Interrogating innate intelligence racial narratives: Students' construction of counter-stories within the history of mathematics

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This paper utilizes poststructural theory to analyze student artifacts that were collected from a history of mathematics course. The course was designed to counter three types of mathematical narratives, relating to: 1) race, 2) intelligence, and 3) innateness. To address these narratives, the course highlighted the contributions of communities of color and other minoritized populations in the historical development of mathematics. It also explicitly challenged dominant constructions of mathematical history and problematized their use to further the power and privilege of particular groups. Analyses of student artifacts showed that this course provided space for students to defy innate intelligence racial narratives and strengthen their own counter-stories.

Introduction

In the US, there is a common perception that some people are simply bad at mathematics (Wai, 2012). From this perspective, one's mathematical destiny is more a matter of birthright than hard work and persistence. Additionally, this destiny is typically linked to race, through stereotypes such as "Asians are good at math" (Shah, 2019) or the perception that math is a set of "rigid conventions…defined by now dead white men" (Reinholz, 2018, p. 71). Given that mathematical performance is often taken as a signifier of intelligence (Au, 2014), it follows that mathematics can play a pernicious role in positioning some students, especially from certain races, as more intelligent than others.

Together, these narratives about race, innateness, and intelligence are part of an oppressive discourse that creates barriers to mathematical learning and belonging (Martin, 2019). These *innate intelligence racial narratives* are defined as narratives that position some racial groups as more intelligent than others, as a product of their innate mathematical abilities. To be clear, such narratives have been implicated in horrific racist projects such as eugenics (Stoskopf, 2002). Today, they manifest in racist disciplinary practices (Carter et al., 2017), tracking (Oakes, 2005), and microaggressions[1] (e.g., ignoring students of color, assuming they do not belong in an advanced class; Larnell et al., 2014; McGee & Martin, 2011).

This study – situated within an undergraduate history of mathematics course – explores how mathematics educators can disrupt dominant mathematical discourses. By problematizing stereotypical depictions of mathematics history, I argue that educators can support students to further develop counter-stories about mathematical success. In this study, personal narratives from five minoritized students were analyzed to address the following research questions:

1. What role do innate intelligence racial narratives play in students' personal narratives of mathematics learning?
2. How can a history of mathematics course create space for students to develop counter-stories?

Recent work attends to the impact of racialized and gendered narratives about mathematics learning and their impact on learners (e.g., Shah, 2017; Stinson, 2008). However, such studies have not yet focused on how racialized narratives are produced through discourses about the historical development of mathematics. Thus, by focusing on the historicity of the production of mathematics discourses, and consequently, how using historical sources that highlight the contributions of historically marginalized groups can challenge such discourses, I envisage that this study makes an important contribution to the literature.

Background

Discourse

[1] The term microaggressions is widely used but also sometimes contested, as the prefix *micro* implies that they are small. Others use terms such as micro-level aggressions, or Racial Battle Fatigue, to better capture this complex racialized experience (e.g., Smith et al., 2007).

A discourse is a collection of symbols, signs, artifacts, and other cultural representations that work together to promote sensemaking (Gee, 2014). Discourses consist of *subject positions* occupied by individuals, which constrain their possible roles and actions within the discourse (Sunderland, 2004). Cosby (2020) likens a discourse to a dinner table, and subject positions as place settings. The meaning of the subject positions (seats) is not inherent but is constituted through the discourse (interactions at the table). For instance, the head of the table is bestowed authority by virtue of its position relative to other seats. Similarly, individuals seated adjacently are encouraged to interact, by virtue of their proximity. Ultimately, discourses are about power, as they guide and constrain how people behave within the social world (Foucault, 1977).

One way that discourses exert power is through normalizing and dividing practices. Normalization is the process of making certain types of abilities or knowledge *normal* or *normative* (Foucault, 1977). In mathematics, these processes define how a mathematician should look, what they should do, what they should know, how they should behave, and so forth. In contrast, dividing practices separate and sort people into different categories, classes, or groups (Foucault, 1982). In mathematics, this concerns "people who can do math" and "people who cannot do math," or ability grouping in classrooms (Alderton & Gifford, 2018). Taken together, these practices relegate individuals to occupy different subject positions, and thus operate as forms of power and control.

Although subject positions exert power, they are not deterministic (Davies & Harré, 1990). Within a given subject position, an individual chooses from a variety of possible actions. Moreover, once perceived as legitimate subjects, individuals can challenge and stretch the boundaries of a particular discourse (e.g., someone who is perceived as a mathematician can stretch the boundaries of what it means to be a mathematician). Thus, discourses are historical and evolve over time. Such evolution can also occur when the tools of normalization and division and are appropriated as tools for empowerment and identity, such as when marginalized people reclaim oppressive language (e.g., racial slurs, or terms such as “queer” and “crip”).

Within mathematics education, poststructuralism has been applied to understand how racial and gender discourses are used to create inequity (Leyva et al., 2020). For instance, discourses exert racialized power over individuals and groups by making certain subject positions (e.g., a mathematician) more available to individuals from some races than others (Shah & Leonardo, 2016). This power is exercised, for instance, when one repeatedly sees narrow representations in the classroom, media, and popular culture (e.g., primarily white male role models in mathematics). While discourses are not deterministic, they require that members of certain groups (e.g., students of color) defy prevailing discourses that reinforce racial hierarchies to succeed (e.g., Larnell et al., 2014). Although the primary focus of this manuscript is racial discourses, the impact of racism can only be understood by simultaneously attending to intersections with other identities (Crenshaw, 1990), such as race-gender intersections (Cosby, 2020; Gholson, 2016). In this way, I attend to the multifaceted nature of student identities.

Within poststructuralism, narratives help explain how discourses exert power over students. Narratives consist of stories that link concepts and ideas within a discourse to produce meaning and explain the world (Hall, 1997). Consider a mathematics classroom in which the highest score on an exam is received by a student of Asian ancestry. In this example, the narrative “Asians are good at math,” can be deployed to make sense of what happens. Simultaneously, this narrative creates particular subject positions for mathematics learners who are not of Asian ancestry—especially students of color—positioning them as “not good at math” (Shah, 2017). Notably, this narrative only has meaning given particular cultural practices such as test-taking, grading, quantifying, and comparing performance. In the absence of these cultural practices within the discourse, the narrative would have no inherent meaning.

