ABSTRACT

Title of Dissertation:	RULES OF ENGAGEMENT: THE ROLE OF GRADUATE TEACHING ASSISTANTS AS AGENTS OF MATHEMATICS SOCIALIZATION FOR UNDERGRADUATE STUDENTS OF COLOR
	Kristyn Emilie Lue, Doctor of Philosophy, 2023
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The field of higher education has been concerned with the retention of underrepresented students of Color in the science, technology, engineering, and math (STEM) fields over the last few decades. STEM identity development has emerged as a useful analytic framework in this research, as students with stronger STEM identities—students who recognize themselves and are recognized by others as "STEM people"—are more likely to persist in the STEM fields. STEM identity develops through the process of socialization, in which agents of socialization set and maintain the norms, culture, and values that newcomers in the STEM fields should emulate. At institutions of higher education, instructors act as primary agents of socialization, signaling who "belongs"—and who doesn't—in the STEM fields.

Although prior research has identified the ways in which mathematics courses gatekeep underrepresented undergraduate students of Color out of the STEM fields, little research has focused specifically on undergraduate mathematics socialization. Furthermore, the role of graduate teaching assistants (GTAs) as agents of mathematics socialization remains unexamined, despite the large role they play in teaching lower-level undergraduate mathematics courses. This qualitative dissertation, which is grounded in Critical Race Theory and Critical Whiteness studies, utilizes critical ethnographic methods in order to examine the ways in which GTAs at a historically white [college and] university (HWCU) serve as agents of mathematics socialization for underrepresented undergraduate students of Color.

Through fieldwork, individual interviews, and a series of focus groups with ten GTAs at a large, public, research-1 institution in the Mid-Atlantic region of the United States (MAU), this dissertation study explored: (1) GTAs' perceptions of the dominant culture (e.g. values and practices) of the mathematics department at their institution, and whether they sought to align with or diverge from this culture, (2) the opportunities and constraints GTAs faced in breaking from these normative values and practices, and (3) whether the ways in which GTAs described trying to break from these practices reinforced the systematic exclusion of underrepresented undergraduate students of Color in their mathematics department. Key findings include four major themes: a culture of individualism and the hidden necessity of social ties in the mathematics department at MAU, the valuation of teaching as a means of doing research, attempts by GTAs to shift normative narratives of mathematical success, and identity tensions in supporting underrepresented undergraduate students of Color. These findings highlight the importance for agents of mathematics socialization to explicitly center race, racism, and power when trying to be inclusive of underrepresented undergraduate students of Color in university mathematics settings. Without doing so, racism and whiteness are reproduced and perpetuated in the mathematics socialization of underrepresented undergraduate students of Color, despite good intentions.

RULES OF ENGAGEMENT: THE ROLE OF GRADUATE TEACHING ASSISTANTS AS AGENTS OF MATHEMATICS SOCIALIZATION FOR UNDERGRADAUTE STUDENTS OF COLOR

by

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Dissertation submitted to the Faculty of the Graduate School of the
University of Maryland, College Park, in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
2023

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DEDICATION

To my family, thank you for the generational sacrifices you have made for my educational opportunities, for teaching me the importance of understanding privilege and positionality in the world, and for your continual support in my educational journey and career trajectory.

To Anna Kim and Tina Lawson, the teachers who brought me back to mathematics, and who were the first to ever call me a mathematician. Thank you for believing in me and for showing me broader perceptions of what it means to be “good” at math.

And to all my students: past, present, and future.

ACKNOWLEDGEMENTS

While a dissertation is technically a solo-authored piece of work, I could not have done this work alone. I am beyond grateful for the support, guidance, mentorship, and community that I have had throughout this journey, and will do my best to try and capture even a fraction of this gratitude in the following section.

To my family, thank you for everything you have done to support me—especially when it came to my education. I am incredibly lucky for the life you gave me, and I would not be here without your sacrifices, your emphasis on the importance of education, the recognition of our privilege, and the collectivist values you instilled in me.

To all of my teachers, from K-12 through graduate school, thank you for always believing in me, and for giving me the language and tools to develop as a learner, an educator, a writer, and scholar.

To my mentors, especially those in higher education. Thank you for encouraging me to explore the field of higher education and student affairs as a potential career path. In doing so, you provided me with a foundational space to formally grow and develop my critical consciousness, find community, and make my way to UMD.

To my master's "co-heart," thank you for making Maryland and UMD home, and for being my east coast family. You all continually inspire me and push me to be a more critical scholar, and a more thoughtful practitioner. Your continued love and support throughout this journey have meant the world to me, and I never would have considered staying in Maryland for an extra five years and one more degree, had it not been for the community and family we built together.

To the other members of my UMD family—in the CfME, TLPL more broadly, and in HESI—thank you for being in community with me, for all of the laughter, love, and adventures, your continued support in navigating academia together, and for the writing accountability! Thank you especially to Margaret (my academic sibling), Blake, Alexis, and Jia for all the long days and late nights spent writing together over the past several months.

To my friends from coast to coast, both inside and outside of academia. Thank you always for your love, for your belief in me, and for ensuring we continue to make and hold space for each other. Thank you for keeping me grounded in community and care.

To my committee, thank you so much for your guidance, your feedback, and your support. Dr. Chazan, thank you for encouraging me to continue with this program when I was at a crossroads in my second year. Dr. Liu, thank you for being in community with me, for your love and support in helping me examine my positionality in this work, for your continual belief in me, and for guiding me in my development as an emerging Critical Race scholar. Dr. Park, thank you for giving me the opportunity to work on your research team, for your incredible feedback and support on my writing, and for sharing so much of your knowledge and experience. Dr. Trivisa, thank you for your enthusiasm for—and belief in—this dissertation project, and for all of your insight and ideas. And to my advisor and chair, Dr. Clark, thank you for everything these last five years. You have been instrumental in helping me grow and develop as a scholar and as a researcher, and you have pushed me to become thoughtful, precise, and confident in my work.

And finally, thank you, M, for your encouragement, your patience, and your unwavering love and support. Thank you for being my biggest cheerleader, my partner, and my home.

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CHAPTER 1: INTRODUCTION

The retention of underrepresented students of Color[1] in the science, technology, engineering, and mathematics (STEM) fields has been a longstanding challenge facing the field of higher education. Over the past two decades, the proportion of incoming freshmen at baccalaureate institutions intending to major in a STEM field has risen among all racial groups—with the exception of American Indian and Alaskan Native students (National Science Board, 2016). Although Asian American and Asian students enter college intending to major in STEM at the highest rates (54.2% in 2014), Black, Latinx, and white[2] students enter college intending to major in STEM at remarkably similar rates to each other (40.4%, 45.1%, and 40.3%,

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[1] The term "underrepresented students of Color" is typically used in the STEM higher education literature to refer to Black, Latinx, and Indigenous students (which includes Native American and Alaskan Native students). While Asian American students are students of Color, they are not considered underrepresented in the STEM fields; therefore, I use the term "underrepresented students of Color" to refer specifically to Black, Latinx, and Indigenous students and remain consistent with the language used in higher education research.

[2] In this dissertation, I have made the decision to capitalize the names of non-white racial groups (i.e., Black, Latinx, Asian American, Indigenous) in order to honor and center their oppressions and sociopolitical histories in the United States that have resulted from their shared racialization under these terms. I have simultaneously made the decision not to capitalize white, in order to work towards the decentering of whiteness and the delegitimization of white as a norm. Furthermore, as Battey and Leyva (2016) explain, whiteness is a fictive ideology that is defined by what it is *not*, in order to oppress those who do not fall within the boundary of "white".

respectively, in 2014) (National Science Board, 2016). Yet, despite entering college with comparable rates of intention to major in a STEM field, Black and Latinx college graduates receive STEM degrees at disproportionately lower rates than white and Asian American college graduates (Trapani & Hale, 2019), suggesting that the attrition and retention—rather than solely the recruitment—of underrepresented students of Color in the STEM fields during their undergraduate careers is a critical area of focus.

STEM identity has emerged as a useful analytic framework over the last two decades in order to better understand the attrition and retention of underrepresented students of Color in the STEM fields (e.g., Carlone & Johnson, 2007; Larnell, 2016; Malone & Barabino, 2008; McGee, 2015; Stinson, 2008). Students with stronger STEM identities—i.e., students who recognize themselves and are recognized by others as "STEM people"—are more likely to persist in the STEM fields (Carlone & Johnson, 2007; Chemers et al., 2011; Malone & Barabino, 2008). STEM identity develops through a socialization process, which in turn is enacted and facilitated by *agents of socialization.* Agents of socialization set and maintain the norms, culture, and values that newcomers in a community should emulate. In the STEM fields, faculty are one of the groups of people who act as agents of socialization (Garibay, 2018). Through this socialization process, STEM faculty both implicitly and explicitly signal who "belongs" in the STEM fields. They also signal through this socialization process who doesn't "belong" in the STEM fields: namely, Black, Latinx, and Indigenous students (e.g., Carlone & Johnson, 2007; Malone & Barabino, 2008; McGee, 2016).

The STEM fields, however, are not a monolith, and each sub-field of STEM has its own norms, culture, and values—and therefore, its own identity development and socialization process. Indeed, research on STEM identity development often focuses discretely on either science identity (e.g., Carlone & Johnson, 2007; Hazari et al., 2009; Malone & Barabino, 2008), engineering identity, (e.g., Pierrakos et al., 2009), or mathematics identity (e.g., Cribbs, Hazari, et al., 2015; McGee, 2015), rather than STEM identity more broadly. Within higher education, there is a more distinct focus on science identity and engineering identity than mathematics identity—and indeed, more research on student-faculty interaction and socialization exists in the science and engineering fields than in university mathematics settings. However, given that mathematics is a gateway into the broader STEM fields (Adiredja & Andrews-Larson, 2017; Leyva, Quea, et al., 2021), higher education research on mathematics identity development and socialization—and in particular, research on student-faculty interaction and the role of mathematics faculty as agents of mathematics socialization for underrepresented undergraduate students of Color—is critical for scholars concerned with racial equity and the retention of underrepresented students of Color in the STEM fields.

