to situations in which his intellectual abilities were degraded. Thus, his emergent mathematical identity, which included more stable responses to racism, actually took shape as he encountered more variations of bias, and he developed strategies to react with sarcasm and humor.

In Tinesha's Calculus III class, the professor began class one day by asking students a series of questions. Tinesha answered several of his questions correctly, and the teacher, with an amazed look on his face, exclaimed, "Wow, that's right. And Tinesha, no one helped you with the answer?" Tinesha shook her head no and held back her tears and embarrassment until the class had ended. Tinesha did not attend that class again for a week, which did have a negative impact on her achievement in the class, albeit temporarily.

In reflecting on these experiences, Rob and Tinesha both felt that they had a right to be upset over such incidents, but they also felt that they could have handled them in ways that did not negatively affect their academic outcomes. However, both students expressed hurt, anger, and disbelief over being targets of bias and stigma. Although Rob was in sixth grade and Tinesha was in her third year of college when these incidents took place, both students reacted with genuine frustration and felt that their academic experiences were tainted by unfairness. Rob and Tinesha were unified in the assurance that acts of racism would always hurt, no matter how sophisticated the strategies they used to minimize their force, even as they perfected more adaptive ways of coping (hooks, 1996).

Tinesha's college experiences created new racial wounds that began to heal over time, and after much internal turmoil, she directed her time and energy toward repairing her damaged mathematical identity. For example, both Tinesha and Rob joined organizations that celebrated the brilliance of Black STEM students or organizations that honored STEM achievement (McGee, 2013a). When confronted with negative covert and overt forms of racism, they developed and borrowed sophisticated methods of dealing with stigma and bias. For example, Tinesha walked into the first day of mathematics and engineering classes with her book prominently displayed, and she purposefully left her A+ calculus test on her desk for all the class to see. Rob frequently wore shirts that had racialized logos on them, such as "Danger: Educated Black Man"; he embraced racialized comedy (e.g., Dave Chappelle, Chris Rock, the satirical publication *The Onion*) to provide stress relief and find solace in shared experiences of marginalization. Rob recalled shifting from being obsessed with pleasing his teachers to caring about "how to love mathematics for my own self-worth and not other peoples' expectations."

Most important, both students appeared to benefit greatly from having a better appreciation of their own mathematics capabilities, realizing that their talents and abilities were greater than the stereotypes that agitated them.

Tinesha found a great deal of enjoyment in her lab experiences and research internships. She revealed that learning how to cope with stereotypes at Medium University helped her deal with racialized encounters in her work-related research positions. Tinesha admitted to "letting too many snide remarks slide" from some of her research colleagues and suggested that some of the "drama" may well have fallen within normal hazing of new employees. She concluded:

> I love my research and I know I deserve to be doing this work. Sometimes the others in lab the will ask me one of those "What is it like to be Black" questions, like "How did it feel to live around gang-bangers?" Then I asked them, "Well, how did it feel to be privileged and not really struggle for anything?" That shuts them down fairly quickly. But I always continue to talk with them as if we did not just insult each other and that actually helps to smooth things over for the most part. But there are always a couple [of her colleagues] that wouldn't give me the time of day.

This excerpt shows that Tinesha had developed a sophisticated and clever strategy of trading stereotypes to show how both parties' experiences could be misrepresented.

Tinesha's and Rob's robust mathematical identities provided space to operate from a position of strength rather than being drained by the force and intensity of their efforts to demonstrate their intelligence. Racialized experiences were still present in their lives, but the ways in which they responded to stereotypes were less detrimental to their psyches and more reflective of how "being raced" works in academic and workplace settings.

Rob and Tinesha made it clear, however, that even as they became better at dealing with multiple forms of racial bias, it was still emotionally and mentally draining. With experience, they were able to create a mixture of strategies to minimize the psychological damage associated with being a high achiever in a field in which negative racial stereotypes exist. Described in more detail elsewhere (McGee & Martin, 2011b), these strategies successfully protected their mathematics (and scholastic) achievements but had negative effects on their emotional stability. Self-efficacy was certainly in play when Rob and Tinesha used their judgment to shape their beliefs and capabilities to control the narrative of their mathematics achievements. As they sought to protect their multiple selves (mental, emotional, and academic), another set of characteristics began to evolve that included positive yet realistic self-appraisal.

