Am I a “Math Person”? How Classroom Cultures Shape Math Identity Among Black and Latinx Students

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Author Note

This manuscript is based upon work supported by the Mindset Scholars Network's Inclusive Mathematics Environments Early Career Fellowship, with funding provided by a grant from the Bill & Melinda Gates Foundation. The content is solely the responsibility of the authors and does not necessarily represent the views of the Mindset Scholars Network or the Bill & Melinda Gates Foundation. Correspondence concerning this manuscript should be addressed to Dana Miller-Cotto, [dana.miller-cotto@ucsf.edu].

Abstract

Identity formation is considered one of the most critical aspects of development, and is an especially important process during adolescence, when students' classrooms shape that development. Within the mathematics domain, identity has been particularly critical, because mathematics identity has been linked to whether students persist and ultimately pursue challenging mathematics activities or coursework. Opportunities to bolster mathematics identity are unclear, and these opportunities may vary for marginalized students, like Black and Latinx learners. The current paper aimed to elucidate how classroom opportunities can be leveraged to affirm Black and Latinx students' mathematics identities. We review the existing theories related to identity, how it is situated within mathematics, and often entangled with ethnic/racial identity. We end with research and practice considerations that may promote Black and Latinx students' mathematics identities in culturally aware mathematics spaces.

Keywords: identity, mathematics, STEM education, classroom culture, inclusive learning

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“I am not a math person.” Each year, students across the United States utter those words as if being a “math person” is an immutable trait that one was either fortunate enough to be born with or unfortunate to be born without. To be clear, mathematical ability does have a heritable component; but geneticists will be the first to acknowledge that although genes explain some variance, mathematical ability is in no way fixed—learning environments play an important role in shaping students’ mathematics and other cognitive abilities (Davis et al., 2014; Ritchie & Tucker-Drob, 2018). Given the malleability of mathematics ability, it is curious that students seem to think of it as fixed—that one is either a “math person” or not (Nolen et al., 2011). Where do students get these ideas? Why are some students more likely to identify as “math people” than others? What are the consequences of those identification processes? And, if the consequences are adverse, what can we do as researchers, educators and policymakers? We aim to answer these questions in the current paper by reviewing and synthesizing research on mathematics education, identity formation and change, and the link between student (math) identities and academic outcomes.

The Role of Identities in Mathematics Achievement

Identities are embodied traits and characteristics, social relationships, roles, and group memberships that people use to define who they are or might become (Oyserman et al., 2012). Forming our identities is considered to be one of the most critical aspects of human development (Erikson, 1968), and the identity formation process is especially active during adolescence (Marcia, 1980; Tanti et al., 2011). Identities serve multiple functions. The assemblage of our identities (also referred to as our “self-concept”) provides us with a lens through which to

interpret our experiences and make meaning of the world around us (Markus & Cross, 1990; Oyserman et al., 2017); they allow us to determine which social groups we belong to (Tajfel & Turner, 1986); and due to those group-memberships, they allow us to determine whether particular behaviors are congruent with what it means to be a member of particular groups (Boaler et al., 2000; Oyserman & Lewis, 2017).

Within the mathematics domain, researchers have highlighted the importance of identity processes, noting that mathematics identity is a predictor of student persistence in challenging mathematics activities and coursework (Boaler & Greeno, 2000). Some research demonstrates that students who see themselves as “math people,” feel empowered to engage with and participate in mathematics communities whereas students who do not identify as “math people” are less likely to do so (Nolan et al., 2011). It seems then, that mathematics identity helps students define or make sense of who they are as mathematics learners, which has implications for whether they excel in mathematics (Wang & Degol, 2013).

Mathematics identity may be particularly important for students who have been historically stereotyped as being less likely to do well in mathematics because they may not see their behaviors as aligned with what mathematicians do. Black and Latinx students, after becoming aware of this stereotype either through implicit or explicit messages (McGee, 2000), may find reasons not to identify as mathematically capable. Critical Race Theory (CRT) proponents suggest that these are not just internalized messaging, but instead are challenges thrust upon Black and Latinx students due to the history of race in our society (Ladson-Billings, 2009). Mathematics is viewed as a gatekeeping domain since it predicts whether students will ultimately graduate from high school, have agency over their life goals, or aspire to many high paying jobs (Knuth et al. 2016; National Mathematics Advisory Panel, 2008). In other

