Mixed-race Learners and the Reification of Mathematical Ability as Genetic

Niral Shah

Michigan State University

Abstract

Beliefs about the nature of mathematical ability are deeply tied to learners' perceptions of their own potential. The case studies presented here of mathematics learners from mixed-race backgrounds shed light on how racial ideologies reify prevailing perceptions of mathematical ability as innate and fixed.

Keywords: mathematics education, beliefs, race, identity

Mixed-race Learners and the Reification of Mathematical Ability as Genetic

The National Council of Teachers of Mathematics's (NCTM) *Principles to Actions* identifies a variety of beliefs deemed "unproductive" for robust mathematics teaching and learning. One such belief is the notion that "students possess different innate levels of ability in mathematics, and these cannot be changed by instruction" (NCTM, 2014, p. 63). Research shows that beliefs about mathematical ability as innate and immutable can have a detrimental impact on how mathematics students engage in the learning process (Dweck, 2006; Mueller & Dweck, 1998). Thus, it is critically important that we understand the nature of these particular beliefs, and how they get constructed in the first place.

To that end, this empirical paper draws on interviews (N = 35) with high school students to investigate how students' perceptions of race influence their beliefs about mathematics learning. Qualitative analysis reveals how racial-mathematical narratives (e.g., "Asians are good at math") become intertwined with societal narratives about mathematical ability as a fixed, genetic trait. In particular, this paper focuses on case studies of three students from mixed-race family backgrounds, a population that has been understudied in the mathematics education literature. The data show how students use race to support views of mathematical ability as innate. I argue that the intertwining of race and mathematical ability is problematic not only for their identities as capable doers of mathematics, but also for students' racial identities.

Theoretical Perspective

Beliefs about mathematical ability as fixed and innate are deeply rooted in discourses of mathematics teaching and learning in the United States (Stevenson & Stigler, 1994). Despite research showing that all human beings share a capacity for mathematics, there is a persistent belief in a "math gene" that some have and others do not (Dehaene, 1997; Devlin, 2000). The

philosopher of mathematics, Paul Ernest (1991), has described how this belief implies a

hierarchical view of mathematical ability, "from the mathematical genius at the top, to the

mathematically incapable, at the bottom" (p. 178). This is problematic because if mathematical

potential is viewed as unequally distributed across the population, then teaching cannot help

those students thought to lack the innate capacity for mathematics. There are also implications

for how students think about their own abilities. Decades of research by Carol Dweck and others

has shown that "fixed mindsets" prevent students from persisting on challenging tasks and even

believing that learning is possible (Dweck, 2006; Mueller & Dweck, 1998).

Although mathematics is often seen as a "culture-free" subject (Nasir, Hand, & Taylor,

2008), issues of culture and race intersect with perceptions of mathematical ability in a variety of

ways (Martin, 2009). For example, similar to how mathematical ability is often considered a

fixed, innate trait, "race" in the United States is also considered to have a genetic basis—this in

spite of scientific consensus that racial categories and hierarchies are social constructions

invented to justify and perpetuate particular power relations in society (Long, 2004; Omi &

Winant, 1994). The intertwining of race and mathematical ability is also evident in the existence

of racial narratives about Asians and White males being innately better at math than other groups

(Shah, 2009; Stinson, 2008).

This conceptual analysis suggests that, in part, mathematical ability is constructed as

fixed and innate vis-à-vis perceptions of race. From an empirical standpoint, then, investigating

the nature of people's beliefs about race in the context of mathematics would lead to a more

nuanced understanding of beliefs about mathematical ability. To that end, the study presented in

this paper was oriented around the following research question: How do students' perceptions of

race mediate their perceptions of their own and their classmates' mathematical ability?

Method

Data collection took place during the 2010-2011 school year at Eastwood High School (a pseudonym), a racially diverse high school in Northern California. While this paper focuses on interview data, the larger ethnographic study also included participant-observation conducted in four mathematics classrooms. From those classes, 35 students were interviewed using a semi-structured protocol. Students self-identified as follows: 29% White, 23% Asian, 17% Latina/o, 14% Black, African, or African American, 14% Polynesian, and 3% mixed-race. The first part of the interview focused on students' beliefs about mathematics learning, while the second part probed students' reasoning about race in the context of mathematics learning.