However, at many institutions of higher education graduate teaching assistants (GTAs) make up a significant part of the mathematics teaching labor force, particularly for lower-level undergraduate courses that are prerequisites for STEM major courses. As such, GTAs play a role in the mathematics socialization of underrepresented undergraduate students of Color (and indeed, all undergraduate students). The extent to which GTAs play a role in this socialization, however, has thus far remained unexplored, especially given the dearth of research on GTAs in university mathematics departments.

The Study

Given this background and the lack of research on the socializing influence of GTAs in mathematics departments, the primary question that guides this study is: *How do GTAs serve as* *agents of mathematics socialization for undergraduate students of Color*[3]*?* Given that most colleges and universities in the United States are historically white colleges and universities (Bonilla-Silva & Peoples, 2022), and given my own positionality as a product of and participant within HWCUs, I focus specifically on mathematics GTAs at a historically white [college and] university (HWCU). At the heart of my research question is how GTAs might serve as *gatekeepers* into the mathematics community at an HWCU. In investigating the role of GTAs as agents of mathematics socialization at an HWCU, it is necessary to first understand the shared values, beliefs, and practices of the mathematics community at this HWCU. I then seek to determine whether GTAs seek to uphold, normalize, and enforce the dominant culture of the mathematics community at an HWCU, or do seek to disrupt and break from it. If the latter, what power and opportunities might GTAs have to transform the ways in which undergraduate students of Color are mathematically socialized—and perhaps be welcomed into mathematics communities by building strong, stable mathematics identities? How might GTAs be constrained

[3] From this point onwards, I will use the term "undergraduate students of Color" to refer to underrepresented undergraduate students of Color. In no way do I mean to imply that Asian American students are not students of Color, or that Asian American students are a monolith who are all accepted into the mathematics communities at HWCUs. In switching to the term "undergraduate students of Color" to refer to underrepresented, undergraduate students of Color, my intention is only to simplify the terms and phrases I am using for the sake of readability. While I hope at some point in my career to critically examine the racialization and experiences of Asian American students in STEM, doing so is beyond the present scope of this study, and runs the risk of making this proposed dissertation too unwieldy.

as agents of socialization, and thus uphold normative mathematics socialization practices that serve to exclude undergraduate students of Color from membership into the mathematics community at an HWCU? And, how might GTAs' own socialization into mathematics communities influence their views on and practices of socialization?

What follows in this chapter is an overview of some of the foundational theoretical and frameworks that guide this study and helped to formulate my overarching research question. I begin by discussing the theoretical groundings of this study in Critical Race Theory (e.g., Davis, 2016; Ladson-Billings, 1995/2016; Tate, 1997) and Critical Whiteness Studies (e.g., Battey & Leyva, 2016; Bonilla-Silva, 2018; Matias et al., 2014. From there, I build out the conceptual framework that guides this study, integrating Martin's (2000) framework on mathematics identity and socialization and Liu's (2017) framework on power governors and privileged spaces. However, in order to understand how I arrived at this study, and the use of these perspectives and frameworks, it is important to first understand who I am, and how I got here.

The Researcher

I never intended to come this far in my educational journey. Attending graduate school was never part of my plan, perhaps in large part because I didn't know what the point of graduate school was. I knew—because of my family's expectations—that I had to go to college, and that I wanted to teach. I also knew there was a possibility that I would have to attend a postbaccalaureate program in order to earn my teaching credential, but I had no idea whether that technically counted as graduate school. While I knew some teachers also obtained a master's or a doctoral degree, I didn't quite understand the point of pursuing one, nor—if I'm being completely honest—did I understand the difference between the two. Ironically, it was my mother—who was instrumental in inspiring me to want to become a teacher—who insisted that I would eventually want to pursue an education beyond a bachelor's degree. My parents didn't know much about graduate school; they didn't know much about the intricacies of navigating college applications to undergraduate programs either. What they did know was that my siblings and I would go to college, as that was an expectation that their parents instilled in them, and that I loved school and loved to learn. So, it seemed only natural to my mother that I would stay in school and continue my formal learning as long as possible.

My love of learning was crucial in my desire to become an educator, but I couldn't have predicted that I would end up in a career that focused on mathematics as a discipline. Instead, I thought that I would end up being an English teacher. I had always loved reading and writing, and from a young age, was interested in the power of stories and perspectives. In my English classes, I was fascinated by the ways in which contexts shaped our interpretations and understandings of texts, and how the meaning and messages behind them could differ so much amongst people, based on their own life experiences. I loved the idea of a career that would allow me to be a lifelong learner, and the idea of cultivating a classroom environment where my students would be validated and respected for the knowledge that they brought with them. As I continued through my high school career, I was seen by my teachers and peers as one of the "good" students who excelled academically. I began to take Advanced Placement classes and eventually, my friend group consisted mainly of people who were in those same courses—the AP kids.

By sophomore and junior year, I began to notice a growing divide in my AP cohort between the "math people" and the "English people". It was at that time that I also became more acutely aware of the power that the stories we tell—about ourselves and others—could have in shaping our trajectories. While English had always been my favorite subject, I also grew up with a love for mathematics, and tested into a seventh-grade math class when I was in sixth grade. From then on, I was always a year "ahead" in math, and enjoyed solving math problems, learning new concepts, and helping my classmates when they were stuck. However, being the classmate who was stuck was decidedly *less* fun, which I realized in my tenth grade Precalculus course. For the first time, I had encountered a math class where I felt I simply could not grasp the concepts—and to this day, the summation notation, which we learned in that class, makes me anxious. Aside from having difficult content, I also found my Precalculus course to be socially isolating. I struggled to connect with both my teacher and my peers, in large part because I had just changed schools and did not yet have community in my courses. I decided that I must not be a "math person" after all (and while I was at it, determined that I didn't much like science either), placing myself firmly in the "English people" camp and bonding with my English teacher.

Junior year of high school, I decided to take AP Statistics with the rest of my friends, despite my apprehension over taking any AP mathematics courses. I became closer to other teachers in the English department, who constantly confirmed that I was "one of them—an English person". I felt that I knew myself and who I was—until my AP Statistics teacher called me a mathematician. No one had ever called me a mathematician before, and by that point in time, I was convinced that I could either be an "English person" or a "math person", and it was clear that I was an "English person". The following year, my AP Calculus teacher also referred to me as a mathematician, while my English teachers[4] continued to insist that I wasn't a "math person" and was "one of them". In fact, when I graduated, the English department nominated me for an Achievement Award for the subject at our Senior Awards Night.

In college, I considered dabbling in both subjects—perhaps, despite what my teachers had told me, I could be both an "English person" *and* a "math person". I decided to minor in mathematics while pursuing an English major. When I found out about the CalTeach program, which would allow me to obtain my teaching credential as an undergraduate if I majored in a STEM field, I decided it would be more economical to major in mathematics and minor in English while working on my teaching credential; once I had a teaching credential in mathematics, I could take the subject exams to add on an English credential later without going through a full postbaccalaureate program. The responses I would get when I told people I was a math major contrasted starkly with the responses I would get when I was an English major; upon learning that I was majoring in math, complete strangers would tell me that I was "smart" and "impressive", even though they knew virtually nothing else about me other than my name and major.

Clearly, math was associated with "smartness", and because I was perceived by others as a "math person", I was also perceived as "intelligent". It also seemed to me that I was treated with more respect, perhaps because of the strength and emphasis on STEM programs at UC

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[4] I loved my English classes so much that in my senior year, I took two out of the four English course options that my high school offered for seniors: AP Literature and Science Fiction Literature. Thus, I had two English teachers that year, and maintained contact with my prior English teachers, who I visited often.

Berkeley, my undergraduate institution. The association between math and perceived intelligence was further confirmed in my student teaching experiences. My students who were "good" at math were perceived by their peers as being the "smart" students. To them, being "good" at math meant grasping concepts quickly and finishing their work early. Many of the students who were "good" at math were young white boys, who would also often stand up and announce to the class to excitedly brag that they had already finished their work.

In contrast, my students who struggled with grasping concepts instantaneously, and needed more scaffolding and assistance with working on problems in class considered themselves to be "bad" at math. They often conflated not being able to quickly understand a concept with never being able to understand it, no matter how hard they tried. Frustration would set in quickly when they needed extra help—and this frustration was often exacerbated by their classmates shouting, "I finished my work already!" I understood this frustration; it was frustration I had also felt in some of my math courses, and that I had especially felt in my tenth grade Precalculus class. What I struggled to relate to, and to even understand, however, was when my students—and in particular, the young Black and Brown girls—would throw down their pencils in exasperation and say, "Ms. Lue, I just don't get it! I'm not good at math! *I'm not smart."* Although I had struggled in some of my math classes, I had never felt that because I wasn't good at math, I simply wasn't smart.

And so, while I saw that perceptions of mathematical ability were associated with perceptions of "smartness" or intelligence, the connection wasn't quite that simple. Why was I, a light-skinned, East Asian American woman, still perceived by others as being smart even when I struggled in my math classes? Why did I not then associate what I felt was a lack of innate mathematical ability with not being smart? Were the perceptions of others and the way I perceived myself related? As for my students, why did the young white boys in my class consider themselves good at math, and why were they seen as being the smartest students in the class, while the young Black and Brown girls felt that because they weren't good at quickly grasping mathematical concepts, they would *never be good at math*, and that they *just weren't smart*? And how could I help them see that they *were* brilliant, and help them reframe their perceptions of what it even meant to be "good" at math, and what it meant to be "smart"?

As my EdTPA and graduation loomed on the horizon, these questions continued to weigh on my mind and my heart. I felt that there was so much more I needed to learn and explore, and that these questions would continue to plague me if I immediately began my classroom career. And so, I decided to continue my educational journey after graduation by pursuing my master's degree in higher education at the University of Maryland, College Park. As an undergraduate, I had the opportunity to work in various student affairs capacities, which introduced me to social justice work and issues of equity and access in higher education. Those experiences gave me the language to begin to describe what I was passionate about: racial equity and justice. It was clear that the questions I had, and the patterns I saw around perceived math ability and intelligence, were somehow connected to issues of power, race, access, and equity all along the P-20 pipeline. I was hopeful that a program in higher education might give me the tools, language, and theory to better understand, discuss, and work towards answering these questions, and better articulating and understanding what it was I wanted to do once I found those answers.