words, not doing well in mathematics may prevent students from engaging in a host of activities as they grow older. CRT scholars argue that the practices and norms upheld in mathematics classrooms are often consistent with White cultural norms, which are assumed to be the standard, and thus guide the ways that mathematics is taught, as well as what practices are valued (Gutierrez, 2008; Martin et al., 2019). This process can manifest itself in a number of ways. First, if students are aware of the stereotypes about their group, as Black and Latinx students often are (Oyserman et al., 1995), this awareness can offer unnecessary pressure for them to do well in spaces where they are not well represented (Steele & Aronson, 1995). Of course, if they are well represented, this may not be the case. However, students can still be in the majority within a mathematics classroom and nevertheless be held to norms that derive from White dominant cultural norms within mathematics. This implicit or explicit pressure may send the message to Black and Latinx students that, in order to succeed in mathematics, they must leave parts of themselves out of the mathematics classroom (Nasir & Shah, 2011).

The Dynamic Construction of (Mathematics) Identity

Although mathematics identity is important, there is no guarantee that students will come to see themselves as “math people,” or have a positive mathematics identity. In fact, many students do not. Why might that be? We suspect it may be due to the nature of how identities are constructed in social contexts, which shape the meaning people make of their everyday experiences (Bayer et al., 2020; Oyserman et al., 2017).

People assume that their identities are fixed (Arkes & Kajdasz, 2011; James, 1890), but that assumption is based on a cognitive illusion (Oyserman et al., 2017). Instead of being fixed, identities are dynamically constructed: they change from place to place, and are influenced by features of the person’s immediate contexts, individuals within that context, as well as past

experiences that are within the same semantic network (Bayer et al., 2020; Kaplan & Flum, 2010; Oyserman & Destin, 2010). These general identity construction processes are relevant for the construction of mathematics identities (Bikner-Ahsbabs, 2003). Mathematics identities contain content about knowledge of mathematics and practices within mathematics classroom settings (Boaler, 2001), as well as knowledge about the shared social norms and practices that allow individuals to actively participate in mathematics classroom spaces. Because of these dynamic processes, the relationship that students have with mathematics can change or be reconstructed at any time (Bikner-Ahsbabs, 2003). In other words, the extent to which students identify with, merely comply with, or resist their classroom mathematics traditions, and thus what it means to know and do mathematics (Cobb et al., 2008) is amenable to external influences that shape internal cognitive processes.

Whether students come to see themselves as “math people” – that is, whether they construct math identities, and engage fully in their mathematics classrooms depends, in part, on the structures and cultures surrounding them, and social scripts that emerge from those structures and cultures (see Bronfenbrenner, 1979; Goffman, 1978; Oyserman & Lewis, 2017). To understand mathematics identity development in the United States, for instance, requires close examinations of the stratified (Lewis & Yates, 2019; Oyserman & Lewis, 2017) and particularly *racialized* nature of American educational organizations (see Ray, 2019; Woodson, 2006). The structure of American educational institutions—both in the past and in the present—creates unequal distributions of resources, imbalanced power relations, and disconnects between abstract rules and concrete practices (Lewis & Yates, 2019; Ray, 2019). These aspects of institutions may be evident in domains like mathematics, where stringent rules and cultural norms are present and seen as the only path to arriving at a correct answer, or a “math person.” That structure creates

academic cultures that afford differential opportunities for students to construct positive and productive student identities (Nasir & McKinney de Royston, 2013; Oyserman & Lewis, 2017).

To underscore these points, let us take a look at the context of kindergarten through 12th grade public schools in the United States. Despite strongly espoused national values of equal opportunities, U.S. public schools are far from equal. Instead, U.S. schools are so segregated that Black and Latinx students are disproportionately more likely to attend low-performing, based on state standards, K-12 schools than are their White peers (Byrnes & Miller-Cotto, 2016; Orfield & Lee, 2005). These structural differences matter for students' psychological experiences in educational systems (Tatum, 2017). Being consigned to low-resourced underperforming schools not only limits marginalized students' choice and control over their (academic) future, it also marks them with stigmatized identities as being intellectually deficient and unmotivated (Oyserman & Lewis, 2017). In other words, the structure reinforces the negative societal stereotypes of Black and Latinx students as less intelligent and unmotivated to do well in school in general, as well as in subjects like mathematics (Lewis & Sekaquaptewa, 2016; McGee, 2013).