A case study approach, which is well suited to building and elaborating theoretical propositions (Yin, 2014), was used to analyze the data presented in this paper. Detailed cases of three students from mixed-race family backgrounds are the focus of the analysis. As will become clear, these students were chosen because the perceptions and experiences of students from these particular backgrounds provides unique insight into the ways in which racial thinking comes to reify perceptions of mathematical ability as fixed and innate.

Analysis proceeded in three passes. In the first pass, information about students' personal and family histories—particularly with respect to race and racial identity—was extracted from the data. In the second pass, information related to students' experiences learning mathematics, as well as their perceptions of mathematics and their own mathematical ability, was identified. These topics were keyed directly to four interview questions. One of the questions asked students to comment on a cartoon of a teacher and a student in a mathematics classroom, where the student says to the teacher: "I had my doctor do a D.N.A. [*sic*] blood analysis. As I suspected, I'm missing the math gene." This question garnered interesting reactions from students and is

referred to throughout the next section. In the third analytical pass, instances were identified where references were made to the focal students' mixed-race heritage—either by themselves or a classmate—to make sense of their mathematical ability.

Findings

When asked about their perceptions of mathematical ability, over 80% of students (29 of 35) rejected the notion that mathematical ability was a genetic trait that some are born with and others are not. And yet, when explicating their views on race related to mathematics, 57% of students (20 of 35) suggested that there is a prevailing belief that Asian people *are* genetically good at math. To explore the tension between these beliefs, the analysis now turns to case studies of three Precalculus students from mixed-race family backgrounds.

Allison: "Full Mexican" with Half-Indian Sisters

Allison was a 12th grade student in Precalculus who described herself as "full Mexican." When Allison was young her biological parents divorced; her Mexican mother then remarried and had two daughters with a second-generation Indian American man. Allison was close with her stepfather and referred to him as "dad." One of Allison's stepsisters was in 10th grade at Eastwood High, while the other sibling attended an elementary school in the district. As will become clear, this family history is central to how Allison made sense of her own mathematical ability.

As she described her personal history of schooling experiences, Allison repeatedly invoked race. Prior to Eastwood High, Allison had attended a variety of schools due to her stepfather's work, which moved the family through the South, to the Pacific Northwest, and eventually to Northern California. At these other schools, students rarely broached the topic of race with Allison, which she attributed to the fact that they were comprised of mainly White

students. When she lived in the South, for example, her classmates simply assumed she was Mexican based on her light brown skin and hair.

However, this changed during the 11th grade when she moved to Eastwood, where students were more curious about her racial background. Allison attributed this curiosity to Eastwood being a place with more "minorities" and "diversity." Whereas other racially diverse schools might have African American or Mexican students, she noted that Eastwood had "so many different Asians and other folks," and students were "more into ethnicity and culture." Allison explicitly positioned this racial diversity as a positive thing relative to the racial homogeneity of the White majority schools she had previously attended. In her view, those White majority schools were organized around racial cliques that made it hard to form new friends, which was significant for someone who moved around as much as Allison did. In contrast, she described Eastwood students as being "a lot nicer."

Beliefs about mathematics and mathematics learning. At the time of the study, Allison was enrolled in Precalculus. Although this is considered an advanced math class at the secondary level, she described herself as someone who is somewhere between "average" and "not so good in math." In elementary school Allison had been placed on an accelerated track called "pre-AP math," but she came to see herself as a mediocre mathematics learner after she was placed back in "regular math" in 7th grade. And yet, Allison remained committed to taking mathematics courses throughout high school. In fact, she was initially surprised to learn that Eastwood High required only three years of math. Due to her college aspirations, it had never occurred to Allison to *not* take mathematics during all four years of high school.

There is evidence that Allison perceived mathematical ability to be a genetic trait. In her words, "Some people just get math. They can look at something and even if they don't get it they can figure it out." For Allison, this perspective applies to other subjects as well:

> I guess for some people [math] just comes naturally and for some people…Like math and science kind of go together, and science for me wasn't good either. I'm not good at science. I'm more of a liberal person when it comes to school; I'm more into English and history and stuff like that.