Math Identity as a Potential Framework

As it turns out, my master's program did indeed give me the opportunities I had hoped for to reflect, learn, and grow. I was introduced to literature, scholarship, language, and tools that helped me to explore the questions I started my program with but pushed me to do so in new ways and with new framings. Specifically, I began to think about these questions through the lens of STEM identity—or how one sees themselves and as seen by others as a "STEM person". I was particularly drawn to the work of Carlone and Johnson, whose 2007 article on the science identity of female graduate students of Color was foundational in my exploration of the literature on STEM identity. Carlone and Johnson's (2007) work brought me to the work of Cribbs, Hazari, et al. (2015), which was my first introduction to *math identity* as a framework.

I should note here, as I noted in the introduction of this chapter, that "STEM identity" is a bit of a misnomer, given how distinct each of the STEM disciplines is. The STEM identity frameworks I came across actually focused specifically on one of the STEM sub-disciplines: science identity (Carlone & Johnson, 2007; Hazari et al., 2009), engineering identity (Pierrakos et al., 2009), and math identity (Cribbs, Hazari, et al., 2015). However, because the field of higher education focuses on STEM as a composite of these disciplines, I tended to view these frameworks as STEM identity frameworks rather than by subdiscipline while I was a master's student. In fact, my work and research interests as a master's student could best be described as racial equity and access in the STEM fields, despite the fact that the questions that had brought me to pursue this program had focused specifically on math.

Towards the end of my master's program, I began to realize how important disaggregating the STEM identity frameworks by discipline was—especially mathematics, given that mathematics is a gateway to the STEM fields. Furthermore, despite the fact that I felt my work was aimed at questioning and dismantling the notions of "STEM people" versus "non-STEM people" (and within that acronym, "math people" versus "non-math people"), my peers—and even some of my faculty—still described me as a "math person" because I had come to the program with an undergraduate degree in math. Some of my peers would then describe themselves in turn as "not a math person," and admit that not being a "math person" made them, at times, feel like they weren't as smart as "math people" (including myself)—even though we were all in the same program, and even though I saw them as brilliant people and friends who I learned so much from. Seeing how deeply the notion of "math people" versus "non-math people" was ingrained, even amongst those who were aware of the research on STEM identity, left me with even *more* questions than I had started the program with.

These continued questions extended my educational journey once more by applying to doctoral programs, which is how I arrived here at the Center for Mathematics Education at the University of Maryland, writing this dissertation. I knew that during my doctoral studies, I wanted to focus specifically on mathematics identity. Although I knew of one mathematics identity framework (Cribbs, Hazari, et al., 2015), it was the only math identity framework I knew of, in part because I had restricted my research to the higher education context, and in part because I was focused more broadly on STEM, rather than mathematics specifically. However, I soon learned that in the K-12 mathematics education research space, there was an abundance of research on math identity (e.g., Bishop, 2012; Gholson & Martin, 2014; Grant et al., 2015; Langer-Osuna, 2016; McGee & Pearman, 2014). Although several math identity frameworks exist (Cobb et al., 2009; Grant et al., 2015; Cribbs, Hazari, et al., 2015; Martin, 2000, McGee, 2015), much of the literature on the mathematics identity of students of Color—the population I was interested in—builds off of Martin's (2000) seminal framework on mathematics identity and socialization.

I found myself drawn to Martin's (2000) framework, which seemed to explain so much of what I had noticed over the years about "math people" versus "non-math people", and how race was related to these categorizations. His findings showed what "appear[ed] to be a close connection between mathematics identity and academic identity among students" (Martin, 2000, p. 20). Furthermore, he contended that mathematics identity is inextricably linked with racial identity. In other words, mathematics identity development is inherently a racialized process—and mathematics identity and socialization cannot be divorced from racial identity development—because culturally, mathematics and mathematics education have racialized norms and expectations (Gutiérrez, 2007; Larnell, 2016; Martin, 2007; Martin, 2009; Nasir & Shah, 2011). As such, Martin's (2000) framework, which I will outline in the next section, is a foundational framework for this dissertation.

Martin's (2000) Original Framework

Martin's (2000) original framework on mathematics identity and socialization was developed from his dissertation research at Hillside Junior High School in Oakland, California. He defines *mathematics identity* as "participants' beliefs about (a) their ability to perform in mathematical contexts, (b) the instrumental importance of mathematical knowledge, (c) constraints and opportunities in mathematical contexts, and (d) the resulting motivations and strategies used to obtain mathematics knowledge" (Martin, 2000, p. 19). In turn, he defines *mathematics socialization* as "the processes and experiences by which individual and collective mathematics identities are shaped in sociohistorical, community, school, and intrapersonal contexts" (Martin, 2000, p. 19). It is important to note that Martin's (2000) work is context-specific; he explicitly focused his dissertation work on the learning, achievement, and persistence of African American students at Hillside Junior High.

The particular context and student population at Hillside influenced the contextual forces of socialization that Martin (2000) included in his multilevel identity framework, which he characterized as a way to help understand the "psychological, academic, and mathematical development of African-American adolescents, viewed in the context of the various forces that come to bear on their development" (p. ix). These forces—the sociohistorical, community, and school levels —are depicted in Figure 1. Martin (2000) noted that while these forces are organized in a way that looks hierarchical, they each interact with each other, and individuals are active participants in navigating these forces. To that end, Martin (2000) also included Figure 2 as a way to better visualize individual agency and the relationships between contextual forces. Figure 2 better represents how mathematics identity development and socialization occur as the individual navigates these various forces. In using a lens of socialization, Martin's (2000) framework was intended to help bridge how African American students at Hillsides' math identity development at the individual level was shaped by their negotiation of the interrelated sociohistorical, community, and school-level forces.

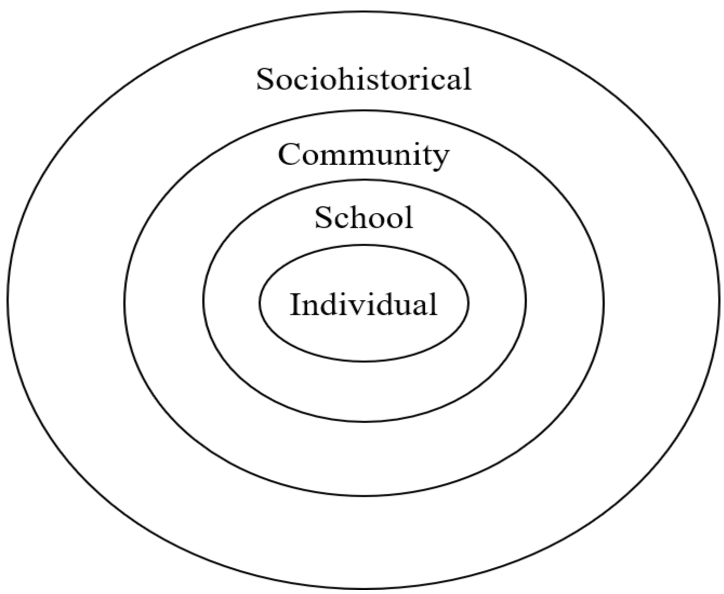

Figure 1. Multiple Contexts of Analysis. Reprinted from Mathematics Success and Failure Among African-American Youth (p. 32), by D. Martin, 2000, Laurence Erlbaum Associates, Inc. Copyright 2000 by Lawrence Erlbaum Associates, Inc. Reprinted with permission.

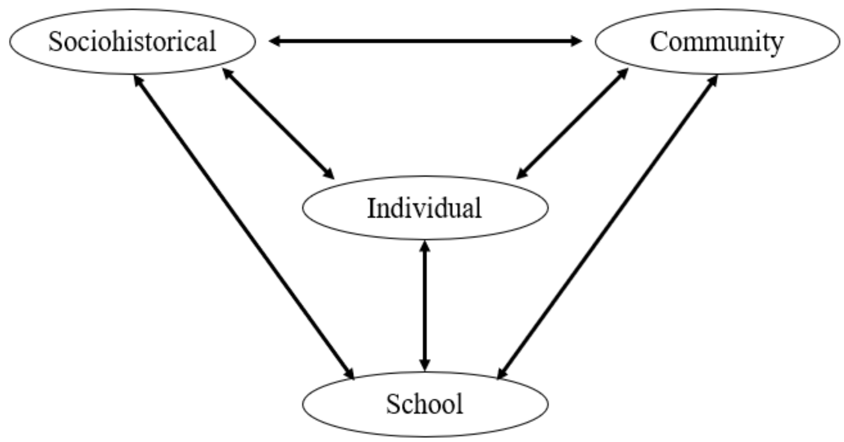

Figure 2. Individual Agency and Mathematics Socialization. Reprinted from Mathematics Success and Failure Among African-American Youth (p. 33), by D. Martin, 2000, Laurence Erlbaum Associates, Inc. Copyright 2000 by Lawrence Erlbaum Associates, Inc. Reprinted with permission.

A consequence of the specificity and contextualization of Martin's (2000) framework is that it was never meant to be a framework that could be generalized without intentional adaptation. Indeed, while Martin (2000) made no claims that his framework could be generalized beyond the African American students at Hillside, he did note that "because it includes history and context, the theoretical framework may be of use in its own right in analyzing the educational situations of other groups for whom history and context play important roles" (p. xi). As an example, he suggested minoritized groups such as "the Native Americans in the United States, the Aboriginals in Australia, and the Maori in New Zealand" (Martin, 2000, p. xi). However, in order to utilize this framework for other populations, context and specificity in the adaptation of this framework is necessary. As such, I began to wonder how this framework might be adequately adapted to a higher education context—specifically, in regard to the mathematics identity development of students of Color.

While most of the research on math identity I found was housed in the K-12 domain, there were some studies that explored math identity in the college context, most of which built off Martin's (2000) original framework. However, much of this work either focused on the ways in which individuals navigated the school and community contexts in their racialized math identity development (Ellington & Frederick, 2010; Oppland-Cordell & Martin, 2015) or excluded race entirely from the analysis (e.g., Cribbs, Hazari, et al., 2015, Cribbs, Piatek-Jimenez, & Mantone, 2015). The literature in the former category did not explicitly attend to and describe the interaction of sociohistorical contexts in students' math identity development—the first level of Martin's (2000) framework. The research that explicitly incorporated the sociohistorical contexts alongside the community, school, and individual factors focused specifically on Black college students in mathematics (Larnell, 2016; McGee, 2015; McGee & Martin, 2011; Stinson, 2008), rather than students of Color more broadly.