Rob protected his robust mathematical identity by dropping out of a prestigious STEM postsecondary institution because he constantly felt the burden of being perceived as an "affirmative action student." It might appear that dropping out of an elite college was an unhealthy reaction until one grasps Rob's reasoning:

> I really thought that I got in because of affirmative action. This experience of self-doubt revolved around race. And I said to myself, "This is very depressing." I dropped out of Science Tech [his initial college before eventually attending Soho University]. I was a smart boy, near genius, but I felt out of place.

Rob reacted to his perceived "affirmative action" status by initially buying into the notion that affirmative action was his main reason for being at Science Tech. He decided that internalizing this stereotype day in and day out was slowly chipping away at his mathematical and racial identities. To escape this daily ordeal, he left the school and enrolled in Soho, a less prestigious STEM-intensive institution located within a racially diverse city, where his mathematics and racial identity thrived.

To maintain their robust mathematical identities outside the classroom, Tinesha and Rob gravitated toward organizations and people that embraced their intellectual and racial identities. Tinesha sought out activities, mostly involving African Americans, in which she could build strength and find comfort and support (e.g., Black Student Union, neo-soul poetry sets, tutoring Black and Latino youths in mathematics). She also incorporated more self-satisfying and affirming experiences to counter, and in some cases diminish, her reactive experiences, such as taking several courses with the same professors to avoid having to prove her talents to unfamiliar faculty. Rob and Tinesha both used these strategies, and they ultimately persevered in moments of challenge and conflict, which seemed to make the difference in their maintaining success and feeling good about it (and about themselves).

Outcomes: External (Bittersweet) Versus Internal (Affirming)

Tinesha and Rob had high levels of achievement in mathematics and engineering, regardless of whether they were operating primarily from a fragile or robust mathematical identity, but how they felt about their accomplishments was different. Rob's and Tinesha's high mathematics achievement did not overshadow the continuing challenges that they faced, including being treated unfairly. During particularly fragile times, they sought mathematics success for external reasons, most often to prove their ability to a teacher, to a peer, or, more generally, to our biased society. They felt that their mathematics success was tempered by continually being devalued by an educational system that constantly seemed to demand proof of their competence. They also were driven to excel to earn praise from teachers and peers, meet parental expectations, earn high test scores, and garner other mainstream measures of achievement, but they rarely spoke of feeling any satisfaction from their achievements. In other words, Rob's and Tinesha's former definitions of success in mathematics were largely marked by the acceptance they sought, acknowledgment that they were smart and capable of learning and doing well in mathematics.

In Rob's K–12 schooling, he made a conscious decision to excel in mathematics as a strategy to showcase his intelligence. Although Rob said some of his success was a result of "awesome competency and aptitude" in mathematics, he constantly felt the pressure to maintain a smart persona. The victory of excelling in mathematics was tempered by the notion that he was compelled to contend with insidious negative stereotypes about Blacks achieving in mathematics, which at times overshadowed his mathematical talents.

> I realized early on that in fact getting good at math was really about showing I was smart. So the thing is, that's why I decided to get good at it, quite consciously. But the fact of the matter is, I know I have to always be on point because I understand that some people think that Black people are stupid at math. That's it.

After proving his mathematical talents by earning three master's degrees and a PhD in applied mathematics, he fears for his African American students who will have to carry the torch of presumed mathematical inferiority.

Tinesha's initial success in the undergraduate bioengineering program was in part positioned as a defense against negative racial stereotypes. As the only Black student in many of her engineering classes, her desire was a simple one:

> I wanted these people in this class to know that I might be the only Black person here but I'm certainly not the dumbest. Because I get the constant feeling that they [professor and peers] did not think I belong there. And if you ask me for instances, I can give you a couple, but more really, it's the looks they give me. I know I'm not crazy. And [I] see them looking at me and they are saying, "You don't really belong here."