Students in general (Antecol et al., 2016), and racial minority students in particular (Oyserman et al., 1995) are very aware of where they stand in academic settings, the stereotypes about their group, and whether they are living up to the expectation's others have of them. It is this acute awareness of others' expectations that can lead the negative racial stereotypes about mathematics abilities (Gutierrez, 2008; McGee, 2013) to undermine the development of positive math identities among Black and Latinx students (McGee, 2013). Opportunities to develop students' mathematical identities frequently happen through social interaction that position students as mathematical doers and provides opportunities for them to engage with mathematics

beyond rote memorization. Students exposed to mathematics that aligns with their thinking and experiences, by offering challenging content specific to their experiences and values, may be more engaged and may promote learning for Black and Latinx students more generally (Tate, 1995).

Given the potential contributions of teacher, peer, and family perceptions on mathematics identity, it may be necessary to also consider how mathematics identity develops. Similar to racial identity, for Black students this may take form when an event occurs that encourages a Black student to think about their racial identity (e.g., discrimination, salience in some contexts; Sellers et al., 1998), prompting students through an exploration phase (Phinney, 1993). Similarly, it may be useful to understand when mathematics identity develops; what event prompts students to reflect on whether they are a “math person”? How does it change over time? Why might it change? Finally, how might it be influenced by the racialized nature of mathematics classrooms? Understanding the answers to these prompts may illuminate when Black and Latinx students become aware of beliefs about who gets to be a math person, deciding whether they themselves are “math people,” and what experiences either push them toward or away from a strong mathematics identity. This understanding would also help us to develop interventions to build mathematics identity. Mathematics identity, much like identity more generally, is context specific. Understanding math identity more broadly studied across contexts (predominantly Black contexts, predominantly White contexts where Black/Latinx students are in the minority) may also offer insights how it changes for each student.

III. Identity, Motivation, and Performance

The development of mathematics identities is critical due to the reciprocal relationship between identities, motivation, knowledge, and practice (Boaler, 2001; Oyserman et al., 2012).

As Oyserman and colleagues (2012) noted in their experiment with low-income middle school students, students' motivation to work on a math task—and as a result their performance on that task—was influenced by the extent to which they were led to believe (in that case, by an experimenter) that it was possible for people like themselves to succeed. When they thought they could succeed, they tried harder and performed better; when they thought they could not succeed, they did not try as hard and performed worse. The implication from this research is that a student's willingness to engage in mathematics and to perform well in the subject depends in part on whether they believe that people like them can succeed—that they are “math people.”

However, some work indicates that mathematical identity, relative to other constructs, may not play a direct role in mathematics achievement. Childs (2017) found that while mathematics identity by itself was a significant predictor of mathematics attainment for high school students, when including other important factors in their prediction model (including past performance), mathematics identity was no longer a significant predictor. It is possible that while mathematics identity does not predict mathematics performance directly, it may be the case that mathematics performance predicts mathematics identity. It is also possible that the two constructs may have a reciprocal and reinforcing relationship, with increase mathematics performance improving mathematics identity, and mathematics identity continuing to improve performance. Nasir (2002) argued that increasing identification with an activity or with a community of practice motivates new learning. In this sense, identities can act as a motivator for new learning, prompting practice participants to seek out and gain the new skills they need to participate in their practice more effectively.

The direction of causality can also point in the opposite direction due to the reinforcing nature of our implicit theories of learning (Arkes & Kajdasz, 2011; Boaler, 2001). If a student

performs well in mathematics early on and begins practicing mathematics regularly due to the rewards of doing well, over time they may come to see themselves as “math people,” since their own behaviors reveal to them that they are capable of being math people (Boaler, 2001; Bem, 1972). Boaler and Greeno (2000) asserted that identity predicts continuation in studying mathematics. Positive mathematics identity requires participating in authentic activities and imagining one’s self as a mathematics learner (Graue et al., 2015). These bi-directional pathways are possible due to the dynamic nature of identity and its implications for motivation and performance (Oyserman et al., 2017). Because the ways that students think influence what they do (James, 1890), and because what students do influence how they think (Bem, 1972), the implication is that it is possible to intervene on either side of the process to create mathematically identified students who perform well in mathematics.

Instructional Practices and Mathematics Identity Development

Now that we have outlined the theoretical processes that underlie the links between mathematics identity and student performance, we next want to examine how instructional practices can influence these processes, since classrooms are the primary contexts in which students are navigating their math identity. The overarching lesson is a reminder that learning is an inherently social activity, and thus to engage individual students and foster their learning, it is necessary to understand their experiences, their feelings about the domain, and how they view themselves within that learning environment (Darragh, 2013; Kaplan & Garner, 2017). Mathematics instruction therefore cannot focus merely on teaching the mechanics of the subject (e.g., order of operations), but instead must be more holistic; it must consider how the structures, cultures, norms and stereotypes, and practices surrounding the topic of mathematics affect students’ experiences when they enter mathematics classrooms.