I could understand why the research that did adapt and attend to all the levels of Martin's (2000) framework in the higher ed context focused specifically on Black students, rather than students of Color more broadly. Attending to specificity and contexts—especially sociohistorical contexts—can be more easily done within rather than across specific racial groups. While there are shared experiences amongst all people of Color in the United States, there are also histories and contexts that are unique to different racial groups, and thus, the experiences of people of Color cannot be flattened into one monolithic experience (Delgado & Stefancic, 2017). However, given my focus on the mathematics identity development of students of Color, I sought to learn how to better articulate the shared experiences that students of Color in higher education had, in order to understand how Martin's (2000) framework might be applied to the mathematics identity development of students of Color in higher education contexts—particularly at historically white colleges and universities (HWCUs).

Framing the Present Study and Arriving at a Conceptual Framework

At the end of this chapter, I detail a conceptual framework of membership into a mathematics community. This framework integrates Martin's (2000) mathematics identity and socialization framework and Liu's (2017) framework on power governors and privileged spaces. I found this framework to be helpful in guiding this study, which seeks to conceptualize how mathematics GTAs socialize undergraduate students of Color at an HWCU through the lens of systemic racism and white supremacy. However, arriving at the framework that guides this study was not a simple—or at times, even a linear—process. It took several iterations—as well as several other integrations of theoretical and conceptual frameworks—to arrive at the final framework that grounds the present proposed study. In the sections that follow, I detail the process through which I shifted, adapted, and added to Martin's (2000) framework on the contextual forces of mathematics socialization to focus on how GTAs socialize undergraduate students of Color in mathematics departments at HWCUs.

Martin's (2000) framework was a necessary starting point for me, as I was interested in the contextual forces of mathematics socialization at an HWCU, and how these forces were integrated and influenced each other. One of the most helpful aspects of Martin's (2000) is how it bridges systems, structures, culture, and individuals. In order to contextualize Martin's (2000) framework to an HWCU, I began by situating the framework within the broader context of systemic racism and white supremacy in the United States. I then defined HWCUs as white institutional spaces (Moore, 2008) which serve to maintain and reproduce whiteness—and then situated mathematics departments at HWCUs as white institutional spaces themselves in order to fully establish my proposed context through the lens of systemic racism and white supremacy. However, while my first modification of Martin's (2000) framework laid the groundwork to examine the identity development and socialization of undergraduate students of Color in math departments at HWCUs, it did not allow me to understand how socializing agents facilitate this process. In other words, while my initial modification of Martin's (2000) framework was helpful in understanding the contextual forces of mathematics socialization at an HWCU, I needed to understand *how* these forces were actively supported and facilitated by agents to protect the racialized consolidation of power in mathematics spaces. Thus, I knew I needed to further modify Martin's (2000) framework if I wanted to examine the role of a specific agent of mathematics socialization—in this case, GTAs—in the socialization and identity development of undergraduate students of Color.

I thus decided to look at this modified framework of mathematics identity development and socialization through the lens of community, membership, and belonging. Because I was still grounding socialization through systemic racism and white supremacy, I turned to Liu's (2017) framework of power governors and privileged spaces to further modify Martin's (2000) framework on mathematics identity development and socialization. The integration of these two frameworks—Liu's (2017) and my initial modification of Martin's (2000) framework—allowed me to focus specifically on how GTAs socialize undergraduate students of Color in mathematics departments at HWCUs through the lens of systemic racism and white supremacy in this study, and how racial power and privilege are consolidated and reproduced through this socialization process.

Over the next several sections, I detail how I moved from my focus on the mathematics identity development of students of Color, to mathematics socialization. I also describe the iterations of my dissertation's conceptual framework as a result of the ways in which my focus shifted from identity development to socialization. I begin with some of the foundational theoretical assumptions and framings that ground this study, before moving on to explain how I first modified Martin's (2000) framework on mathematics identity and socialization, and then re-modified it by integrating it with Liu's (2017) framework on power governors and privileged spaces in order to move from framing identity development, to framing a racialized socialization process facilitated by agents of mathematics of socialization—in this case, GTAs.

Theoretical Foundations: Race, Racism, Whiteness, and White Supremacy

In the early years of my doctoral program, I had thought that I wanted to focus on the mathematics identity development of students of Color at an institution of higher education for my dissertation. As such, I wanted to understand the shared experiences of students of Color in higher education to understand how Martin's (2000) framework might be applied to a context of higher education. My search for how to better articulate and understand the shared experiences of students of Color led me to take a course in Critical Race Theory during my second year of my doctoral program. This course gave me the language tools, and theory to frame the shared experiences of students of Color in higher education through the lens of structural racism and white supremacy. It also helped me to ground my work in Critical Race Theory—and eventually, Critical Whiteness Studies—and identify as an emerging critical race mathematics education scholar.

As an emerging critical race math education scholar, I come to this work with several foundational assumptions from the works of scholars and theorists such as Bell (1992), Crenshaw (1993/2016), Delgado and Stefancic (2017), Harris (1993), Ladson-Billings (1998/2016), and Tate (1997). These assumptions include the following:

- Racism is *endemic and ordinary in our society*, and is a permanent fixture in everyday life.
- *Liberalism must be critiqued*, as it does not allow for the kind of sweeping changes necessary to combat racism. Instead, liberalism focuses on incremental changes, which allow racism and white supremacy to mutate even while appearing to provide benefits for people and communities of Color.
- Whites have *no incentive to change the status quo*, as racism results in psychological and material benefits for them. Any change to the status quo can only happen when it also benefits white interests (a concept called *interest convergence*). As such, civil rights legislation has primarily benefited whites.
- Race is a social construct; that is, racial categories have no scientific, biological basis. However, the *meanings assigned to racial categories through the process of racialization are consequential*.
- People of Color experience *differential racialization over space and time*, based on white interests and the needs of the labor market.
- Oppression from multiple structures interact in ways that inform the experiences of those with multiple marginalized identities; in other words, the experiences of any one person of Color cannot be fully understood through the lens of race alone, but rather, can only be understood through the *intersectionality* of their oppressions.
- There exists a unique "voice of Color" due to oppression and discrimination that is shared (though not in essentialist ways) by people of Color. People of Color have lived experiences that whites cannot understand, and *centering these lived*

experiences and narratives as a form of valid knowledge is a key component of Critical Race Theory.

This list of assumptions is by no means comprehensive or universal. Drawing on Crenshaw et al. (1995), Ladson-Billings (1998/2016) notes that "there is no 'canonical set of doctrines or methodologies to which [CRT scholars] all subscribe' (p. xiii). However, these scholars are unified by two common interests—to understand how a 'regime of white supremacy and its subordination of people of color have been created and maintained in America (p. xiii) and to change the bond that exists between law and racial power" (p. 20).

While my goals as a critical race mathematics education scholar are to change the bond that exists between mathematics and racial power, rather than law and racial power, I share the goals of CRT scholars that Ladson-Billings (1995/2016) describes. Given the first foundational assumption that I named, which is a primary assumption of Critical Race Theorists, because racism is endemic in U.S. society, "the strategy becomes one of unmasking and exposing racism in its various permutations," (Ladson-Billings, 1995/2016, p. 18). As Davis (2019) asserts, "to understand how racism operates in mathematics education, stakeholders must understand how racism works in the larger society. The racism that functions in mathematics education is a microcosm of the racism that functions globally" (p. 184). Much like constructions of race itself, racism has adapted and evolved over time (Bonilla-Silva, 2018; Omi & Winant, 1994). Whereas notions of racism—and particularly, historical racism—are often rooted in overt and explicit acts of violence and supremacy, racism today is also covert, and is normalized through "neutral" and "color-blind" ideology, discourse, policies, and practices (Bell, 1992; Bonilla-Silva, 2018; Omi & Winant, 1994). Despite its invisibility, racism today continues to function for the same purpose that it always has: to maintain the dominant racial order and hierarchy.

As Tate (1997) discusses, the dominant racial order in the United States has always been rooted in the Black-white binary. The oppositional categorization of Blacks as inferior and whites as superior has been an ideological cornerstone of American history and society (Tate, 1997). As the United States has become more multiracial, some scholars (e.g., Chang, 1993; Hernández-Truyol, 1997; Omi & Winant, 1994) have challenged the Black-white binary and argued that it must be abandoned or expanded, contending that there is not sufficient room within the Black-white binary to encompass the whole of the United States' racial landscape. Kim (1999), however, refutes the argument that the Black-white binary is too restrictive, and contends that it is a multidimensional and complex theory that can be used to understand and conceptualize race relations in a multicultural United States context.

In this vein, the Black-white binary and positioning of Blacks at the bottom of the racial hierarchy and whites at the top is the groundwork for understanding the racial stratification that is present in the United States; this is the dominant racial order that racism functions to serve. As Kim (1999) states:

> Racial conceptualization and stratification in the United States are dominated by the notion that "black" and "white" are positioned at opposite extremes that denote race oppression and privilege… regardless of how the paradigm came about, it is undeniably one of the chief mechanisms by which individuals and groups become racialized, and even self-identify, on both legal and social/cultural planes (p. 2394).

Thus, non-Black people of Color are racialized and positioned with respect to these opposite extremes of whiteness and Blackness. Bonilla-Silva (2004) presents a different conceptualization—or rather, *re*conceptualization—of the Black-white binary, suggesting instead a tri-racial order with "Whites" at the top, "Honorary Whites" in the middle, and "Collective Black" at the bottom.

Although there are differences in these conceptions of the racial hierarchy, what is consistent across these paradigms is the positioning of whites. In the dominant racial order, whiteness is always at the top, and the dual function of racism is to protect whiteness while oppressing, exploiting, and marginalizing people of Color. As Davis (2019) discusses, this is also true in mathematics education, which is not immune to the broader contexts of systemic racism and whiteness.