Tinesha and Rob did not believe or accept the negative stigmas that persisted; nevertheless, they were driven to dispel those expectations. Their academic successes were not as fulfilling as they expected, largely because of their anticipation of the next experience of being mathematically devalued.

As Tinesha and Rob drew on their passion for mathematics as a motivation for learning, their mathematical identities shifted toward being more robust. Rob and Tinesha spoke of falling in love, or at least "strong like," with mathematics and engineering, and they saw these fields as avenues for teaching and mentoring younger students and helping them develop their passions. They also placed a great deal of emphasis on a responsibility to serve underrepresented students and greater dedication to their communities. Mathematics changed from a way for them to demonstrate their intelligence to a tool for understanding, knowing, and serving the world or their communities. Thus, they appeared to have internalized pride in their mathematics accomplishments and found mathematics self-gratifying.

Rob, now a mathematics professor at a predominantly Black university, realizes that his presence alone represents much more than just being a content-rich mathematics teacher. Rob intentionally sought out his school as a place where he could carve out a greater purpose for his mathematical talents:

> If I want to be effective in my subject, I actually need to teach in a predominantly African American institution. And in fact, I mean, I really wasn't that excited about being a professor anymore, I was just getting this PhD just to get it. In other words, maybe you detected some of that initial frustration, I did not expect to get that job [assistant professor of mathematics at a predominantly African American university]. If I hadn't gotten that job, I really wasn't excited about teaching anywhere. You know, I'm a good teacher, but if my teaching isn't integrated with my sort of social justice, I'm actually not that excited about it. I like math and I'm excited about math. But in the back of my mind, I'm always just like, you know, like the reverend says, if not me, who? If not now, when? Someone's got to do this, and I think I'm prepared to do it [teach mathematics to Black college students].

Rob readily identified teaching mathematics to Black students as part of his motivation to teach. At the time of my interviews, Rob's mathematical identity appeared confidently robust and was connected with his desire to fight for educational equity and justice for Black students, armed with a thirst for mathematics and the knowledge that critical mathematics access and education can change the conditions of his students' lives. Rob is still deeply troubled by high-achieving Black students' lack of confidence, and he wants to create a "competition-crushing" all-Black high school and college math team:

> Being good in mathematics is like being an athlete, an Olympic athlete. My goal [is] to create an all-Black math team. Just like [the one] I had—minus the White kids. . . . Someone's got to do this, and I think I'm prepared to do it. As a college teacher or as a high school teacher, I have got to undo years of neglect from stupid teachers. I mean, some of these kids think that they are beat before you get started.

Rob had benefited from being a member of a math club for most of his high school career. Even though his high school was about 75% Black and 18% White, his high school math team was mostly White and Asian. Rob is determined to serve as a role model for Black students and to influence their beliefs that they are fully capable of succeeding in the field.

Similarly, at the time of my interviews, Tinesha was an instructor and performed in a leadership capacity for a progressive youth-oriented mathematics organization. Her students were mostly Black and Latino and came from neighborhoods that were considered distressed. However, her future goals were far grander:

> I would own a business. A company specifically, and design orthopedic devices specifically to integrate into human bodies. And then I would have those proceeds from the company. And all the proceeds that don't go back into running the business and things like that. After taking care of my family, the proceeds would go into creating a school, an engineering school where Black and Brown students kind of learn in this very dynamic nature, if I can say that. So I envision an everyday school except everything is culturally centered and mathematically centered. So mathematically culturally centered. I would have to create culturally centered math. There would be boards [of directors] and teams of people, engineers and other mathematicians. Hopefully all Black engineers just to kind of put the idea out there, you know. 'Cause I think, like, Black engineers, you know, are stuffed under the carpet sometimes.

Tinesha's mathematical identity was heavily tied to using her culturally relevant mathematics and engineering education to improve the opportunities of African American and Latino students in distressed communities. She wanted to create a company that would provide health-care products for people in her community who need orthopedic devices. Tinesha had received several scholarships to attend college, and she said that her own company would offer scholarships to Black and Latino students.