When teachers or other educators in positions of power within the classroom praise some students over others after providing a correct answer, this alone may not make group inclusion or exclusion particularly obvious. However, if that praise is instead “Well done, Greg! Greg is our resident mathematician,” this may implicitly indicate to some students in the room that there is some “essence” (Gelman, 2004) about Greg that allows him to be included in this group. Moreover, whenever the list of ‘resident mathematicians’ contains far more people named “Greg” than, say, “Jamal” (see also Bertrand & Mullainathan, 2004), that too is an indicator to students about who their teacher does and does not consider to be math people. These instructional practices matter: teachers’ expectations about their students affect their performance (Zanna et al., 1975; Sorhagen, 2013), and as we have discussed, students’ performance have implications for their identity and engagement (Boaler, 2001; Oyserman et al., 2012).

Power may play a role in what identities and social practices students gain access to, especially given the socio-historical positions of Black and Latinx students in the U.S. racial exclusion and domination in U.S. schools has often assumed that Black students, particularly boys, behave in opposition to a positive student identity (Ogbu, 1985), suggesting that teachers may be less likely to offer opportunities, or access, to Black students (Nasir & McKinney de Royston, 2013). Students who have been historically viewed as being in opposition to positive student identity may be prevented from having access to positional identities within the mathematics classrooms (Esmonde, 2009). Access to relatable content, discourse, practices, role models, and opportunities to engage may reinforce that you have a mathematical identity thereby reinforcing whether a student belongs within the mathematics classroom to begin with. Dialogic interaction can also support students' mathematical agency and influence their identities in relation to engaging in mathematical activity (Gresalfi et al., 2009). Similar to earlier arguments

around social interaction in mathematics identity formation, Boaler and colleagues (2000) suggest a more social approach to encouraging mathematics identity by encouraging mathematics teachers to allow students opportunities to construct themselves in relation to mathematics practice. In one study, Boaler and colleagues (2000) found that students tended to struggle between wanting to do well in school while also engaging in the classroom in ways that did not alienate them from their peers or groups whom they identified most with.

Thus, positioning students, as mathematical doers and providing opportunities for them to engage with mathematics must go beyond rote memorization. Unfortunately, in schools with high proportions of Black and Latinx students, students tend to be exposed to more rote memorization, with fewer opportunities for engaging activities that lead to conceptual knowledge. One study, the Opportunity Myth, found that Black and Latinx students were more likely to be exposed to rote memorization and be ill prepared for college level mathematics (TNTP, 2018). Rote memorization has been linked to procedural knowledge, which focuses on procedures and correct answers rather than strategies, examples, or counterexamples that demonstrate deeper understanding of a problem (Booth et al., 2013; Skemp, 1976). One way to circumvent this problem is to engage in more social interactions in mathematics. One way this might play out in a mathematical classroom is to present students with activities that tap in to their interests, such as personal bests in their gym class, statistics of their favorite athletes, or the mathematics behind music, as well as solving real world problems relevant to their communities, such as mathematics problems situated within challenges that affect their communities (e.g., in the city of Houston, many students' parents may have been the victim of payday loans. Some mathematics educators have used these examples to help students understand how these loans and interest work to understand how families may have lost their homes to banks). These

approaches will encourage students to be more engaged, participate in the problem-solving process, employ critical thinking, and position themselves as mathematical thinkers rather than relying on their teachers for the correct answer (Cobb & Hodge, 2011). The standard approach in which content is presented to all students at the same time, where they are given worksheets and so on to master it in a fixed time, and if they do not, they still move on, promotes the idea of having a natural aptitude. If mastery learning is emphasized and the National Mathematics Advisory board recommendations are adopted with a focus on fewer topics with a deeper dive (more time allotted), perhaps how fast a student understands the content will not matter. Therefore, everyone is a math person if you keep trying. One limitation of this current perspective is that opportunities for discussion and social interaction is the starting point for more engaged students. We assert that the starting point instead is for teachers to view their students as doers, potentially by getting to know their students and personalizing ways that they can develop their mathematics identity.