The idea that mathematics comes "naturally" for some people helps Allison explain why she does not excel in the subject. Her belief that "math and science kind of go together" also allows her to extend this explanation to her struggles in science. In contrast, she believes that being a "liberal person" facilitates her interest and success in English and history. Indeed, Allison later pointed out that she was enrolled in AP History and AP English.

Overall, Allison's perception of a disciplinary divide between the STEM disciplines and the humanities was related to how she understood herself as a person. When describing these subjects, she notes that English class is a place where you get to "express yourself a lot," but that mathematics is "not really that creative." These descriptions aligned with her view of herself as being an "outgoing" and "social" person. Thus, the data suggest that from Allison's perspective, people are born with certain fundamental personality traits that predispose them to succeed in certain domains over others. In the next section, I demonstrate how her perspective on mathematical ability as innate was reified by her sense making about race and the racial configuration of her family.

Racial views and experiences related to mathematical ability. Recall the racial mix of Allison's family: her step-father is Indian American with parents born in India; her mother is

Mexican; her stepsisters are half-Indian, half-Mexican; and Allison herself is Mexican. With regards to her stepfather, Allison remembered how she always saw him as a key support in mathematics:

> With math I would always go to my dad for help, and a lot of nights I would
> spend on my math homework because he would make me do it until I got it right.
> He wouldn't just give me the answer, he would make me go to my room and
> figure it out for like two hours (laughs).

While this comment does not explicitly connect mathematical ability to race, as Allison continued to make sense of her family's various academic strengths and weaknesses, it became clear how racial narratives shaped her perceptions of mathematical ability:

> It's weird because since my dad isn't my biological father but he's Indian, and so
> my sisters are half-Indian…and they're good at math, I don't know. For me it just
> doesn't come, but for them it does. So, it kind of makes the perception [of Asians
> being good at math] a little bit true I guess, depending on your parents or where
> you're from. Yeah! Cause my mom's like me too: she likes English and history,
> not math…My sisters are the opposite of me. I think maybe it's because they're
> like my dad, because he's really good at math too. I don't know, they're just really
> good at it. They can do it fast. My [youngest] sister is still in elementary so I can
> still help her with some stuff, but the sophomore is pretty good at math and
> science because she's the opposite of me. She doesn't like English or history, but
> she likes math and science.

Allison uses race to explain differences in perceived mathematical aptitude among her family members. Her sisters constitute a useful foil because they allow Allison an opportunity to

isolate race as an explanatory variable. Whereas math "just doesn't come" for Allison, she sees her sisters as excelling in math. Allison explains this in racial terms based on the fact that her sisters' father is Indian and her own biological father is not. The implication is that mathematical ability is a racialized quantity passed on through the blood, and that Allison's sisters succeed in math because they inherited a "math gene" from Allison's stepfather.

It is also noteworthy how Allison positions her mom with respect to race and mathematical ability. Like Allison, her mom "likes English and history, not math." Again, the implication is that her mother's genes endowed Allison with an interest and ability in the humanities. Interestingly, though, Allison does not say that her sisters like math and science *and* English and history. If domain abilities and interests were truly genetic, then her mixed-race siblings should have inherited faculties in *both* areas: STEM ability from their Indian father and humanities ability from their Mexican mother. However, this is not the story that Allison constructs about her family. It could be that Allison's sense of a strict divide between the disciplines (i.e., either you are a "math person" or a "liberal person") precludes her from considering this possibility. Another consideration is that Allison may associate certain disciplines more closely with race than others. Compared with the link between Asians and mathematics, perhaps she did not see English and history as "Mexican subjects." This reflects the potency and prevalence in the U.S. of the "Asians are good at math" narrative, and the lack of racial narratives positioning Mexican learners as academically competent.

Overall, Allison's understanding of mathematical ability is intertwined with racialized views of a disciplinary divide between the STEM disciplines and the humanities. This relation is grounded in a conceptualization of both race and mathematical ability as genetic traits inherited

from generation to generation. In the next section, I discuss how similar themes emerged for another student of mixed-race background.