Rob and Tinesha developed their aspirations by encompassing mathematics within a collectivist ideology (Akom, 2003) that is connected to improving the lives of young Black students. They developed from anxious students preoccupied with disproving negative racial stereotypes (fragile identity) into inspirational, self-defined scholars in their fields who strive to do their part to make the world

a better place for future generations of students like them (robust identity). However, stereotypes and low expectations continue to plague their mathematical identities in spite of their agency and perseverance to maintain them.

Discussion and Conclusion

The Fragile and Robust Mathematical Identity Framework encompasses the experiences, perspectives, ideologies, and the complex terrain that Black students must navigate in order to persist in college-level mathematics and mathematics-related majors. To my knowledge, no one to date has attempted to "operationalize" the mathematical identity development of African American students in a framework. The framework exposes the deficit narratives, practices, and policies that high-achieving Black students face daily, the strategies that they employ to greater or lesser success, and the ways in which their motivations affect their satisfaction of their mathematics achievements. It also validates that race matters in terms of how most Black students either identify themselves or are identified and treated by others (Gosa & Alexander, 2007). The accounts of Tinesha and Rob demonstrate that racist experiences take place in the mathematics classroom, adding to the research on how school mathematics is used to perpetuate social inequities and how Black students navigate racialized spaces while achieving and maintaining success. Using the framework, I described how these students responded to issues of race and racism in their lives, how they exhibited strength and perseverance in the face of persistent stereotypes, and how they characterized their experiences in mathematics learning and participation, both inside and outside the classroom (Martin, 2012; Sellers et al., 1998). The intersection of race, resilience, and mathematical identity is an important concept for researchers to consider when unpacking the ways that African American college students learn and succeed in competitive and socially valued mathematics-related fields and how they experience life in their campus environments (McGee, 2013a).

Because of the high number of racialized incidents that still occur in the lives of high-achieving Black mathematics and engineering college students, fragile mathematical identity appears to be a permanent aspect of their mathematical identity as a quick form of protection and response to treatment that is largely based on stereotypical assumptions about Black intelligence or the lack thereof. These strategies are situated as fragile because they operate from a preoccupation with defending oneself against external and damaging criteria. Mathematical identity functioning in a mainly fragile state results in perceptions of one's intellect being unfairly judged. These viable and seemingly unavoidable outcomes are what keep some students in a constant state of fear that their success in mathematics could be devalued. As a result, their perseverance in mathematics is motivated more by a challenge against their presumed fear of failure than by the reward of success (McGee & Bentley, 2015). This leaves me wondering how many Black students who could have navigated the academic mathematics terrain instead aborted their majors because of lack of know-how in developing a more intrinsically guided mathematical identity and positive Black identity. Future work

using this construct could assist in exploring these important factors as well as in challenging current ideology that suggests the mathematics itself is the culprit as opposed to other possibly equally important motivational influences. Moreover, researchers and educators need to understand more fully the negative ideologies about Black achievement in mathematics and their role in adversely affecting the psychological motivations of high-achieving Black students.

Educators and researchers often discuss how experiences of racism and discrimination can result in lower academic achievement for African Americans without having a vigorous understanding of the other side of achievement outcomes: African American high achievers. Warikoo and Carter (2009) remind us that learning is not simply conceptual knowledge and skill development but also negotiating and decoding the system. The construct of fragile and robust mathematical identity characterizes how students can simultaneously manipulate socially constructed racial boundaries and use adaptive coping strategies to deal with racism and discrimination in the classroom and in life while engaging in achievement-oriented behaviors. In the stories of Tinesha and Rob, we saw how students learned to operate within racially charged spaces that minimized their accomplishments, criticized their culture, and rewarded behavior that emulates the White middle class. Thus, educators becoming more race conscious in designing learning opportunities for students might lead to increased intrinsic and self-guided motivations to develop a passion for, not simply a proficiency in, mathematics.