How Whiteness Operates

Due to its position at the top of the racial hierarchy, whiteness is not only protected and preserved as the ideal (Battey & Leyva, 2016), but becomes the standard for normalcy (Cabrera, 2014; Matias et al., 2014; Patton & Haynes, 2020)—and thus, humanity and humanization (Allen, 2004). As an ideological and social construct, whiteness is able to remain hidden through this normalization, as well as through color-blind ideology (Bonilla-Silva, 2018) and claims of benevolence, innocence, objectivity, and neutrality (Leonardo, 2004; Martin, 2008). Whiteness is then enacted and preserved through white supremacy and racism, which continuously evolve and self-correct in order to preserve the ideology of whiteness, the legitimization of its position, and the privileges and tangible and material benefits to white people that result from it while people of Color are oppressed (Battey & Leyva, 2016; Harris, 1993; Patton & Haynes, 2020; Woodall, 2013).

Like racism, white supremacy is often thought of as the explicit and overt actions of "bad" white people, and as something that historically held far more power than it does today. However, as Leonardo (2004) explains, whites not only invest in white supremacy, but "recreate their own racial supremacy, *despite good intentions"* (p. 144, italics added). In other words, "good" white people still invest in, maintain, and benefit from white supremacy—regardless of intent. Furthermore, because whiteness is so normalized and enmeshed in our structures, systems, and institutions it does not need to be consciously recognized at the individual level in order to exist and operate—or for white people to benefit from white supremacy (Matias et al., 2014). As Battey and Leyva (2016) explain, "whiteness functions within structures, deciding how resources, labor, and space will be distributed by means of housing segregation as well as educational and financial stratification. These structures are in place to benefit future generations" (p. 57).

The more I learned about racism, whiteness, and white supremacy, the more I began to reflect on the questions, experiences, and interests that brought me to the doctoral program through a more critical lens. I began to both refine and define my research interests in a way that focused on the systems and structures that reproduce racism and white supremacy. This led me to realize that it was not only the mathematics identity development of students of Color that interested me—it was also the ways in which mathematics education worked as a system to consolidate power and prestige in a racialized manner, using ideologies of meritocracy to maintain the dominant racial order as a form of covert racism (Chen & Buell, 2018; Lue & Turner, 2020). Because of my own experiences as a mathematics major, my work in higher education and student affairs, and my experiences teaching as a graduate assistant in a mathematics department, I then began to think more critically about the ways in which mathematics education was situated in higher education. Because I was both a product of and participant in an HWCU, I specifically considered the ways in which mathematics education and the mathematics identity development of students of Color were situated within HWCUs, and how HWCUs operated as white institutional spaces—or spaces that are "the foundation for contemporary white institutional norms and policies that reproduce white privilege and power within these spaces" (Moore, 2008, p. 27). In the following section, I specifically define what I mean by the term HWCU, and how HWCUs might be characterized as white institutional spaces.

Historically White Colleges and Universities as White Institutional Spaces

The higher education literature has traditionally differentiated between predominantly white institutions (PWIs) and minority serving institutions (MSIs)[5]. However, it is important within contemporary literature to differentiate between PWIs, MSIs, and HWCUs—or historically white colleges and universities (Bonilla-Silva & Peoples, 2022). As Bonilla-Silva and Peoples (2022) explain, the first colleges and universities in the United States were exclusively white institutions that were "directly tied to white supremacy via the dispossession of Native Americans' land and the enslavement of Africans" (p. 2). Although racial integration was mandated during the civil rights era, it was opposed by white students, faculty, and administrators, and informal segregation still exists at HWCUs to this day (Bonilla-Silva &

[5] MSIs are broadly defined as "institutions of higher education that serve minority populations" (U.S. Department of the Interior, n.d.) and receive federal funding under the Higher Education Act to support their mission of serving students of Color (U.S. Department of Education. n.d.). The term MSI covers a broad range of institutions of higher education, such as historically Black colleges and universities (HBCUs), Hispanic-serving institutions (HSIs), Tribal Colleges and Universities (TCUs), Alaska Native-serving institutions or Native Hawaiian Institutions (ANSIs & NHSIs) and Asian American and Native Pacific Islander Serving Institutions (AANAPISIs).

Peoples, 2022). Moreover, HWCUs remain "sites of disenfranchisement for people of color" (Bonilla-Silva & Peoples, 2022, p. 4) due to their historical whiteness, white demography, white logic, white curriculum, white climate, and the way whiteness permeates HWCUs' physical space. As Bonilla-Silva and Peoples (2022) explain, even as HWCUs continue to racially diversify, "HWCUs are not just spaces where everyone belongs equally, but are instead 'white spaces' (Moore, 2008)" (p. 3).

White institutional spaces serve to reproduce systems of domination, and the consolidation of power along racial lines (Bonilla-Silva & Peoples, 2022; Moore, 2008). As Moore (2008) explains:

> The concept of institutional racism captures how racist relations can be reproduced without individuals' intentional racist acts, because racism is deeply entrenched within our institutions… and because these institutions are fundamentally racialized, they function to reproduce racist social relations and ideologies that support these relations as institutions (as opposed to individuals, or even collections of individuals) (p. 25).

Such white institutional spaces are characterized by the following four elements (Moore, 2008; Martin, 2008):

1. Racial exclusion of people of color from elite spaces and positions of power.
2. Development of a white frame that organizes the logic of the institution.
3. Historical construction of a curricular model based upon the thinking of white elites.
4. Assertions of neutrality and impartiality with a lack of connection to power relations or politics.

HWCUs' beginnings as exclusively white institutions—and later, predominantly white institutions—are an innate part of their legacy and framing as white institutional space, and play an important role in justifying how they are characterized as white institutional spaces through Moore's (2008) framework.

Racial Exclusion from Power

The first element that characterizes white institutional space is the historical and contemporary racist exclusion of people of Color from elite spaces and positions of power. As evidenced in the previous section, HWCUs have historical foundations in racist exclusion of people of Color from elite spaces and positions of power, due to the fact that they were originally built on the premise of racial exclusion. Today, power remains consolidated within racial lines, both administratively and academically. While current national datasets do not allow for the disaggregation of data by classification as an HWCU, 83% of college presidents in 2016 were white, which is a vast majority (American Council on Education, 2017). Furthermore, it is likely that the percentage of white college presidents at HWCUs is higher than this national aggregate, given that the percentage of white college presidents at MSIs is lower than 83% (Imlay & Schapp, 2017; Seltzer, 2017). As for the professoriate, 76% of college professors are white (Davis & Fry, 2019). Along tenure-track lines, racial diversity is increasing amongst assistant professors; 73% of assistant professors are white, as compared to 76% and 81% of associate professors and full professors, respectively (Davis & Fry, 2019). However, while these numbers are promising to a modest extent, it is important to note that faculty of Color often face discrimination and racism during the tenure track process, which can lead to attrition during the tenure process (Diggs et al., 2009).

Even as a system, higher education in the United States concentrates prestige and elite status within HWCUs. Although rankings systems are not necessarily indicators of excellence, universities are attuned to rankings systems, and strive to benchmark against institutions based on these indicators (O'Meara, 2007). The top 11[6] universities in the United States—as ranked by the U.S. News 2022-2023 Best National Universities (U.S. News, 2022a)—are all private HWCUs that were established prior to 1900. Of the top 11[7] public universities in the United States (U.S. News, 2022b), only one college—the University of California at Irvine—was established after desegregation in 1965. However, UC Irvine is part of the University of California System, which was established in 1868 as a result of the Morrill Act and is thus part of a Historically White System of institutions. Furthermore, the Ivy League schools, which are commonly referred to as the nation's most prestigious schools—though some no longer rank in the top 10 according to the U.S. News System —are all HWCUs. While not every HWCU is considered an elite space, it is clear that through standard college ranking measures (Chang et al., 2008; Ortagus, 2016), the most elite universities in the United States are HWCUs and were founded as exclusively white spaces, and students of Color have historically been excluded from accessing them. Even today, many elite and selective universities are still predominantly white (Ashkenas, et al., 2017; Chang et al., 2008), and students of Color report hostile campus climates where they are marginalized and excluded (Gusa, 2010).

Development of a White Frame

In discussing the second dimension of white institutional space, Moore (2008) adopts Feagin's (2006) definition of a white frame: "an organized set of racialized ideas, emotions, and

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[6] The list of top 10 universities ends in a tie between Duke University and Northwestern University for 10th place.

[7] The list of top 10 universities ends in a tie between the University of California, Davis, and the University of Texas at Austin for 10th place.

inclinations, as well as recurring or habitual discriminatory actions, that are consciously or unconsciously expressed in, and constitutive of, the routine operation and racist institutions of U.S. society" (p. 26). As Cabrera, Franklin, and Watson (2016) discuss, one of the dimensions of whiteness in higher education is whiteness as ontological expansiveness. Campus space functions as white space, affording access, comfort and belonging, and entitlement to white students while restricting students of Color (Brunsma et al., 2012; Cabrera, Franklin, & Watson, 2016, Gusa, 2010). The ontological expansiveness of whiteness (Cabrera, Franklin, & Watson, 2016) is largely accepted as the norm at HWCUs; while this is in large part due to their histories and foundations in racist exclusion, HWCUs have also neglected to sufficiently understand and dismantle the influence of their histories on present-day norms (Moore, 2008). As Cabrera, Franklin, and Watson (2016) discuss, while "the racial composition of higher education may be changing… this does not mean the institution's racial culture, climate, or ecology is changing" (p. 52). In other words, the white frames that were developed when HWCUs were founded and operated as exclusively white institutions continue to reproduce and reify themselves.

An example of the white frame and ontological expansiveness of whiteness can be seen in how self-segregation at universities is viewed. As Park (2020) discusses, critics of diversity initiatives in higher education may claim that students of Color tend to self-segregate. What is rarely addressed is the clustering and self-segregation of white students, because it is so normalized and expected under a white frame. The onus of change is then shifted onto students of Color, who are hypervisible in white spaces, and whose clustering is therefore more noticeable. Under a white frame, it is also seen as peculiar that students of Color would not want to cluster around white students, because whiteness is so normalized. In fact, Park's (2020) research shows that students of Color are actually more likely to have cross-racial friendships than their white peers—and yet, white students are rarely accused of self-segregating in the same way. The white frame masks this phenomenon by normalizing it, and also by masking the ways in which students of Color may seek solidarity because of the ways in which the ontological expansiveness of whiteness creates an unwelcome and even hostile culture and campus climate for them (Cabrera, Franklin, & Watson, 2016).