In addition to societal narratives such as the above, students also tell personal narratives about their mathematical trajectories. A personal narrative can be understood as a story that one communicates – including actors, audience, context, and events – to make sense of oneself with respect to particular events (Bamberg & Georgakopoulou, 2008). From a poststructuralist lens, personal narratives provide evidence of how people sees themselves within dominant discourses (Nasir & Shah, 2011). Individuals can also use personal narratives to defy these discourses.

Delgado (1989) describes *counter-storytelling* as a methodology through which marginalized populations tell their own stories to analyze and challenge dominant discourses. Viewing reality as a social construction, these stories do more simply describe reality, but they actually *create* it. These counter-stories elevate the experiences of minoritized populations, rather than simply allowing the dominant narratives to define reality. Solorzano and Yosso (2002) argue that these counter-stories "can shatter complacency, challenge the dominant discourse on race, and further the struggle for racial reform (p. 32)." In this way, counter-stories play an important role in refiguring dominant discourses, and thus are an important mechanism for racial justice (Solórzano & Bernal, 2001). It is for this reason that the present manuscript focuses on students' counter-stories as a mechanism to disrupt oppressive discourses.

Ethnomathematics

Ethnomathematics focuses on how the construction of mathematical discourses is historically and culturally bound. Ethnomathematics highlights how particular forms of mathematical activity arise within given cultural contexts, and thus, no single body of knowledge can be called "mathematics." As a broad research paradigm, ethnomathematics aims to upend the Western hegemony on the production and validation of knowledge (Rosa et al., 2017). As ethnomathematics is brought into schools, it can be used to achieve the complementary goals of disrupting existing narratives and producing counternarratives (D'Ambrosio & Rosa, 2017).

One way that ethnomathematics is deployed in schools is by studying and teaching mathematical practices within a particular cultural context (e.g., Guerrero, 2018; Selin & D'Ambrosio, 2000). For example, through ethnomodeling, educators can combine aspects of mathematical modeling with the cultural practices of mathematizing particular cultural phenomena as a way to engage in mathematical activity (Rosa & Orey, 2011). Such a pedagogy is more than simply "matching" particular forms of mathematics with cultural groups; it aims to provide of broader view of what mathematics is and who a mathematician is.

Ethnomathematics also influences the teaching of the history of mathematics to pre-service teachers (Schubring et al., 2002). Other work focuses on how historical artifacts can be used directly in the process of learning mathematics (Barnett et al., 2014). Less attention has been given to teaching the history of mathematics to achieve the broader ethnomathematics goals of disrupting problematic narratives. This disruption is the focus of the present work. This is consistent with a critical perspective of mathematics (Skovsmose, 2008), which attends to both how mathematics can empower and disempower students.

Discursive production through the history of mathematics

Stereotypical portrayals of the history of mathematics are complicit in reifying innate intelligence racial narratives. Here, narratives about race, intelligence, and innateness are treated separately, although in practice, they are closely interconnected and difficult to separate.

Race

In the US, mathematics is portrayed primarily through the contributions of famous white, male mathematicians. Mathematical history is typically organized around significant historical events in Western mathematics, including the development of Euclidean Geometry and calculus. In addition, many mathematical inventions are attributed to white male mathematicians, even though they were independently discovered earlier by mathematicians from other parts of the world. Notable examples include: the *Pythagorean* theorem (Riedwig, 2005, p. 27), *Pascal's* triangle[2] (Needham, 1986), and the *Fibonacci* sequence (Singh, 1985). On the whole, this creates a false image of white male superiority in mathematics.

Important events outside of Western mathematics are given less emphasis. Students rarely learn that the standard representation of numbers, the Hindu-Arabic numerals, first developed in India, were modified in Persia, and then brought to Europe (Wardley & White, 2003). And few students know that the terms "algebra" and "algorithm" are references to the Islamic scholar al-Khwarizmi and the first comprehensive algebra text he wrote, al-Kitāb *al-mukhtaṣar fī ḥisāb al-jabr wal-muqābala*, with algebra coming from "al-jabr," which meant restoration, referring to adding the same number to both sides to cancel terms (Gandz, 1926). These omissions downplay the contributions of communities of color to mathematics.

Intelligence

[2] Pascal's triangle is called Tartaglia's triangle in Italy. Differences in attributions of mathematical ideas also exist between Western mathematicians, but the central argument here is that many ideas from non-Western mathematicians are attributed to Western mathematicians, which creates a skewed perception of mathematics.

Mathematical measures of intelligence are ubiquitous: IQ testing, standardized tests in school, and college admissions exams (Au, 2014). In popular culture, mathematical ability is tantamount to intelligence. This is evident in “lone genius narratives,” about individuals (e.g., Newton and Einstein) who create mathematics through their brilliance and dedication (Hottinger, 2016). These narratives are also racialized, because lone geniuses are typically portrayed as white men, further perpetuating the image of mathematics as largely white and masculine.

Mathematics is commonly understood as perfect and universal (Garcia et al., 2018), which allows it to serve a unique role as “an *objective* judge,” of intelligence (Volmink, 1994, pp. 51–52). In contrast to the commonsense (Platonist) view of mathematics as timeless and perfect (Handdock, 1987), social constructivists highlight the human dimension of mathematics (Ernest, 1992). Social constructivism highlights that proofs are not perfect, but rather, are rigorous arguments that meet socially-negotiated and continuously evolving standards (Harel & Sowder, 2007). This evolution is an important part of doing mathematics, which is developed through a nonlinear process of naïve conjectures, counterexamples, critique, and revision (Lakatos, 1976). For example, what was once understood simply as “geometry” has been radically reimagined to a variety of different mathematical fields (Rosenfeld, 1988). When mathematics is no longer regarded as objective and perfect, it becomes just another skill that one can develop, and loses its special status as a unique signifier of intelligence.

Innateness

Conventional wisdom in the US is that some people are simply bad at mathematics (Wai, 2012). From this viewpoint, success in mathematics is viewed as an innate ability, not the result of hard work (Dweck, 2006). In reality, a fixed view of ability is a self-fulfilling prophecy. For instance, STEM faculty who believe in fixed ability are much more likely to marginalize students with minoritized racial identities (Canning et al., 2019). Moreover, narratives of fixed mathematical ability are largely US-specific and would be rejected in other parts of the world, including much of Asia (Boaler, 2013; Nisbett, 2010).