The Fragile and Robust Mathematical Identity Framework draws attention to the structural forces within U.S. history and culture that continue to challenge the mathematics efforts of high-achieving African American students. I further postulate that we are losing talented, intelligent Black students who have not had the opportunity to develop robust mathematical identities. If some African American students get stalled in a fragile mathematical identity and never progress to one that is robust, then presumably they will not develop a strong, sustainable mathematical identity. This can potentially limit the number of African American professionals in mathematics-based fields. Understanding students' fragile and robust mathematical identities could assist in improving the climate and not just the outcomes for Black students in mathematics.

Consideration of further research and next steps with the Fragile and Robust Mathematical Identity Framework leads me to a series of questions that I pose to the mathematics education community. Should we ask high-achieving Black STEM students to become more resilient to acquire their STEM degree, or should postsecondary systems be more committed to disarming the structures of racism so that Black students need not be resilient to the point of compromising their racial and mathematical identities? What are the short-term and long-term effects of continually attempting to achieve in a STEM environment in which encountering racial obstacles is the norm? We must contemplate how much resilience and perseverance is healthy and nurturing as well as how much longer and at what cost Black learners must continue to work to succeed in STEM fields. How might mathematics teachers work within this framework to assist Black students

in not becoming "stalled" in a fragile mathematical identity? How might this framework for mathematical identity assist in understanding the otherness factor for mathematically talented, historically underrepresented students (e.g., females, Latina females, Native American students, Southeast Asian students)? As Black STEM students struggle to develop coping mechanisms to safeguard their academic hardiness and protect themselves from racially injurious educational environments, what are the roles of the institutions in mitigating these injuries?

In an era in which simply *being* African American or Black continues to be devalued by the larger society, including college institutions (Perry, Steele, & Hilliard, 2003), students' resistance to fulfilling negative stereotypes is a strong acknowledgment of their abilities to persist in the face of stereotype threat. Applauding the hidden agency of these students' negotiation of racial spaces within and beyond the mathematics classroom can create a more complete picture of Black mathematics success. This emerging framework affords a starting point for understanding and answering these questions and highlights the complexity of the experiences of mathematically high-achieving African Americans.

References

Akom, A. A. (2003). Reexamining resistance as oppositional behavior: The Nation of Islam and the creation of a Black achievement ideology. *Sociology of Education, 76*(4), 305–325. doi:10.2307/1519868

Berry, R. Q., III. (2005). Voices of success: Descriptive portraits of two successful African American male middle school mathematics students. *Journal of African American Studies, 8*(4), 46–62. doi:10.1007/s12111-005-1003-y

Berry, R. Q., III. (2008). Access to upper-level mathematics: The stories of successful African American middle school boys. *Journal for Research in Mathematics Education, 39*(5), 464–488.

Berry, R. Q., III, Ellis, M., & Hughes, S. (2014). Examining a history of failed reforms and recent stories of success: Mathematics education and Black learners of mathematics in the United States. *Race Ethnicity and Education, 17*(4), 540–568. doi:10.1080/13613324.2013.818534

Boaler, J., & Greeno, J. G. (2000). Identity, agency, and knowing in mathematics worlds. In J. Boaler (Ed.), *Multiple perspectives on mathematics teaching and learning* (pp. 171–200). Westport, CT: Ablex.

Boaler, J., Wiliam, D., & Zevenbergen, R. (2000, March). *The construction of identity in secondary mathematics education*. Paper presented at the International Mathematics Education and Society Conference, Montechoro, Portugal. Retrieved from http://files.eric.ed.gov/fulltext/ED482654.pdf

Cobb, P., & Hodge, L. L. (2002). A relational perspective on issues of cultural diversity and equity as they play out in the mathematics classroom. *Mathematical Thinking and Learning, 4*(2–3), 249–284. doi:10.1207/S15327833MTL04023_7

Chao, R. C.-L., Mallinckrodt, B., & Wei, M. (2012). Co-occurring presenting problems in African American college clients reporting racial discrimination distress. *Professional Psychology: Research and Practice, 43*(3), 199–207. doi:10.1037/a0027861

Chen, X. (2009, July). *Students who study science, technology, engineering, and mathematics (STEM) in postsecondary education* (NCES 2009-161). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Educational Statistics. Retrieved from http://eric.ed.gov/?id=ED506035

Ellington, R. M. (2006). *Having their say: Eight high-achieving African-American under-graduate mathematics majors discuss their success and persistence in mathematics* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database (UMI No. 3222482)

Ellington, R. M., & Frederick, R. (2010). Black high achieving undergraduate mathematics majors discuss success and persistence in mathematics. *Negro Educational Review, 61*(1–4), 61–84.