Historical Curricular Models by White Elites

The third dimension of white institutional space in Moore's (2008) framework is the historical construction of a curricular model based upon the thinking of white elites. Since many early universities in the United States had small endowments, the most respected universities were only attended by the wealthiest students, who could afford to pay full tuition (Bowen et al., 2005). As a result, college curricula catered to their values, and the university became a place to prepare responsible, civic-minded citizens that would be useful to society in ways that differentiated their "learned" class from the "laboring" class (Bowen et al., 2005). The white elite values that permeated historical curricular models persist today; the curricula at most HWCUs are still centered around the preparation of civic-minded graduates that will contribute productively to American society and the labor workforce.

The influence of finance, economics, and market forces that implicitly shaped historic curricular models also continue to influence contemporary curricula. While HWCUs have a vast array of departments, major programs, and coursework requirements, Trow (1999) notes that: "cluster of shared characteristics marks our curricula, teaching styles, and patterns of assessment: the unique role of general education as a component of nearly all American first degree courses; the considerable extent of student choice in the selection of courses; and the modular course earning *unit-credits*, an academic currency that makes a system of 3300 separate institutions" (p.

10). Thus, despite the vast diversity of major programs and degree offerings across HWCUs, one thing that unites them is an underlying, base curricular model rooted in the white, elite values of capitalism and the free-market system, where students can transfer and exchange educational currency throughout the system to fulfill common, generalized degree requirements.

Assertions of Impartiality and Neutrality

The final characteristic of white institutional space is an assertion (or assertions) of neutrality and impartiality, with a lack of connection to power relations or politics. These assertions are commonly rooted in colorblind ideology (Bonilla-Silva, 2018), and can manifest in a variety of different ways. One prominent example is admissions. For example, many HWCUs require standardized test scores—either the ACT or the SAT—as a component of their application for admission. Although these exams are inequitable (Santelices & Wilson, 2010) and have been shown to be relatively weak predictors of students' future academic performance in comparison to factors such as GPA (Bowen et al., 2009), many HWCUs still use the exams as purportedly "neutral" admissions criteria to determine applicants' academic aptitudes (Gusa, 2010).

Affirmative action is another admissions-related example of assertions of impartiality and neutrality at HWCUs. Critics of race-conscious admissions policies often frame their arguments under impartiality and neutrality, stating that schools should admit the most qualified students—regardless of race. However, these assertions are disconnected from sociohistorical power dynamics and the United States' history of racial exclusion and oppression that has advantaged white students in having competitive admissions applications (Cabrera, 2020; Gusa, 2010). These histories are often not acknowledged, and contemporary racial disparities in admissions—particularly at selective HWCUs —are minimized or explained by naturalization arguments or cultural racism (Bonilla-Silva, 2018). These naturalization arguments and justification using cultural racism ultimately serve to reify and reproduce segregation in higher education.

Both of these admissions examples also rely on the foundational premise of meritocracy, which is another way in which HWCUs present themselves as neutral and impartial spaces. Under the premise of meritocracy, all students have the ability to succeed at HWCUs if they are smart enough, work hard enough, or have proven themselves to be deserving enough. However, the myth of meritocracy does not account for the racism and discrimination that students of Color often face in higher education settings—and particularly, math and STEM settings —that hinder their academic achievement and persistence (e.g., Park et al., 2019). Thus, meritocracy is yet another way that HWCUs present themselves as neutral and impartial spaces and divorce themselves from their historical foundations and contemporary perpetuation of exclusion. In doing so, HWCUs are able to shield themselves from acknowledging the role that systemic racism and whiteness play on their campuses, and on the educational trajectories and experiences of students of Color.

Arriving at an Initial Modified Math Identity Framework

With the foundations of HWCUs as white institutional space modified Martin's (2000) original framework, which is presented in Figure 3, to frame my research interests on the contextual forces of mathematics socialization at an HWCU, and how these forces interrelate and affect the mathematics identity development of undergraduate students of Color. As illustrated in Figure 1, I propose that the top level of Martin's (2000) framework, the sociohistorical level, be modified to include not only sociohistorical, but *sociopolitical* contexts of undergraduate mathematics education. The community level then becomes the broader university as community, and the school level becomes the mathematics department. As discussed previously, the individuals in this modified framework are undergraduate students of Color, and the framework is situated within the context of HWCUs as white institutional space. Each level of the modified framework is briefly detailed in the next few sections. Before moving forward with the explanation of this framework, however, I feel compelled to reiterate that while this modified framework focuses more broadly on students of Color, they are by no means a monolith, and I do not claim that the experiences of students of Color at HWCUs are all the same. Students of Color—and indeed, even white students—are racialized and positioned differently based on their racial identities. What does unite the experiences of students of Color at HWCUs is their existence and persistence in a space that privileges and centers whiteness while oppressing, exploiting, and excluding them.

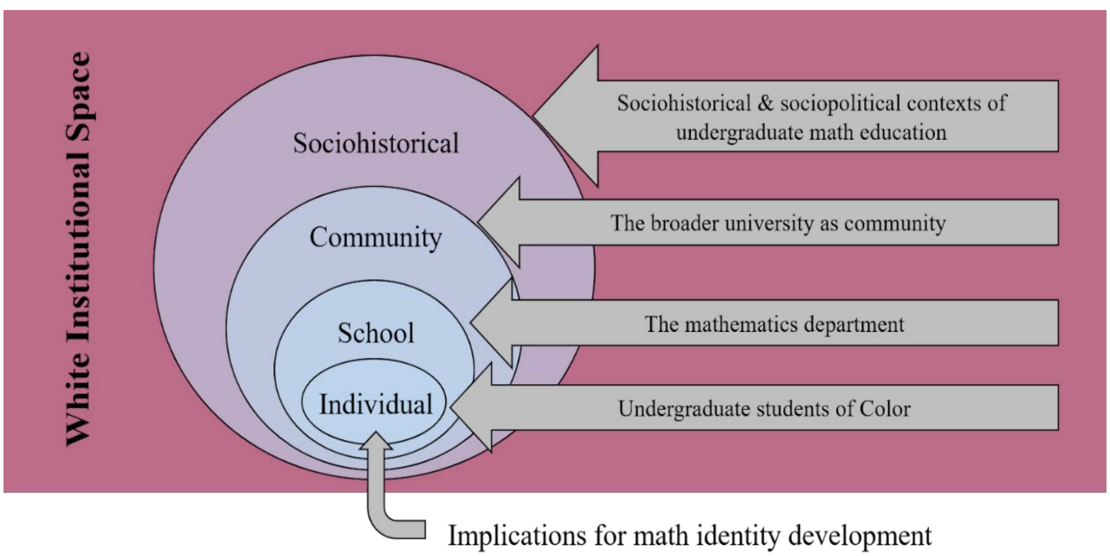

Figure 3. A Modified Framework for Mathematics Identity and Socialization in Higher Education Contexts. Adapted from Mathematics Success and Failure Among African-American Youth (p. 32), by D. Martin, 2000, Laurence Erlbaum Associates, Inc. Copyright 2000 by Laurence Erlbaum Associates, Inc. Adapted with permission.

Expanding the Sociohistorical to the Sociopolitical

The first level of Martin's (2000) framework is the sociohistorical influences on mathematics education and mathematics identity development, which are important foundations for contemporary research on racial equity and justice in mathematics. However, given this study's groundings in Critical Race Theory, which is a sociopolitical perspective, the sociohistorical context of math identity development cannot be divorced from the *sociopolitical* history and context of mathematics and math education (Clark et al., 2013; Martin, 2019; Moses & Cobb, 2001; Phillips, 2014)—particularly in regard to research on race in mathematics education. As Nasir and McKinney de Royston (2013) note, "a sociopolitical analysis attends to how race and power operate in learning settings, especially as they may relate to privilege and marginalization" (p. 266). Though the sociopolitical turn in mathematics education research (Gutiérrez, 2013) has gained traction over the last decade (e.g., Aguirre et al., 2017; Martin, 2013; Turner et al., 2013), it has only recently permeated research in university-level math education (Adiredja & Andrews-Larson, 2017). Yet, mathematics education at the university level is situated within the sociopolitical contexts of mathematics education, higher education, and society more broadly, and these contexts are crucial to consider in any research focused on racial justice and equity (Martin, 2009). Thus, it is imperative to expand the top level of the framework to include not just the sociohistorical context, but the sociopolitical context of undergraduate mathematics education. While this expansion is in some ways redundant, due to this study's grounding in sociopolitical perspectives, I felt it helpful to specify this expansion in my modified version of Martin's (2000) framework in case of use in the future by others who may not share my same theoretical groundings.

The Broader University as Community

Martin's (2000) initial concept of *community* included African-American students, parents, and other community members who play a role in African-American students' socialization, and in forming their beliefs about the importance of mathematics. While he states that his use of the term does not imply that all African-Americans share the exact same experiences and beliefs, they do share common experiences because of their racial identities and the sociohistorical contexts of what it means to be African-American and a doer of mathematics. He uses the term *community forces* to bridge individual and collective experiences as well as beliefs about the importance of mathematics and describe their subsequent effects on African-American students' socialization and identity development (Martin, 2000).

In the modified framework, the concept of community becomes slightly more expansive, and also diverges from Martin's (2000) original concept of community forces. While in Martin's (2000) original framework, community forces were intended to conceptualize a community that African-American students already belonged to, in this modified framework, the community level conceptualizes a community that undergraduate students of Color are entering: the university. Thus, in this modified framework, the community-level represents a normative culture that undergraduate students of Color are entering and potentially adapting to, rather than a community they are in that may conflict with the dominant culture as in Martin's (2000) original work. As such, rather than only including undergraduate students of Color at the university-level of socialization in this modified framework—or even university community members of Color—the notion of university community in the modified framework includes faculty, administrators, advisors, staff, and both undergraduate and graduate students, regardless of race. In the context of an HWCU, the white frame (Feagin, 2006) that characterizes white institutional spaces is reified and reinforced by both white and non-white community members who act as institutional agents. This frame positions mathematics as a subject that is neutral, and where success is based on a combination of innate intelligence and hard work, rather than being an exclusionary and racialized space where power and status are consolidated (Lue & Turner, 2020).