In addition, prior work demonstrates that teachers hold negative biases against Black and Latinx students when assessing their mathematical ability (Copur-Gencturk et al., 2019). Prior work has also demonstrated that respectful student-teacher relationships have been found to influence a sense of school belonging (Anderman, 2003; Fine, 1991). As underrepresented minority (URM) students are, by definition, underrepresented in mathematics (NSF, 2018) and more likely to be aware of stigmas (Gillen-O'Neel et al., 2011) it is logical to assume that perceptions of others would impact their mathematics identity. Research on teachers' implicit biases suggests it is also possible that Black and Latinx students are less likely to experience external recognition from their teachers in mathematics compared to White and Asian peers (Rubovitz & Maehr, 1973). Future work should examine the role of URM students' perceptions

of recognition by others as well as teachers' potential biases of their mathematics ability in the development of Black and Latinx students' mathematics identity.

Implications for Policy and Practice

One useful way to think about mathematics identity is that three components are important: one's sense of belonging to the mathematics community, a sense of achievement based on the norms of the mathematics community, and specific behaviors that are associated with members of the mathematics community (Boaler et al., 2000). To date, the importance of mathematics identities for Black and Latinx students for mathematics proficiency, as well as ways to support these identities, has been well documented. However, while both researchers and educators can agree that the way students' view themselves is a huge part of how they engage with mathematics, very little of this research has made its way into their classrooms, continuing the challenge of youth who do not feel like they identify as mathematicians. We have specified the numerous challenges and risks when Black and Latinx youth do not see themselves as "math people" herein. Thus, we propose using research insights to make recommendations to policy and practice by suggesting alternative approaches to supporting math identities for Black and Latinx students.

There is great value in making mathematics relevant for Black and Latinx learners. As we've noted throughout our paper, learning is not isolated to simply bestowing facts on students, but a social process. Part of this social process is enabling students to understand how mathematics plays a role in their everyday lives, communities, and interests. For instance, Nasir (2011) argued that in some instances where students are asked to solve mathematics problems, they might struggle or ultimately get the wrong answer. However, when they are asked to discuss topics like proportions or fractions within the context of their interests, answers are automatic,

and responses are much faster. One implication then, is the importance of teachers taking the time early on in their classes to figure out what students' interests are and incorporating that into their teaching.

Relatedly, Cobb and Hodge (2011) argued that, if using a funds of knowledge approach (Gonzalez, Moll, & Amanti, 2006), math teachers can collaborate with Latinx students to reduce inequities by examining practices in their home communities. This helps to develop innovative instructional activities and practices that build on students out of school experiences. Engaging students with mathematics activities where they can solve real world problems relevant to their communities further enables them to see themselves as mathematical thinkers and doers. This work has been observed using the Meyerhoff Scholars Program, a program that is widely known for improving the STEM pipeline exclusively for Black student and boasts that students who participate in this program are five times more likely to pursue a STEM Ph.D. Research findings from interviews and focus groups indicate that students who were enrolled in Meyerhoff felt more connected to their peers and developed a deep sense of belonging and identity (Maton et al., 2012; Stolle-McAllister, 2011).

Finally, we want to emphasize that the language we use to talk about Black and Latinx students in the mathematics classrooms and research matter. Implicitly, when characteristics like ethnicity, race, or gender are salient (and favoring one group over another) this may send the message that Black or Latinx students do not engage with mathematics in an appropriate way. Explicitly, it's necessary to take researchers and practitioners to task in confronting our own biases about Black and Latinx students and how that informs the way we talk with and about Black and Latinx students. Using phrases like "under-performing," "under achieving," or "low-achieving" to describe Black and Latinx students' mathematical outcomes

creates the assumption that these students aren't trying hard enough and downplays the environment or structures that historically were not intended and designed for Black and Latinx students. We argue that these implicit and explicit messages can contribute to Black and Latinx students' mathematical identities in profound ways.

Conclusion

Mathematics identity may be an important contributor to mathematics performance and persistence in mathematics. However, classroom culture and the historically racialized nature of mathematics may be preemptively alienating Black and Latinx students before their mathematics identity has a chance to take form in a positive way that will promote their continued engagement in mathematics. Black and Latinx students may be motivated to participate in mathematics and see themselves as mathematicians in contexts where they are offered opportunities to participate, engage in activities where they can see the links between what they are learning and their communities, and have their thinking affirmed. Whereas many changes in classrooms may require a complete classroom overhaul, changes that affirm Black and Latinx students can be implemented through teacher professional development and alterations to the language we use to describe Black and Latinx learners in mathematics. These changes may have long-lasting effects on how Black and Latinx students see themselves as mathematicians, allowing them to use mathematics in ways that are relevant and valuable to them.

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