Gosa, T. L., & Alexander, K. L. (2007). Family (dis)advantage and the educational prospects of better off African American youth: How race still matters. *Teachers College Record, 109*(2), 285–321.

Gutiérrez, R. (2008). A "gap gazing" fetish in mathematics education? Problematizing research on the achievement gap. *Journal for Research in Mathematics Education, 39*(4), 357–364.

Gutierrez, K. D., & Rogoff, B. (2003). Cultural ways of learning: Individual traits or repertoires of practice. *Educational Researcher, 32*(5), 19–25. doi:10.3102/0013189X032005019

hooks, b. (1996). *Killing rage. Ending racism*. New York, NY: Henry Holt and Company.

Jett, C. C. (2011). "I once was lost, but now am found": The mathematics journey of an African American male mathematics doctoral student. *Journal of Black Studies, 42*(7), 1125–1147. doi:10.1177/0021934711404236

Jett, C. C. (2013). HBCUs propel African American male mathematics majors. *Journal of African American Studies, 17*(2), 189–205. doi:10.1007/s12111-011-9194-x

Lee, C. D., Spencer, M. B., & Harpalani, V. (2003). "Every shut eye ain't sleep": Studying how people live culturally. *Educational Researcher, 32*(5), 6–13. doi:10.3102/0013189X032005006

Lubienski, S. T. (2008). On "gap gazing" in mathematics education: The need for gaps analyses. *Journal for Research in Mathematics Education, 39*(4), 350–356.

Martin, D. B. (2000). *Mathematics success and failure among African American youth: The roles of sociohistorical context, community forces, school influence, and individual agency*. Mahwah, NJ: Lawrence Erlbaum.

Martin, D. B. (2006). Mathematics learning and participation as racialized forms of experience: African-American parents speak on the struggle for mathematics literacy. *Mathematical Thinking and Learning, 8*(3), 197–229. doi:10.1207/s15327833mtl0803_2

Martin, D. B. (2007). Mathematics learning and participation in the African American context: The co-construction of identity in two intersecting realms of experience. In N. Nasir & P. Cobb (Eds.), *Improving access to mathematics: Diversity and equity in the classroom* (pp. 146–158). New York, NY: Teachers College Press.

Martin, D. B. (2009). Researching race in mathematics education. *Teachers College Record, 111*(2), 295–338.

Martin, D. B. (2012). Learning mathematics while Black. *Journal of Educational Foundations, 26*(1–2), 47–66. Retrieved from http://files.eric.ed.gov/fulltext/EJ968817.pdf

Martin, D. B. (2013). Race, racial projects, and mathematics education. *Journal for Research in Mathematics Education, 44*(1), 316–333. doi:10.5951/jresematheduc.44.1.0316

Martin, D., & McGee, E. (2009). Mathematics literacy and liberation: Reframing mathematics education for African American children. In B. Greer, S. Mukhopadhyay, A. B. Powell, & S. Nelson-Barber (Eds.), *Culturally responsive mathematics education* (pp. 207–238). New York, NY: Routledge.

Mayfield, L., Hellwig, M., & Banks, B. (1999). The Chicago response to urban problems: Building university-community collaborations. *American Behavioral Scientist, 42*(5), 863–875. doi:10.1177/0002764299042005011

McAdams, D. P. (2008). Personal narratives and the life story. In O. P. John, R. W. Robins, & L. A. Pervin (Eds.), *Handbook of personality: Theory and research* (3rd ed., pp. 242–264). New York, NY: Guilford Press.