Assumptions about innateness are embedded into modern assessment practices. For instance, IQ testing has its roots in the eugenics movement, which aimed to classify "disabled" and "feeble-minded" individuals for exclusion from mainstream society, and ultimately resulted in over 60,000 forced sterilizations, mostly in poor Black communities (Farber, 2008). Standardized testing carries on the racist legacy of IQ testing, continuing to separate students based on race and class, while at the surface appearing more benign (Au, 2014). Similarly, increasing evidence shows that measures such as the GRE do not actually predict student success, but do promote racial and gender inequity (Miller et al., 2019).

Innate Intelligence Racial Narratives

When intelligence is viewed as innate, mathematics is seen an objective measure of that innate intelligence, and some races are deemed as mathematically superior, it creates a racial hierarchy in mathematics and society writ large (Battey & Leyva, 2016; Martin, 2019; Shah, 2017). Although the present focus is race, mathematics is also weaponized to serve other oppressive systems, such as patriarchy (Ernest et al., 2019). Throughout history, women have been excluded from higher education (Noordenbos, 2002), their contributions are downplayed (Rossiter, 1982), and there have been explicit efforts to delegitimize their work (Hahn, 2019). These factors create a dominant history of mathematics that is predominantly masculine, which in turn is used to support male supremacy.

Most importantly, systems of oppression do not work in isolation, but manifest across intersectional identities (Solórzano & Bernal, 2001). For example, women of color face must confront the interlocking systems of patriarchy and racism. Thus, from the perspective of intersectionality (Crenshaw, 1990), racism cannot truly be understood without understanding how racism is intertwined with one's other identities. Accordingly, the role of oppression across intersectional identities is highlighted below in the analyses of students' descriptions of their mathematical trajectories. Next, I describe the context of the course in which I investigated students' narratives, which provides background for the study methods.

Course Design

Overview

The focal course was taught at Hispanic Serving Institution (HSI) in California, USA. Classes met 50 minutes three times each week and involved active student engagement. Students were diverse in terms of gender, race, income, veteran status, and student major (see below, in methods). The instructor of the course was the author of this paper, who presents as a white man (with invisible disabilities, although they were not centered in class discussions). The author recognizes the intersectional privilege afforded by their presentation, especially in the context of teaching history of math. For this reason, the instructor was intentional to elevate student perspectives during class sessions and bring in sources that told the history of mathematics from minoritized perspectives. The instructor also recognizes the inherent tension of being someone from a dominant position trying to support a critical perspective within the classroom (Ellsworth, 1989). All results must be interpreted in light of this caveat.

Course Goals and Materials

The primary goal of the course was to problematize innate intelligence racial narratives to disrupt the dominant discourse of mathematics. Three texts were chosen to support this goal (Hottinger, 2016; Joseph, 2011; Williams, 2018). *Inventing the Mathematician* was chosen to introduce students to critical feminist theories to help deconstruct the White masculine construction of mathematics identity (Hottinger, 2016). *Power in Numbers* provided accessible biographies of women in mathematics and described how they overcame gender and racial barriers (Williams, 2018). Finally, *The Crest of the Peacock* provided a comprehensive non-Western historical development of fundamental mathematics concepts (Joseph, 2011)[3]. The primary materials were supplemented with biographies of mathematicians and popular press (blogs, newspaper articles, and YouTube media).

Assessment

Students were assessed using a combination of essays, group presentations, and a culminating portfolio. Students completed a total of three essays, focused on a variety of topics connection to identity and the history of mathematics. Roughly half of the class sessions were led by students. Students signed up in four-person groups to create their own lessons. One of the goals of allowing students to present lessons was to provide students opportunities to bring their own voices and perspectives to the teaching and learning of the history of mathematics. Finally, the culminating assessment was an individual portfolio in which students summarized their work in the class and reflected upon their own learning.

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[3] CK Raju has accused the author of plagiarizing his work on the history of mathematics. This led to an erratum/acknowledgement: https://www.manchester.ac.uk/discover/news/indians-predated-newton-discovery-by-250-years/.

Course Activities

I now describe a subset of course activities that were used to deconstruct innate intelligence racial narratives.

Race

Drawing heavily from the *Crest of the Peacock*, the class studied how mathematics was developed around the world. Students learned about the astronomy of the Maya and the Quipus of the Inca. They studied the development of algebra in Ancient Egypt, Mesopotamia, India, China, and Persia. They also learned how Algebra and Geometry were brought together in the Islamic World, and how the very notion of what constitutes mathematics has evolved.

Other course activities developed by the instructor directly addressed students' intersecting identities (Simmons & Chen, 2014), implicit bias (Staats et al., 2017) and microaggressions (Suárez-Orozco et al., 2015). The "draw a mathematician" task was used to have students reflect on stereotypical images of a mathematician (Picker & Berry, 2000). Students also viewed three depictions of mathematics in popular culture: Sheldon from the Big Bang Theory, John Nash in a Beautiful Mind, and the "Asian Calculator" in Family Guy (see Shah, 2019, for a critical analysis of the last two of these three depictions). These media were used to understand mathematical stereotypes in popular culture.

Intelligence

Students deconstructed the "lone genius" narrative to challenge everyday ideas about mathematics and intelligence. Students analyzed historical documents from Einstein, to see how his discoveries were supported by others. Students analyzed Newton's *Principia* to understand the historical evolution of calculus. This led to a discussion of Platonism (Rosado Handdock, 1987) and social constructivism (Ernest, 1992). The class studied Gödel’s incompleteness theorems to ponder whether a formal system could be consistent and complete. The class also analyzed the peer review process, disproved conjectures over time, and methods of proof verification. The purpose of these explorations was to recognize mathematics as subjective and imperfect, and not a unique signifier of intelligence.