Farah: A "Syrian Taco" (Half-Arab, Half-Mexican)

Farah was a 10th grade student enrolled in Precalculus. Her dad was from Syria and her mom was from Mexico. She also indicated that she was part White ("Northern European"), but did not clarify to which side of the family tree she attributed this lineage. Similar to Allison, racial identity was a complicated affair for Farah. Because of her light skin tone, Farah was often identified as White. From a young age, though, she resisted this positioning: "When I was younger, [I would tell people] 'No, I'm not White! I'm Syrian and Mexican and *then* White…and that's not even a lot."

Issues of race often came up when she visited relatives in Syria and Mexico. On one trip to Syria Farah became "completely tan," after which her relatives told her that she was "true Arab-looking." On trips to Mexico people would immediately speak to her in Spanish, assuming that she was a local. In that sense, she described herself as a "chameleon." Ultimately, Farah insisted on maintaining strong ties to both identities: Arab *and* Mexican. And although sometimes students at Eastwood mistook her for White, her friends recognized her mixed-race background, affectionately referring to her as a "Syrian taco."

Beliefs about mathematics and mathematics learning. From a young age, Farah found mathematics appealing and excelled in the subject. Throughout her schooling classmates called her a "nerd." She skipped pre-algebra in the 7th grade, which allowed her to take Precalculus as a 10th grader. There were only three 10th grade students in the Precalculus class; most of the students were 11th and 12th graders. Unlike Allison, Farah expressed strong confidence in her mathematical ability. In part, her interest and confidence in mathematics stemmed from her

family members. Her father was a software engineer at a major U.S. engineering company, and Farah noted that she learned about advanced mathematics topics like calculus and statistics from older cousins in college. With respect to the future, Farah expressed a strong desire to pursue a career in software engineering, working for either Google or her father's company.

When Farah was shown the "math gene" cartoon, she articulated the following perspective on the nature of academic ability overall:

> I mean, people have different genes I guess. Each person has their own thing: like one person could be a scientist and meant to be a chemist in the future. It's just in you, it's just who you are and it just shows up sometimes throughout school history. Some people really don't have a math gene, but just need to get through it to pass high school and do their college credits and stuff. You just have to figure out what your passion is and maybe that isn't it, and I think that's what they mean by math gene.

In saying that "each person has their own thing," Farah endorses a view of academic ability as innate. She explains this in terms of the idea that everyone has a destiny based on the particular academic gene they were granted upon birth. Within this framework, school is a place where a person's innate proclivities "show up sometimes," as those latent abilities are revealed over time. However, Farah does not argue that missing a "math gene" precludes someone from succeeding in mathematics. Indeed, later in the interview she explained that students' struggles in mathematics were often a matter of motivation—that if you "pushed yourself" you could succeed in mathematics, at least at the level needed to "pass high school and do their college credits and stuff."

Notably, this differs from Allison's model of what it takes to succeed in mathematics. For Allison, the world is divided between "math people" and "liberal (arts) people," and genetic predispositions toward certain subjects determine students' success in those areas. In contrast, Farah viewed the disciplinary divide between STEM and the humanities as more permeable. Although she did point out that her younger brother struggled in mathematics but excelled in writing, Farah also indicated that she herself found history more enjoyable than mathematics and that she struggled in chemistry. Altogether, these data suggest that although Farah believes that people are born with certain preferences or skills, she does not believe that these initial tendencies *determine* their academic fate.

Racial views and experiences related to mathematical ability. Unlike Allison, Farah did not use race in a reflexive way. Instead, Farah described how her *classmates* used race to make sense of her mathematical ability. In the transcript below, Farah recounts a racial exchange where a classmate explained her mathematical success in terms of her Arab heritage:

> In World History class we learned that "algebra" is actually an Arabic word, and my friend Setu [a Polynesian classmate] came up to me and he was like, "Oh, Farah, you're Syrian! You guys are Arab! You guys made algebra! No wonder why you're hella smart in math!" And I just sat there and I'm like, "Yeah. I don't think that's the reason." And you know, I'm like, I'm not going to argue this, so I just stayed quiet.