McGee, E. O. (2009). *Race, identity, and resilience: Black college students negotiating success in mathematics and engineering* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 3364621)

McGee, E. O. (2013a). Growing up Black and brilliant: Narratives of two mathematically high achieving college students. In J. Leonard & D. B. Martin (Eds.), *The brilliance of Black children in mathematics: Beyond the numbers and toward new discourse* (pp. 247–272). Charlotte, NC: Information Age.

McGee, E. O. (2013b). Threatened and placed at risk: High achieving African American males in urban high schools. *Urban Review, 45*(4), 448–471. doi:10.1007/s11256-013-0265-2

McGee, E. O. (2013c). Young, Black, mathematically gifted, and stereotyped. *High School Journal, 96*(3), 253–263. doi:10.1353/hsj.2013.0011

McGee, E. O. (2014). When it comes to the mathematics experiences of Black preservice teachers . . . race matters. *Teachers College Record, 116*(6), 1–50. Retrieved from http://www.tcrecord.org/library ID Number: 17469

McGee, E. O., & Bentley, L. (2015). *Consequences of the myth of meritocracy: Troubled success for African American college students*. Manuscript submitted for publication.

McGee, E. O., & Martin, D. B. (2011a). From the hood to being hooded: A *case study of a Black male PhD. Journal* of African American Males in Education, 2(1), 46–65. Retrieved from http://journalofafricanamericanmales.com/wp-content/uploads/downloads/2011/02/From-the-Hood-to-Being-Hooded.pdf

McGee, E. O., & Martin, D. B. (2011b). "You would not believe what I have to go through to prove my intellectual value!" Stereotype management among academically successful Black mathematics and engineering students. *American Education Research Journal, 48*(6), 1347–1389. doi:10.3102/0002831211423972

McGee, E. O., & Spencer, M. B. (2012). Theoretical analysis of resilience and identity: An African American engineer's life story. In E. J. Dixon-Román & E. W. Gordon (Eds.), *Thinking comprehensively about education: Spaces of educative possibility and their implications for public policy* (pp. 161–178). New York, NY: Routledge.

McGee, E. O., & Spencer, M. B. (2014). The development of coping skills for science, technology, engineering, and mathematics students: Transitioning from minority to majority environments. In C. C. Yeakey, V. L. S. Thompson, & A. Wells (Eds.), *Urban ills: Twenty-first century complexities of urban living in global contexts* (Vol. 1, pp. 351–378). Lanham, MD: Lexington Books.

McGee, E. O., & Spencer, M. B. (2015). *Black parents as advocates, influencers, and teachers of mathematics*. Manuscript submitted for publication.

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

Nasir, N. S. (2000). "Points ain't everything": Emergent goals and average and percent understandings in the play of basketball among African-American students. *Anthropology and Education Quarterly, 31*(3), 283–305. doi:10.1525/aeq.2000.31.3.283

Nasir, N. (2002). Identity, goals, and learning: Mathematics in cultural practice. *Mathematical Thinking and Learning, 4*(2–3), 213–247. doi:10.1207/S15327833MTL04023_6

Nasir, N. S., & Cobb, P. (2002). Diversity, equity, and mathematical learning. *Mathematical Thinking and Learning, 4*(2–3), 91–102. doi:10.1207/S15327833MTL04023_1

Nasir, N. S., & Saxe, G. B. (2003). Ethnic and academic identities: A cultural practice page perspective on emerging tensions and their management in the lives of minority students. *Educational Researcher, 32*(5), 14–18. doi:10.3102/0013189X032005014

Noble, R. (2011). Mathematics self-efficacy and African American male students: An examination of models of success. *Journal of African American Males in Education, 2*(2), 188–213. Retrieved from http://journalofafricanamericanmales.com/wp-content/uploads/downloads/2011/08/Noble-20112.pdf

Perry, T., Steele, C., & Hilliard, A., III. (2003). *Young, gifted, and Black: Promoting high achievement among African-American students*. Boston, MA: Beacon Press.