Innateness

To challenge the idea that mathematical ability is innate, students explored the social construction of ability through narratives. Interviews with Danica McKellar were used to present a case study of an individual (actress, author, mathematician) who has been positioned as not a mathematician by a variety of sources (e.g., Simon, 2006). Students deconstructed how gendered narratives were used to position McKellar as not a mathematician within the dominant discourse. This became a recurrent theme throughout the semester, looking at biographies of women in math (e.g., Emmy Noether, Euphemia Haynes, Shakuntala Devi, Maria Klawe, Tatiana Toro, Maryam Mirzakhani) and understanding the patriarchal and racist ways that history is written. In addition, the students analyzed typical word problems to uncover the subtexts that are present in mathematics texts, critique gender stereotypes, and move beyond binary notions of gender (Yeh & Otis, 2019).

Connecting courses activities and goals

Table 1 connects aspects of the course goals, major activities, and assessments.

Table 1. Summary of course goals, major activities, and assessments.

Course Goal	Unit and Major Activities	Primary Assessment*
Recognize racism and white supremacy in the construction of mathematical history.	Development of Mathematics (A variety of math tasks and histories around the world) Deconstructing Narratives (Cultural Identity Inventory, Microaggressions, Draw a Mathematician)	Group Presentations
Understand mathematics as an imperfect, human construction, not a unique signifier of intelligence.	Deconstructing lone genius narratives (Einstein's Letters) Newton's Writings, Gödel's Incompleteness Theorems	Essays
Recognize mathematical ability as something that is developed and constructed within society, not an innate skill.	Debiasing History (Danica McKellar, Say Mean Matter) Highlighting Contributions (Biographies of Mathematicians)	Portfolio

*Activities and Assessments are related to multiple course goals; here I outline the most closely related course goals.

Method

Use of Personal Narratives

Data collection, sampling, and analysis were all guided by a poststructuralist perspective. Within a poststructuralist framework, I focus on personal narratives as the primary object of study. The rationale behind this choice is that personal narratives provide evidence of how individuals are positioned as subjects within dominant discourses, and also how they are able to defy dominant discourses through their own narrative constructions. Personal narratives provided insight into the two overarching research goals: 1) how students saw themselves the dominant narratives around race, innateness, and intelligence, and 2) how they constructed counter-stories.

Participants

A total of 36 out of 70 students provided consent for the study. For these students, all course assignments were collected, including essays, student presentations, and portfolios. Student-reported racial and gender demographics are given in Table 2, and there were 17 multilingual students, and 8 disabled students. Students came from a variety of majors, primarily including pre-service teachers (across K-12), engineers, and mathematics majors, although other majors such as art and business were also enrolled.

Table 2. Racial and gender demographics.

Race / Gender	Asian*	Black	Latinx	Indigenous/Latinx	White
Woman	1	2	4	-	7
Man	2	1	9	1	8
Non-Binary	1	-	-	-	-

*There were two Indian students, one Thai student, and one Vietnamese American.

Data Sources

Student essays were the primary data source for the analysis. In particular, analyses focused on: 1) students' math biographies, 2) the mathematical identity essay, and 3) mathematics and future career essays. These essays provided multiple prompts to help students construct personal narratives. For example, the identity essay prompt asked students to describe:

> **Your mathematical past.** What were your experiences with mathematics growing up? You may wish to address some of the following questions: What was easy, or hard? How did your experiences depend on situational and societal forces? Did you find yourself fitting stereotypes, or defying them? How might your past have been different if you grew up under different circumstances? (It is okay for you to use material from your math biography, but I expect you to do so more critically based on what we have learned in the class so far.)
>
> **Your mathematical present.** Who are you as a mathematician today? In what ways is mathematics personally meaningful, useful, or important? In what ways do you still have a somewhat less than positive relationship with math?

Your mathematical future. Describe the role you think math will play in your life in the future. What might your contributions to mathematics be? Will you prove a new theorem, use math to make a new discovery, teach others, or help break down problematic ideas about who can do math and what math is. Be creative here!

Through answering these questions, students used personal narratives to describe how they were positioned and how they positioned themselves within dominant discourses. Because students had a choice of the order in which they would complete essays, students completed and submitted these essays at different times throughout the semester. Student presentations and portfolios were secondary data sources.

Sampling and Case Selection

The initial data corpus of 36 students was sampled to focus on students who were most relevant to the particular research questions. The first round of sampling focused only on students of color (N = 21), as white students almost never mentioned race in their personal narratives. Next, sampling narrowed to students who grew up in the US (N = 14). Given that the teaching of mathematics history and racial narratives are context-specific, it was important to focus on a single context (the US) to increase comparability across student narratives. These students were split into two groups. Students who perceived themselves as negatively positioned by dominant discourses (N=10) and those who described success and perceived little discrimination (N = 4).

For these 10 students, innate intelligence racial narratives were salient. However, given that students' personal narratives were written as course assignments, rather than obtained through an interview process, it was not possible to ask follow-up, clarifying questions. For this reason, not all personal narratives were equally complete. Thus, I chose 5 of these 10 personal narratives because they were the students that described in the greatest depth how innate intelligence racial narratives were salient to their mathematical trajectories. In this way, I do not aim to represent the experience of all racially-minoritized students in the US, but rather use these particular narratives as critical cases that highlight the role of dominant narratives and illustrate students' counter-stories. The stories below are of one Black woman, two Latinx women, an Indigenous man, and a genderqueer Vietnamese woman. Below in the results, I also provide a brief summary of findings across the larger sample.

Analytic Methods

MaxQDA® was used to code all data, and analysis proceeded through the development and use of a coding scheme organized around the *a priori* categories of discourses on race, objective intelligence, and innate ability. The first round involved reading the essays, portfolios, and presentations of all 21 students analyzed. A second round consisted of writing brief summaries of each student's personal narrative, which were used to select five focal students. The third round of involved re-reading student artifacts and generating preliminary codes based on the categories of race, objective intelligence, and innate ability. It was from here that proper codes were constructed (see Table 3). A fourth round of coding involved applying the codes. Once the codes were applied, a fifth and final round of analysis involved drawing out the deeper themes related to dominant discourses and counter-stories. Through this analysis, I paid particular attention to how students were *positioned* within mathematical discourses through dominant narratives (e.g., through normalizing and diving practices), and how they constructed counter-stories.

Table 3. Coding Table.