For Farah's friend and classmate, Setu, learning the etymology of the word "algebra" triggers an epiphany. Suddenly, he understands the "real" reason why Farah performs well in mathematics: that Farah inherited a natural talent for mathematics passed on through the generations by her Arab ancestors. By framing her success as the inevitable byproduct of an

innate gift, Setu devalues Farah's years of hard work and perseverance in mathematics. This

view is also problematic because, in effect, Setu implicitly rejects Farah's Mexican heritage. He

does not consider that Farah's "Mexican side" may be contributing to her mathematical

competence. Given that Farah valued *both* racialized identities, it is not surprising that she

appears uncomfortable and perhaps annoyed by being reduced to "half" of her full identity.

Overall, Farah's mixed-race background leaves her in a double bind: the "compliment"

toward her Arab roots dismisses the considerable effort she exerts to succeed in mathematics,

and the implicit denial of her Mexican side denigrates who she is as a person. How do her

classmates perceive her Mexican heritage in relation to her mathematical competence? Do they

see it as a detriment her mathematical ability, which is then somehow checked or mitigated by

her Arab-ness?

Rey: Samoan with a Half-Chinese Grandfather

Rey was a 12th grade student in Precalculus who proudly identified as Samoan. His

grandparents were originally from Samoa, and while his parents were born in the U.S., they too

had spent part of their lives in Samoa. Rey was their youngest child, among three sisters and a

brother. It was important to Rey that Samoan culture be continued and passed on among his

generation. Part of this culture for Rey's family was their Mormon religious affiliation. So at the

same time Rey discussed attending community college in the future and becoming a firefighter

or an emergency medical technician, he also viewed serving a mission (i.e., moving to another

part of the world to perform community service and spread Mormon teachings) as being a part of

his future. Fulfilling this religious duty is a central practice of the Mormon faith.

Beliefs about mathematics and mathematics learning. Rey enjoyed mathematics since

he was a young boy. From elementary to middle school, he had been placed on the accelerated

track in mathematics. However, he said that he began to "slack" when he entered high school. For example, Rey stopped answering questions in class because he wanted to be seen as "cool" rather than a "nerd." Although he passed 9th grade accelerated Geometry, he earned D's in 10th grade Algebra 2 and had to repeat the course. This is why he was enrolled in Precalculus as a 12th grader, as opposed to AP Calculus.

In spite of this underperformance (relative to the path he was originally on), Rey maintained confidence in his mathematical ability. In his view, as long as he has a teacher that can teach, he can learn mathematics. In fact, he considered himself the "best math person out of all of my siblings." Whereas he always succeeded in mathematics, Rey always wondered why his siblings couldn't "get it" and didn't "catch on as fast." When shown the "math gene" cartoon, Rey's reaction suggested that he had not heard the term before. The cartoon did prompt him to say that his father was good at mathematics, but at that point in the interview, he neither endorsed nor rejected the view that mathematical ability depends on someone's genes.

Racial views and experiences related to mathematical ability. Like most participants in the study, Rey spoke extensively about how Asians are perceived to be "smart" and to excel in math. However, it was only well into the interview that he connected the "Asians are good at math" narrative to his own experiences learning mathematics:

> You know what just came to my memory? I'm Chinese…(laughs). And I just thought about that because my grandpa is half-Chinese, so I was born there, dang! Okay, maybe their gene is…maybe I do have that math gene from there.

Just as Allison linked her mixed-race sisters' mathematical ability to an Indian lineage, Rey connects his own to the presence of "Chinese genes" in his family tree. In both cases, having at least *some* "Asian" in the genome provides a mathematical "boost." It is not clear how serious

Rey is in making this claim. Indeed, his reasoning cannot explain why he does well in mathematics but his siblings do not. If Rey is one-sixteenth Chinese, then so are his siblings—why did they not receive a "Chinese math gene"? It is also significant that similar to Farah, this genetic view of mathematical ability comes at the expense of Rey's Samoan heritage. That is, his Samoan-ness is not considered a plausible explanation for his success in mathematics.