This consolidation of power and status can also be seen in the hierarchy of academic disciplines. The hierarchy of academic disciplines is correlated with the hierarchy of math courses; many STEM disciplines require advanced math courses that are seen as more difficult and prestigious—such as Multivariable Calculus and Linear Algebra and differential equations—while humanities or social science majors require courses that are perceived as less rigorous and prestigious—such as Algebra and Trigonometry or Precalculus. Some universities also have tracked levels of Calculus, differentiating between Calculus for STEM majors, and Calculus for non-STEM majors, with the former perceived as being for the "smarter" students. Such notions then inform the collective community beliefs and community forces that influence the experiences of undergraduate students of Color as they navigate their socialization and math identity development.

The Mathematics Department at School-Level

The third level of Martin's (2000) original framework focused on school-level factors at Hillside. These school-level factors included administrators and other institutional support, community-based programs, peers, and mathematical content and curriculum. However, the main school-level factor was the negotiated relationship between students and teachers. While teachers held certain expectations of students, enforced classrooms and mathematical norms, and selected curriculum and content, students also held beliefs about mathematics and had their own norms and culture that often conflicted with what the teacher sought to establish. By serving as *agents of mathematics socialization* (Martin, 2000), teachers worked alongside students in collective sense-making as they navigated these oppositional norms and beliefs. Similarly to students, teacher beliefs were also influenced by both collective community forces and sociohistorical forces. However, teachers had other constraints that affected their choices and practices, such as state, district, and school mandates.

In the modified framework, mathematics departments at HWCUs operate at the school level. Mathematics departments, like schools, have norms and graduation requirements that are influenced and sometimes constrained by federal, state, or university system mandates. Faculty and graduate student instructors also serve as agents of mathematical socialization, and have expectations and beliefs about student achievement, mathematical norms, and classroom culture that may be in opposition to norms that undergraduate students of Color hold (e.g., Daempfle, 2003, McGee, 2016). And so, undergraduate students of Color must navigate the mathematics department-level forces, which impact not only their socialization and math identity development, but their academic trajectories.

The policies and practices of mathematics departments are influenced by sociohistorical, sociopolitical, and collective university community norms and contexts—much like how Hillside was influenced by the community and sociohistorical contexts. As a microcosm of a white institutional space, the mathematics department is embedded in the same sociohistorical and sociopolitical contexts as the larger university, as well as the same norms, frames, and curricular models. Mathematics departments also administer their own placement exams under assertions of impartiality and neutrality, which classify students' mathematical aptitude and readiness. However, like admissions tests, math placement exams are not the strongest predictors of students' future performance in mathematics, and often "under-place" students into developmental education when they do not need it (Burdman, 2012). Black and Latinx students are disproportionately overrepresented in developmental education courses (Jiminez, 2016; Ngo & Kosiewicz, 2017), and research has shown that only 40% of students who have to enroll in developmental math coursework end up completing enough math courses to satisfy math graduation requirements (Ngo & Kosiewicz, 2017). Thus, students of Color are disproportionately harmed and excluded by allegedly neutral and impartial high-stakes policies that mathematics departments create and enforce.

These placement exams perpetuate the racial consolidation of power amongst undergraduate students, whose graduation and even admission into selective degree programs—such as engineering or computer science—are contingent on these placement exam results. This racial consolidation of power is mirrored in the classroom, with college instructors often reinforcing traditional mathematical classroom norms through their teaching practices. Such practices often involve imparting mathematical knowledge to students through lectures and gauging students' knowledge through high-stakes assessments (Bergsten, 2007; Hillel, 2001; Leyva, McNeill, et al., 2021). These teaching practices socialize undergraduate students of Color by emphasizing that white epistemologies are normative in mathematics classrooms, and white-dominant ways of knowing and learning are necessary to be "good" at mathematics (Adiredja & Andrews-Larson, 2017; Larnell, 2016; Leyva, McNeill, et al, 2021; McGee, 2016; Mills, 2007).

The racial consolidation of power is also evident when considering the demographics of mathematics department faculty. Approximately three quarters of full-time mathematics faculty are white (Blair et al., 2018). While the American Mathematical Association only collects data on department chair gender, rather than race, the underrepresentation of mathematics faculty of

Color—and specifically, Black, Latinx, and Indigenous faculty—makes it likely that the majority of mathematics department chairs are also white. It can thus be determined that at the modified school level of the framework, mathematics departments at HWCUs operate not only within HWCUs as white institutional spaces, but as white institutional spaces themselves, which has profound impacts for the development, socialization, and academic trajectories of students of Color.

Undergraduate Resilience and Individual Agency

The fourth and final level of Martin's (2000) framework is the individual level, which focuses on students' math identity development as well as their success, resilience, and agency. Although the students at Hillside had to navigate various contextual forces and barriers detailed in the other three levels of the framework, some of them were able to negotiate these forces successfully. Similarly, while undergraduate students of Color—and in particular, underrepresented students of Color —at HWCUs navigate the contextual forces presented in the modified framework, they are able to be both mathematically and academically successful and resilient (Ellington & Frederick, 2010; Larnell, 2016; McGee, 2015). However, success takes on a complicated definition in the modified framework, and this definition is worthy of questioning. While mathematical success can be characterized through the traditional, external markers that are defined within a white institutional space—such as grades, exam scores, and recognition from faculty as being a "math person"—for students of Color, success often involves reframing, redefining, or subverting these norms in math and STEM (e.g., Carlone & Johnson, 2007; Ellington & Frederick, 2010; Larnell, 2016; McGee, 2015).

Moments of (Re)flection and Defining the Research Question

As discussed earlier in this chapter, when I first began considering a modification of Martin's (2000) original framework, I had intended for my dissertation work to focus on the mathematics identity development of undergraduate students of Color at an HWCU. Specifically, I had planned on focusing on underrepresented undergraduate students of Color. However, immersing myself in critical studies that focused on the math and STEM experiences and identity development of Black and Latinx students (e.g., Ellington & Frederick, 2010; Larnell, 2016; McGee, 2015; McGee, 2016; Oppland-Cordell & Martin, 2015) led me to reflect more critically on my own mathematics identity development and my place in this body of research. As an Asian American woman who had struggled in my mathematics identity development but had not navigated contextual forces that positioned me as intrinsically mathematically or academically inferior, I wondered whether it was my place to illuminate the narratives and stories of underrepresented students of Color. If my research was meant to be transformative and truly in service of racial justice in mathematics and STEM, I didn't want to only focus on the narratives of students whose racial identity I did not share. In a way, that felt exploitative of the trauma and harm they may have experienced, and there were better ways to use the platform that my positionality afforded me.

In reflecting more on my positionality, I thought about how my own proximity to whiteness—especially as a light skinned East Asian American woman—and my mathematics credentials from a prestigious HWCU afforded me access and power in mathematics spaces. How then, might my dissertation focus on the structures that reproduce whiteness and white supremacy in mathematics spaces, and work towards dismantling them? I revisited Martin's (2000) framework, and realized that what I ultimately needed to focus on was not the mathematics identity development of underrepresented students of Color at HWCUs, but how that development happened: socialization. Specifically, I needed to look at the actors who facilitated that socialization, whom Martin (2000) refers to as *agents of mathematics socialization*. At the university level, while both faculty and graduate teaching assistants serve as instructors—and thus, agents of mathematics socialization—I realized that I was particularly interested in the role of graduate teaching assistants (GTA) due to the unique roles that they played as agents of mathematics socialization during a crucial time of their own socialization (Lue, 2022). I wondered, based on my own experiences as a GTA and in taking a graduate mathematics course with other GTAs, what influences GTAs had on the mathematics identity development of undergraduate students of Color. In particular, I wondered about the opportunities and strengths they had in enacting meaningful change for undergraduate students of Color through their teaching practices and modes of interaction. Furthermore, I wondered how they conceptualized the power and constraints they had within these roles to enact meaningful change and disrupt the reproduction of whiteness in mathematics departments at HWCUs. However, in order to frame these questions, and the research question and subquestions that ultimately guide this dissertation, I needed to situate GTAs within my modified mathematics identity and socialization framework. Specifically, rather than only identifying the contextual forces of socialization, I wanted to understand how the process of socialization was facilitated by GTAs, as well as how this socialization process reified the racial consolidation of power. These goals led to the integration of Liu's (2017) framework on power governors and privileged spaces, which I explain in the following section.

The Final Modified Framework: A Model of Membership

In order to situate GTAs within the modified mathematics identity and socialization framework as agents, I chose to reconceptualize mathematics identity as *membership* into the mathematics community at an HWCU by drawing on Liu's (2017) work on racialized and privileged spaces (Figure 4). Liu (2017) contends that:

> Institutions work in concert to regulate, legitimize, and afford privileges to individuals… These interdependent institutions or, as this author will refers to as, "power- governors" … are institutions (e.g., a state legislature) or individual actors (e.g., a school or a bank) that have legitimacy and authority to regulate access to its resources (e.g., voting, education, money, and housing), power, and privileges… And individuals within these power-governors are empowered to work on their behalf. Thus, privilege is not a natural product of human interaction where people grant each other privileges; rather, it is a synthetic product of institutional necessity (p. 351).

White supremacy, then, is upheld through these power governors—which often can be simultaneously thought of as white institutional spaces (Moore, 2008). These power governors restrict access to privileged spaces, which white people can move between freely while maintaining their privilege, because of "scaffolds" that connect them (Liu, 2017). People of Color are able to access individual privileged spaces through the "ladder of upward mobility" and can even receive benefits from those spaces. Liu (2017), however, refers to these benefits as proxy or peripheral privileges, because they are contingent on being in those specific privileged spaces. In other words, while people of Color can have privilege and power in specific spaces, they cannot move freely between privileged spaces and maintain their benefits in the same ways that white people do, because only whites have access to the scaffolds that connect power governors.