Narratives	Description	Example
Race	Describing the role of race or culture in mathematics learning.	"This added more stress to my doubts about myself as a woman of color and a lowerclassman."
Intelligence	Using mathematical ability to measure one's intelligence or value.	"There were many times when my peers disregarded my opinion because they did not see me as their equal."
Innateness	Describing mathematical ability as something that one either has or does not have.	"Strength in math [is] an ability that came naturally"

Results

Overview

Table 4 provides brief summaries of the personal narratives for the 21 students of color. Seven students were born outside of the US. The five who completed high school outside of the US (India, Thailand, Madagascar, and Mexico) did not recall encountering any racial stereotypes around mathematics growing up. This is plausible, because the students grew up in racially homogenous environments. Nonetheless, students did face certain expectations to be successful in engineering (in India), or to perform well as a student in the science track (in Madagascar). And all three Asian students mentioned the salience of narratives about Asians in mathematics after moving to the US. The two students who immigrated from Mexico at a young age both mentioned facing language-based discrimination and bullying. Although they were mathematically successful in Mexico, they faced language discrimination in a new context.

Of the fourteen students who were born in the US, only four of them described feeling generally successful in mathematics with little perceived discrimination. Some of these students, such as Monica, mentioned other mediating factors such as strong parent advocacy that shaped her positive experiences. While such factors were not made explicit by all students, stories of a smooth mathematical trajectory were an exception. All ten of the remaining students who grew up in the US mentioned various forms of discrimination related to innate intelligence racial narratives. They also mentioned other various forms of intersectional discrimination, for instance, based on gender or socioeconomic status, or as a result of being a first-generation college student. From this sample of ten students, five are analyzed in-depth below, because they described most explicitly how racial narratives impacted their experiences. In alignment with a counter-storytelling methodology, I first tell students stories in their entirety, before drawing out salient themes.

Table 4. Summary of student stories (*included below in in-depth analyses).

Name	Race	Gender	Summary
Vikram	Asian	Man	Grew up in India. Intense pressure and support to learn math. Enjoyed math. First encountered racial narratives after moving to the US.
Akara	Asian	Man	Completed high school in Thailand. Modestly successful at math. First encountered racial narratives after moving to the US.
Nandita	Asian	Woman	Indian parents (teacher and engineer) provided intensive support. First encountered racial narratives after moving to the US.
*Scarlet	Asian	Genderqueer	Faced community pressure to teach math rather than do math, because math was perceived as too difficult for them.
Hasin	Black	Man	Grew up in Madagascar. As a science major felt great pressure to succeed. Felt less pressure upon coming to US for college.
Monica	Black	Woman	Strong parent advocacy. Placed into advanced track in second grade. Negative high school experiences.
*Candace	Black	Woman	Interest developed from stepfather as electrical apprentice. Faced lots of racial discrimination.
*Sam	Indigenous	Man	Was a native English speaker but was placed into ESL classes; faced narratives that "Latinos can't do math."
Carlos	Latinx	Man	Had anxiety starting in second grade due to timed arithmetic tests. As an adult, feels like an outsider to the math stereotypes.
Lorenzo	Latinx	Man	Generally positive experiences and success with math.
Miguel	Latinx	Man	Identifies as a nerd and was always successful in math.
Emilio	Latinx	Man	Grew up in Mexico, always did well at math. Identifies as a nerd. Contrasts Mexico and US teaching styles.
Javier	Latinx	Man	Received one F in high school and doubted mathematical ability. In college began to see ability as a result of effort and not innate.
Marco	Latinx	Man	Aspiring engineer. Generally successful in mathematics.
Mario	Latinx	Man	As a student athlete was discouraged by peers and teachers in high school not to pursue mathematics.
Julio	Latinx	Man	Immigrated from Mexico as a child. Faced barriers due to English discrimination and being a first-generation student.
Guillermo	Latinx	Man	Immigrated from Mexico as a child. Discriminated against for learning English while learning math. Successful once fluent in English.
*Thalia	Latinx	Woman	Grew up doing math workbooks on the bus. Placed in high-track math class, teacher made her feel as though she did not belong.
Estrella	Latinx	Woman	Grew up compared to her brother who was considered an "innate genius;" she felt dumb in comparison.
*Natasha	Latinx	Woman	Successful early in math. In high school, felt looked down upon by her white male peers.
Isabella	Latinx	Woman	High school teacher said "there are some things you will never understand." Felt discriminated against based on gender.

Students' personal narratives

Sam. Sam is a military veteran and a Maya Indian man. His early interest in mathematics was "sparked" by watching his older sister do mathematics homework. Despite his interest, he was "put in English as Second Language (ESL) Classes," although his "first language was in fact English." It was not until fifth grade that his teacher questioned his placement,

> [M]y math teacher asked me why I was not in the same classes as my sister. I replied that in the classes that I am taking they do not give challenging work because we (Latinos) "would never be able to grasp complex math."

As Sam's quote highlights, he was subjected to normalizing and dividing practices as a young child. As a result of false assumptions based on racial stereotypes, he was separated into a different mathematics track. It was only with his teacher's advocacy that Sam learned more about the mathematical contributions of the Maya and was placed into a "regular mathematics class." Sam joined the math club and retained a keen interest in mathematics until AP Calculus in high school. At this time, his teacher told him "athletes did not make good mathematicians because sports don't require brains." Sam "quit" because he was "convinced" he would not "do well." Sam joined the Marines after graduating.

After 20 years of service, Sam returned to school to study Mechanical Engineering. He continued to be positioned as not a mathematician, for example, when his undergraduate advisor, also a person of color, expressed "sincere surprise" at Sam's mathematical interest in mathematics, noting that "most of [his] Mexican friends are horrible at math." Rather than being discouraged, Sam felt it was his "duty to educate this man and make him aware of implicit bias." This example shows how now, later in life, Sam had constructed his own counter-story about his mathematical aptitude and was able to use it to defy the dominant discourse.