Discussion

Beliefs about the nature of mathematical ability are deeply tied to learners' perceptions of their own potential. The case studies presented here of mathematics learners from mixed-race backgrounds shed some light on how racial ideologies can reify prevailing perceptions of mathematical ability as innate and fixed. Allison uses race to explain why she struggles in math compared with her sisters, who Allison contends excel because they have an "Indian math gene." Similarly, Rey speculates that his mathematical success may be a function of having a half-Chinese grandfather. In invoking the "Asians are good at math" narrative, both of these students describe a model of mathematical potential that is rooted in the Asian-ness of one's family tree.

The view that mathematical ability is genetic is already problematic because it dismisses the relevance of both personal effort and a student's access to opportunities to learn. If some people are simply born better at math than others—and if school is simply a place to sort students and identify the mathematically gifted—then there is little reason to consider policy reforms that foster perseverance in students or to address structural inequities. The findings from this study show how students can deploy erroneous views about race and mathematical ability as genetic traits, thereby solidifying the already longstanding narrative about mathematics being accessible to only the elite few (Ernest, 1991; Schoenfeld, 2002).

The intertwining of racial ideology and beliefs about mathematical ability is also problematic for another reason. In each of the case studies, the racialization of mathematical ability resulted in the devaluation of already marginalized racial groups. When Farah's classmate explained her mathematical competence in terms of her Arab heritage, he implicitly denigrated the mathematical, academic, and intellectual qualities of Farah's "Mexican side." Similarly, Rey and Allison implicitly devalue their Samoan and Mexican identities, respectively, by suggesting that it may not be possible to do well in mathematics without at least some Asian blood. Not only is this perspective counterproductive for mathematics teaching and learning, but it also perpetuates negative positioning of these racial groups in the U.S. context.

Overall, continuing to unpack the complexity of these belief systems is critical if we are to foster the view that mathematical ability is something that can grow with persistence and instruction, as opposed to something that is largely determined at birth. Debunking ideologies that conceptualize race and mathematical ability as innate traits—as well as troubling the widely accepted correlation between race and mathematical ability—will go a long way toward fostering equitable opportunities for all students to see themselves as capable of succeeding in mathematics.

References

Dehaene, S. (1997). *The number sense: How the mind creates mathematics*. New York: Oxford University Press.

Devlin, K. J. (2000). *The math gene: How mathematical thinking evolved and why numbers are like gossip*: Basic Books New York.

Dweck, C. (2006). *Mindset: The new psychology of success*: Random House LLC.

Ernest, P. (1991). *The philosophy of mathematics education*. London: The Falmer Press.

Long, J. C. (2004). *Human genetic variation: The mechanisms and results of microevolution*.

Paper presented at the American Anthropological Association (AAA) Annual Meeting,

Chicago, IL.

Martin, D. B. (2009). Researching race in mathematics education. *The Teachers College Record,*

111(2), 295-338.

Mueller, C. M., & Dweck, C. S. (1998). Praise for intelligence can undermine children's

motivation and performance. *Journal of personality and social psychology, 75*(1), 33.

Nasir, N. S., Hand, V., & Taylor, E. V. (2008). Culture and mathematics in school: Boundaries

between "cultural" and "domain" knowledge in the mathematics classroom and beyond.

Review of Research in Education, 32(1), 187-240.

Omi, M., & Winant, H. (1994). *Racial formation in the United States: From the 1960s to the*

1990s. New York: Routledge.

Schoenfeld, A. H. (2002). Making mathematics work for all children: Issues of standards,

testing, and equity. *Educational Researcher, 31*(1), 13-25.

Shah, N. (2009). A student's causal explanations of the racial achievement gap in mathematics

education. In S. Swars, D. Stinson, & S. Lemons-Smith (Eds.), *31st annual meeting of the*

North America Chapter of the International Group for the Psychology of Mathematics

Education (Vol. 5, pp. 444-452). Atlanta, GA: Georgia State University.

Stevenson, H., & Stigler, J. W. (1994). *The learning gap: Why our schools are failing and what*

we can learn from Japanese And Chinese Education. New York, NY: Simon and

Schuster.

Stinson, D. W. (2008). Negotiating sociocultural discourses: The counter-storytelling of

academically (and mathematically) successful African American male students.

American Educational Research Journal, 45(4), 975-1010.

Yin, R. K. (2014). *Case study research: Design and methods* (5th ed.). Thousand Oaks, CA:

Sage Publications.