Peshkin, A. (1988). In search of subjectivity—One's own. *Educational Researcher, 17*(7), 17–21. doi:10.3102/0013189X017007017

Rubin, H. J., & Rubin, I. S. (2012). *Qualitative interviewing: The art of hearing data*. (3rd ed.). Thousand Oaks, CA: SAGE

Sellers, R. M., Caldwell, C. H., Schmeelk-Cone, K. H., & Zimmerman, M. A. (2003). Racial identity, racial discrimination, perceived stress, and psychological distress among African American young adults. *Journal of Health and Social Behavior, 44*(3), 302–317.

Sellers, R. M., Smith, M. A., Shelton, J. N., Rowley, S. A. J., & Chavous, T. M. (1998). Multidimensional model of racial identity: A reconceptualization of African American racial identity. *Personality and Social Psychology Review, 2*(1), 18–39. doi:10.1207/s15327957pspr0201_2

Smith, V. (1998). *Not just race, not just gender: Black feminist readings*. New York, NY: Routledge.

Spencer, J. A. (2009). Identity at the crossroads: Understanding the practices and forces that shape African American success and struggle in mathematics. In D. B. Martin (Ed.), *Mathematics teaching, learning, and liberation in the lives of Black children* (pp. 200–230). New York, NY: Routledge.

Spencer, M. B. (2006). Phenomenology and ecological systems theory: Development of diverse groups. In W. Damon & R. M. Lerner (Eds.), *Handbook of child psychology: Theoretical models of human development* (6th ed., Vol. 1, pp. 829–893). Hoboken, NJ: John Wiley & Sons.

Spencer, M. B. (2008). Lessons learned and opportunities ignored since *Brown v. Board of Education*: Youth development and the myth of a color-blind society [Fourth annual Brown lecture in education research]. *Educational Researcher, 37*(5), 253–266. doi:10.3102/0013189X08322767

Steele, C. M. (1997). A threat in the air: How stereotypes shape intellectual identity and performance. *American Psychologist, 52*(6), 613–629. doi:10.1037/0003-066X.52.6.613

Stewart, D.-L. (2015). Know your role: Black college students, racial identity, and performance. *International Journal of Qualitative Studies in Education, 28*(2), 238–258. doi:10.1080/09518398.2014.916000

Stinson, D. W. (2011). Editorial: "Race" in mathematics education: Are we a community of cowards? *Journal of Urban Mathematics Education, 4*(1), 1–6.

Stinson, D. W. (2013). Negotiating the "White male math myth": African American male students and success in school mathematics. *Journal for Research in Mathematics Education, 44*(1), 69–99. doi:10.5951/jresematheduc.44.1.0069

Suddaby, R. (2006). From the editors: What grounded theory is not. *Academy of Management Journal, 49*(4), 633–642. doi:10.5465/AMJ.2006.22083020

Tatum, B. D. (1997). "*Why are all the Black kids sitting together in the cafeteria?" And other conversations about race*. New York, NY: Basic Books.

Thompson, L. R., & Lewis, B. F. (2005). Shooting for the stars: A case study of the mathematics achievement and career attainment of an African American male high school student. *High School Journal, 88*(4), 6–18. doi:10.1353/hsj.2005.0011

Walker, E. N. (2011). Supporting giftedness: Historical and contemporary contexts for mentoring within Black mathematicians' academic communities. *Canadian Journal of Science, Mathematics and Technology Education, 11*(1), 19–28. doi:10.1080/14926156.2011.548899

Walker, E. N. (2012). Cultivating mathematics identities in and out of school and in between. *Journal of Urban Mathematics Education, 5*(1), 66–83.

Warikoo, N., & Carter, P. (2009). Cultural explanations for racial and ethnic stratification in academic achievement: A call for a new and improved theory. *Review of Educational Research, 79*(1), 366–394. doi:10.3102/0034654308326162

Wood, M. B. (2013). Mathematical micro-identities: Moment-to-moment positioning and learning in a fourth-grade classroom. *Journal for Research in Mathematics Education, 44*(5), 775–808. doi:10.5951/jresematheduc.44.5.0775

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