Sam also worked to disrupt dominant discourses around gender in mathematics. For example, after a boy in his daughter's "college prep math class told her she should not be in the class because boys are better than girls at math," Sam took a women's studies course to better understand gender bias. He used course readings from the book *Inventing the Mathematician* and the interviews with Danica McKellar further deconstruct how math is gendered. As a tutor in the on-campus Mathematics Learning Center, Sam could "see his daughter" in the young women with mathematical aspirations who sought tutoring. He was committed to apply his growing understandings of racial and gender oppression to help these students defy stereotypes and succeed. Given his own experiences of being othered in mathematics, Sam used his own subject position as someone who was mathematically capable (i.e. an engineering student) to disrupt the dominant discourse. These efforts were also evident in his group's presentation, in which they challenged stereotypes by sharing a history of Maya mathematics and presenting on Marilyn Vos Savant and the sexist responses she received when mathematicians attempted to "correct" her correct answer to the Monty Hall Problem (Crockett, 2016).

Mathematical discourses were salient across Sam's story. In Sam's case, the narratives contained elements of *race*, *intelligence*, and *innateness*. For instance, Sam encountered the idea that "Latinos would never be able to grasp complex math" very early in life, as he was inappropriately placed in courses for students learning English. During high school, the narrative that "sports don't require brains" pushed Sam away from math, as he was an athlete. As shown in prior research, such narratives about physical ability are one way of positioning individuals as not good at math (Shah, 2017). Later in life as he returned to college, he again encountered the narrative that Mexicans are "horrible at math," but given his life experiences he was able to defy it. From educating his academic advisor, to his daughters, to other students in the Mathematics

Learning Center, Sam had constructed a powerful counter-story of his own mathematical success and was determined to empower other minoritized students.

Thalia. Thalia is a Latinx woman. She developed interest in math as a young child while "[w]orking on math workbooks" from Costco. She also enjoyed "playing teacher" rather than "playing with other toys," and "always" knew at some level she "wanted to become an educator."

As a middle school student, she was placed into a high-tracked mathematics course. However, she recalled that "[t]he teacher of the class quickly took a disliking to [her]," which was "apparent to [her] and all of her peers." Accordingly, "it took little time to feel as though [she] did not belong." The teacher used to "disregard [her] comments, disregard [her] questions, and simply move onto the following student as if [she] were invisible." Through these dividing practices of disregarding comments, questions, and ignoring Thalia, her instructor was rendering her into the subject position of someone not capable of doing mathematics. The impact of this positioning was evident in Thalia's own narrative, when she ultimately decided to "switch into the less advanced class," and by the time Thalia reached high school, she "had convinced [herself] that [she] was not good at math," even though she "still possessed a love for math." Although Thalia herself did not invoke race or gender to describe these particular experiences, her instructor's positioning of her (as a Latina) was consistent with dominant narratives that privilege White/Asian men in mathematics. In this way, seemingly "neutral" actions can actually be racialized and gendered, because they invoke racialized and gendered discourses to marginalize students. Although such teacher actions could negatively impact any student, their negative impact on Thalia was amplified by the broader discourses around mathematics.

Thalia was the first person in her family to attend college. She began in a community college, given her financial situation, even though she was accepted to her top choice of universities. After transferring to a four-year institution, she rediscovered her "love for mathematics and became excited about [her] education" again. Still, despite her passion for the subject, Thalia felt that lack of representation was a barrier,

> My less positive relationship with math stems from my under-representation in the field…As I flipped through the novel *Power in Numbers: The Rebel Women of Mathematics* although it is filled with personal stories and achievements of women, it was still underrepresented by Latinx women. Even though I often doubt my abilities in mathematics, the under-representation is what ultimately pushes myself to continue with my focus. I want to become a representative in the mathematical field.

Thalia's description of her underrepresentation highlights how the dominant discourse actively resisted people similar to her occupying the subject position of a competent mathematician. Even though the course text was intended to help empower women, in fact, the lack of representation of Latinx women actually contributed to dominant discourses around race. This highlights the complexity of challenging dominant discourses, and how a text that aimed to challenge gender discourses could actually reify problematic racial discourses. Nonetheless, Thalia had aspirations to defy this discourse. Ultimately Thalia wanted to be a "Latinx woman teaching elementary-aged students," ideally in a "lower-income school" so she could educate students "why people of color and/or women are underrepresented in the field." Especially as a "first-generation student" and immigrant from Mexico, she felt that "mathematics as a whole is often misrepresented and [she] hope[s] to change that." In contrast to her earlier experiences in which she was discouraged and switched to a less-advanced course, she had now developed her own counter-story and was committed improving representation in mathematics.

Thalia described the “underrepresentation” of “Latinx women” as a reason for her “less positive relationship with math.” In this case, Thalia was invoking *racial* narratives about who belongs in math, as evidenced by racialized representations of mathematicians. Thalia also described how after being negatively positioned as a learner while in high-tracked mathematics class she became “convinced” that “was not good at math.” This positioning of her as “not a math person” ties into the idea that mathematical ability is *innate*, which is an idea that she later was able to problematize. Ultimately, Thalia’s desire to be a “representative” for others motivates her to continue. In this way, Thalia is constructing a counter-story for herself, as someone who is mathematically capable and can inspire others.

Natasha. Natasha is a Latinx woman. She described how she “enjoyed learning and doing math” while she was growing up. Early in life she as her “strength in math as an ability that came naturally” (i.e. is *innate*), but later she came to see it as “a result of hard work.” Things began to change in high school, as she could “feel the negativity” from her “white, upperclassmen, male” peers in AP Calculus. They would “look down” on her, and “not acknowledge” her in class,

> This added more stress to my doubts about myself as a woman of color and a lowerclassman. I was reminded of this when we heard the podcast with Danica McKellar when the host of the podcast disregarded her input about the information because she is a female (“Danica”). There were many times when my peers disregarded my opinion because they did not see me as their equal.

Similar to Thalia, Natasha also describes dividing practices of being ignored that positioned her as someone who is not a mathematician. Natasha analogized her experiences to the sexist discrimination that Danica McKellar faced as she was being interviewed, as was discussed in class. Given those negative experiences, Natasha still has a “fear of being looked down on by [her] peers” in mathematics classes today. As a result, Natasha “had never considered [herself] a mathematician,” but “[t]hrough this [history of math] class” she “realized that [her] experience” does “make [her] a mathematician.” She now recognized how a lack of representation can lead to a “lack of identity,” for instance, due to stereotypical problems with “white” names. Natasha continued by describing the experiences of students of color, who only,

> learn how their ancestors arrived in this country, but not much more information. They do not hear about the accomplishments made by their ancestors because there is no documentation about them. They are not able to identify with the material being taught in class because the people who they are learning about are not the same as them. The little information they do learn about their past usually comes from negative events in history.

Here, Natasha is describing the normalizing practices that reify whiteness within the history of mathematics. Natasha expressed her commitment to address the “lack of cultural diversity in the classroom” that hinders students learning, and “break down a stereotype that teachers are white women.” As “a Latina” she wants to show “diversity among teachers” and be a “role model” to show her students that they can “succeed.” As a role model, Natasha embraces her own counter-story as a competent mathematician and someone who can inspire others similar to her.

Racial intelligence narratives were prominent in Natasha’s story, as she described being looked down upon by “white male” peers, as a result of her being a woman of color. Moreover, these experiences have had a lasting impact and still continue to bring her anxiety in math classes to today. We also see Natasha shifts from believing that this intelligence was *innate* to recognizing the role of hard work. This is consistent with her commitment to be a Latina role model for her students and show "diversity among teachers." Although Natasha acknowledges she continues to be negatively impacted by the dominant discourses today, she also has begun to embrace a counter-story that she can be a role model and increase diversity among teachers.

Candace. Candace is a Black woman and a military veteran. As a young child, she "would watch [her] stepfather do his homework as an electrical apprentice." As a result of these early experiences, math became her "favorite subject," and she was "always ahead or top of [her] class when it came to the sciences and mathematics." She recounted seeing role models such as Bill Nye, Neil deGrasse Tyson, and Katherine Johnson in the media that "influenced [her] continuation in mathematics."

The situation began to change in high school, where Candace "met quite a few prejudices" based on her race, such as being told that she did not belong in a particular class,

> The first day I arrive in my Pre-Calculus class, I was told by the teacher that, "I was not their student", before they checked their attendance sheet or the schedule in my hand. There was never a need to exclusively identified myself or have I ever before then, but I was the only junior and young woman of color in the Pre-Calculus class. I was ignored, not taught correctly, the notorious red pen was used and scribbled all over my work, and the teachers tried their best to remove me from the class before entering, every week.

Candace described normalizing and dividing practices that positioned her as a young Black woman as someone who did not belong in an advanced mathematics classroom. From questioning whether or not she belonged in the class to scribbling on her papers with red pen, the teacher positioned her as not belonging. There was no seat at the table of the dominant discourse for her. As a result, Candace abandoned her further pursuit of mathematics, but after changing courses, she "felt like something was missing," and eventually joined the military "into a STEM-based job." Candace described how "[a]ll the joys returned," but "once again [she] was met with prejudice."

Candace reflected that through all of her schooling, her "science and math courses never had a teacher or instructor that was a person of color." This normalization contributed to a dominant racial discourse on who could do mathematics. She saw this as a barrier and she "pushed away from something that [she] had an innate talent for and wanted to continue to grow in." Candace was determined to break down such barriers for others,

> In "Power in Numbers", the author Talithia Williams, states, "Many were alone on their journey, but with every female who enters the field of math, it makes it easier and more achievable for the next one, and the one after that." At times I am the only female in the dominated male fields and many of times I am the only female of color. Usually there is no one I can talk to, collaborate with, share my viewpoints with, or they are shut down. For many decades I thought mathematicians and scientists worked alone, which made me want to become one of the "lone geniuses" that I have come to know. But for the future me, I want to continue to break down barriers, negative connotations, and continue to uplift and inspire others about mathematics.

Here, Candace talks about the oppressive impact of the dominant discourse, and how she hopes to challenge the discourse to inspire others. For Candace, *racial* narratives were particularly salient, as instructors and peers told her that she did not belong. In contrast to the other students, Candace did focus on her perceived *innate intelligence* and how barriers such as never having a teacher of color made it difficult for her to actualize her potential. As Candace reflects, she thinks of ways that she hopes to make mathematics accessible not just for “lone geniuses” that she had tried to become, but more “relatable” to others who were “stopped” from “pursuing their interests.” Here we see that Candace has constructed a counter-story of herself as a capable mathematician that can succeed despite barriers, and who can continue to break down barriers to support others.

Scarlet. Scarlet is a Vietnamese American and a genderqueer/nonbinary woman. They talked about how “math always made sense” to them growing up (*innate* ability), unlike other subjects. Yet, Scarlet expressed their struggle with the lack of mathematical role models growing up. While they “idolized” their teachers, they noticed that “all the mathematicians” in “movies, TV shows, and math textbooks,” and in the names of “theorems, equations, and functions” were men. As a result of this normalization, they “believed that if [they] wanted to pursue a career in math in the future, [they] could only go as far as teaching.” In this way, the dominant discourse positioned Scarlet as not a mathematician.

When asked what they are studying, Scarlet would say they are “a teaching major rather than a math major.” This particular description made it easier to find acceptance from “elders in [their] community and family,” who would otherwise comment how difficult math was, and tell Scarlet “to pursue something easier.” Scarlet continued,

> It seemed that my personal community was instilling in me the same message I grew up on, that there is no place for women in mathematics, and my math community was solidifying the idea that math teachers are not “real mathematicians.”

Scarlet's description highlights the interdiscursivity of racial and gender discourses. In her particular racial/ethnic community, the discourses around gender were such that someone similar to her (i.e. a genderqueer woman) could be a mathematics teacher, but not mathematician. Although Scarlet had "struggle[d] with the idea that [they] could not be a mathematician," Scarlet felt that "this class ha[d] taught [them] otherwise." Scarlet continued,

> The first four sessions challenged my idea of what a mathematician was supposed to look like. During the activity where we were asked to draw a mathematician…I drew myself and I drew a mirror. That activity and the following sessions, listening to Danica McKellar speak about her experiences as a mathematician, empowered me as a woman and as a mathematician. I could make a real contribution to the math community by inspiring and guiding the youth to pursue math like my teachers did for me and like McKellar continues to do through her children's books. I was finally starting to call myself a mathematician.

Scarlet's description here shows how the class activities helped them construct a counter-story that positioned them as a capable mathematician that would inspire the youth. Given their genderqueer identity, representations of gender in mathematics were also particularly salient for Scarlet. They said,

> When I realized that math textbooks not only enforce the binary gender discourse but also reinforces gender role [as a result of the textbook analysis activity], I left the classroom and told everyone that would listen…I want to show young people that math can, too, be a part of their future careers. However, the idea that there are only two genders present in math textbooks is outdated in today's society. We are blatantly leaving out and

> dismissing everyone in between. When we allow for this discourse to continue, we allow mathematics textbooks to set the standard for what "normal" looks like.

Here Scarlet describes how the class activity helped expose a dominant discourse around gender in mathematics, and the dividing practices that erase nonbinary people. Once this discourse was made explicit, it became something that Scarlet could work to defy. Scarlet described strategies that they wanted to use for including their students in math class, such as getting to know their names, using their names in problems, and challenging the "stereotypical ideas that have come with mathematics."

In Scarlet's personal narrative we see the intersection of *race* and gender play out, as Scarlet talked about the "elders in [their] community and family," and what was culturally acceptable for a woman to aspire to. Further, Scarlet is positioned as someone who "can be successful," but "cannot succeed in mathematics," because they were told that math is too difficult for them (i.e. they do not have the *innate intelligence*). This narrative also highlights the complex interactions of race and gender. For example, gendered binary narratives impact white students and students of color alike. Nonetheless, these gendered narratives are still racialized (Gholson, 2016); the way Scarlet experienced gender marginalization was a result of their particular racial/ethnic identity, and how gender was viewed by their "elders." Methodologically, this points to the need to attend to the discursive co-construction of race and gender. Ultimately, despite these barriers, Scarlet was able to use the course activities to challenge the dominant discourse and construct their own counter-story.

Discussion

Drawing on the theoretical perspectives of poststructural theory and ethnomathematics, this manuscript explores the construction of dominant mathematics discourses through the history of mathematics. Analyses focused on how the dominant discourse led to oppression through narratives organized around race, intelligence, and innateness. Across the focal students, these types of narratives were salient. Together, these narratives supported normalizing and dividing practices that were used to position students as inferior, provide them with fewer and lower-quality learning opportunities, and discourage them from mathematical pursuits. For example, Sam, Candace, and Natasha described how teachers perceived them as less intelligent based on their racial identities, and Thalia described how her white male peers actively ignored her. These experiences had considerable material consequences for students, for instance, as being placed in lower-tracked mathematics courses impacted their likelihood of pursuing higher level mathematics. Students' trajectories also highlight racism does not operate in a vacuum; the way that each of these students experienced racism was also influenced by their gender identities. For Sam, being a male athlete on top of an indigenous person of color amplified the discrimination he faced. For both Thalia and Natasha, gendered components of their experiences were salient. Similarly, for Scarlet, whose genderqueer identity was salient, gender was a primary concern. Given that these racialized experiences were specific to students who grew up in the US, an intersectional approach to race, nationality, gender, and other identities is needed to understand the role of interlocking systems of oppression (hooks, 2014, p. 17).

Students' personal narratives provided evidence that the history of mathematics provided them with tools to construct counter-stories and position themselves as capable mathematicians. Even though the students were successful enough to enroll in the course, at the beginning of the course, not all of them saw themselves as mathematicians. However, this changed as students engaged with relevant class activities that challenged the dominant discourse. For Candace and Thalia, the course made the exclusionary nature of mathematics explicit, validating their prior experiences, and inspiring them to serve as role models for others. For Natasha and Scarlet, it was particular course activities (e.g., interviews with Danica McKellar) that drew attention to gendered oppression that resonated with their experiences as gender minorities and people of color. For Sam, he already began the semester as someone who was dedicated to challenging stereotypes and educating others, and he took up aspects of the course design (e.g., the group presentation) to continue doing this work. While these results are promising, it is also important to recognize the positioning of the identities of the instructor in relation to the students. It is plausible that an instructor teaching the course with different identities would have a different experience. In addition, student narratives were collected as a part of course assignments, which could have had some impact on what they chose to write (or not write). These theoretical findings have a number of practical implications.

First, there is an urgent need to disrupt the dominant discourses about mathematics. Because innate intelligence racial narratives are tripartite, there are opportunities for resistance across different components of such a narrative. For example, Candance referred to the lone genius stereotype (focused on innate intelligence), and all students referred to racial narratives. Given that there are multiple opportunities for resistance, this suggests that interventions (such as those on mathematical mindsets or grit) may have some benefit for racial and gender justice, but taken in isolation, are unlikely to disrupt racism. On the whole, such interventions are limited because they focus on change within individual students without recognizing the role of oppressive systems (Gutiérrez, 2017).

Second, when students from minoritized backgrounds enroll in advanced mathematics courses, it is most likely a safe assumption that they have experienced racial, gender, or other forms of oppression earlier in their mathematical trajectories. While students likely experience oppression across a wide variety of disciplinary domains, I argue that the impacts are particularly profound in mathematics, given the prevalence of innate intelligence racial narratives. Given this, it is insufficient to remain neutral, or to provide a "non-negative" experience of mathematics. Rather, educators must actively disrupt and counteract prior mathematical experiences. This is an imperative for primary, secondary, and postsecondary educators.

Third, instructors need practical tools that they can implement to disrupt oppressive mathematical discourses. Given that the curriculum most educators are presented with is racist and sexist, explicit effort is needed to counter it. For example, Yeh and Otis (2019) offer the "say, mean, matter" matrix as one tool for interrogating and disrupting gender stereotypes in mathematics. Similarly, Dubbs (2016) discusses an approach coined "add queers and stir" to problematize normative gender constructions in mathematics. Similarly, efforts to make the curriculum culturally-relevant (Ladson-Billings, 1995) and healing-informed and socially just (Kokka, 2018). The disability justice movement may also offer insights into recognizing the intersections of ableism, racism, and sexism (Sins Invalid, 2019). All of these efforts only begin to challenge the normative construction of a mathematician as a white cis-gender straight able-bodied man. Beyond changing aspects of the curriculum, educators can explicitly draw upon the history of mathematics and historical events that disrupt the problematic status-quo narrative. All of the aspects of the history of math course described above can be incorporated partially into other mathematics courses, to confront and disrupt racism head on.

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