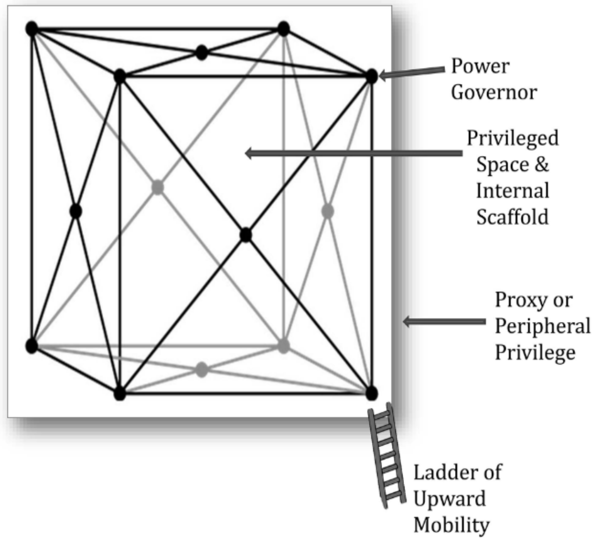

Figure 4. Power Governors and Privileged Spaces. Reprinted from White Male Power and Privilege: The Relationship Between White Supremacy and Social Class, by W.M. Liu, 2017, Journal of Counseling Psychology, 64(4), p. 351. Copyright 2017 by the American Psychological Association. Reprinted with permission.

In this vein, mathematics departments at HWCUs can be thought of as power governors; the mathematics community is then the privileged space. It should be noted that the mathematics department and the mathematics community are not interchangeable; the mathematics community consists of those who are seen and respected as “math people” and have strong mathematics identities and senses of belonging within the mathematics department. The mathematics community, then, consists of faculty and students, while the department also includes advisors, administrators, and other actors that may not necessarily be part of the mathematics community. Membership into the mathematics community is restricted by the math department, which operates simultaneously as a power governor and a white institutional space.

Thus, because the mathematics community is a privileged space, membership into the mathematics community also provides unrestricted access for whites into other privileged spaces. This privileged space is protected and restricted by members of the mathematical community within the mathematics department—namely, instructors—who act as agents of mathematics socialization and agents of the institution by setting and upholding the values and norms of the mathematics community. In doing so, they assert who "belongs" in the community, and set the criteria for recognition of "math people". These members thus define and maintain the boundaries of who has access to membership within the mathematics community, and who is able to develop strong, stable mathematics identities where they see themselves—and are respected as, deferred to, and seen by others—as "math people".

The integration of the modified mathematics identity and socialization framework and Liu's (2017) conceptualization of privileged spaces is depicted in Figure 5. In this reconceptualization, membership into the mathematics community can be almost thought of as a physical building, similarly to how Liu's (2017) work is representative of a physical space. This building is constructed by walls, which then serve as the boundaries that restrict access into the mathematics community at an HWCU. These walls are constructed by the norms and culture of the mathematics department at the school level, and the broader university as community; as such, the mathematics community is constructed by the department-level and university-level forces of socialization.

Similarly to Liu's (2017) framework, there are scaffolds along the walls of the mathematics community. These scaffolds provide permanent structural support and points of connection to white norms, values, and power—thus protecting white members and allowing them free and unrestricted access to other power governors and privileged spaces. I draw further on Liu (2017) and specify that these scaffolds are built and upheld by agents of mathematics socialization, who maintain the boundaries of, and restrict access to, the mathematical community. These agents are dispatched to preserve and protect the mathematics community and receive benefits and privileges in return for protecting the space. Thus, white supremacy and whiteness in the mathematics community at an HWCU are enacted and reproduced by these agents, who benefit from maintaining this structure and system.

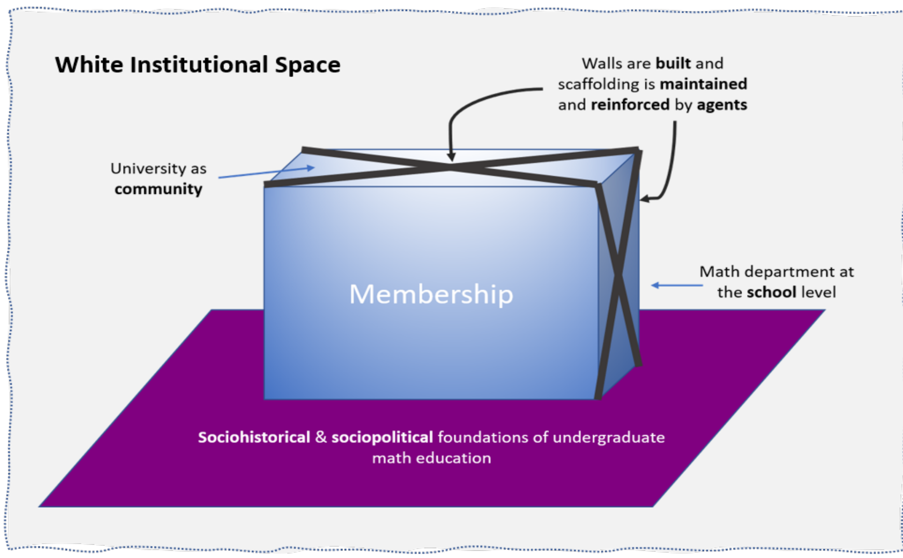

Figure 5. A Reconceptualization of Mathematics Identity and Socialization as Membership Into Mathematical Communities at HWCUs

As depicted in Figure 5, I also contend that membership into the mathematical community at an HWCU also sits upon the sociohistorical and sociopolitical foundations of undergraduate mathematics education, all of which is situated within a white institutional space (Martin, 2008; Moore, 2008; Turner, 2020). The sociohistorical and sociopolitical foundations of undergraduate mathematics education, as well as white institutional space, are not restricted or confined by the walls of membership into the mathematical community. This is an intentional representation. For undergraduate students of Color, there are consequences associated with being restricted from accessing membership into the mathematical community at an HWCU. Certainly, undergraduate students of Color can be successful in their mathematics education, the broader STEM fields, or even non-STEM academic fields, without having access to membership into the mathematical community at an HWCU. However, navigating these paths to success can be difficult and even traumatic, due to the ways in which HWCUs as white institutional space and the sociopolitical and sociohistorical foundations of undergraduate mathematics education permeate the holistic undergraduate experience.

Situating GTAs in the Revised Membership Model

As discussed in the previous section, instructors in mathematics departments act as primary agents of mathematics socialization that restrict access to the mathematics community; in this sense, power within the mathematics department is consolidated and centralized among them. However, it should be noted that there are differential levels of both power and membership. While differential levels of power are contingent on status within the community, differential levels of memberships are contingent on race.

Differential Levels of Power

While all members of the mathematics community have privilege and power within the space, this power is most consolidated and centralized among established and tenured professors who have the most history within the community. As newer members of the mathematics community who are at a critical point in their own socialization process (Lue, 2022), GTAs have less power than established and tenured professors in shifting and changing the norms and values of the space, and their power is mostly relegated to their decisions to adopt and uphold the norms and values of the mathematics community. However, despite having less power as newer members of the mathematics community, they are still authorized to gatekeep membership into the mathematics department because their labor as instructors is functional to protect the boundaries of the mathematics community, thus ensuring the mathematics community remains valued, restricted, and protected. This is how power centralizes, functions, and conserves itself —through consolidation and strategic authorization (Liu, 2020).

Racialized Membership Levels

Furthermore, because mathematics communities operate as power governors and white institutional spaces, levels of membership into mathematics communities are racialized. Full membership into the mathematics community can only be granted to white people, while people of Color can only be granted contingent membership and proxy privileges (Liu, 2017). This means that only white GTAs can be considered full members of the mathematics community, and thus, white GTAs have more protected power than GTAs of Color. Nevertheless, GTAs of Color can still be authorized to hold power in mathematics communities; however, this power is contingent on them upholding whiteness and reinforcing normative values and beliefs. Furthermore, GTAs of Color may be more or less inclined to maintain their contingent membership based on their proximity to whiteness (for example, East Asian GTAs may be more inclined to assimilate to and uphold white norms and values). Despite these different levels of membership, however, all GTAs can act as agents of mathematics socialization, and I will not be excluding GTAs from participating in this study based on their race.

However, attending to GTAs' race is still an important consideration for this study. Due to these racialized levels of membership, white GTAs and GTAs of Color have different opportunities and constraints in enacting change that disrupts the white institutional culture of mathematics communities at HWCUs that will be important to acknowledge in this study. For example, since GTAs of Color gain proxy privilege and power in mathematics communities only through their contingent membership, the personal benefits of maintaining their contingent membership may outweigh their desire to subvert the norms and values of the mathematics community in service of undergraduate students of Color. Because white GTAs are closer in proximity to the power source of mathematics departments at HWCUs, and are protected by their whiteness, they may not face the same type of constraints, and may have more opportunities and potential to disrupt the reproduction of whiteness in the mathematics community at an HWCU.

It is possible that there may be potential for all GTAs—regardless of race—to be able to disrupt the white institutional culture of mathematics communities at HWCUs, and potential for them to redefine the boundaries of membership to be permeable to students of Color. However, the possibilities for critical change cannot be identified without first fully understanding how GTAs act as agents of mathematics socialization at HWCUs for undergraduate students of Color. Thus, the present study seeks to use this framework of membership to understand *how GTAs serve as agents of mathematics socialization for undergraduate students of Color at an HWCU*, and what agency they may have in doing so. In the next chapter (Chapter 2), I situate the focus of this dissertation study in the relevant literature, before moving on to specifically describe the methods for this study in Chapter 3.

CHAPTER 2: LITERATURE REVIEW

The purpose of this dissertation study is to understand the role of graduate teaching assistants (GTAs) as agents of mathematics socialization for undergraduate students of Color at a historically white institution of higher education (HWI). It is my hope that the findings from this study can contribute to the scholarship that seeks to enact critical change in university mathematics environments in pursuit of racial equity and justice in the STEM fields and beyond. With this larger goal in mind, one way of thinking about the broad aims of this study is that I seek to better understand GTAs as a key factor in the STEM experiences of students of Color—and in particular, underrepresented students of Color—as it relates to their retention or attrition in the STEM fields. As such, I have organized the literature review in a way that helps to situate how this proposed study fits into the broader landscape of research on the retention, attrition, and experiences of students of Color in the STEM fields. I will begin this literature review with an overview of the racialized experiences of underrepresented students of Color[8] in STEM. From there, I review the research on STEM faculty as socializing agents and potential sites of structural change before narrowing the focus to the role of GTAs in mathematics and the unique socialization process that mathematics GTAs are situated within, and why it is important to focus on them as agents of mathematics socialization.

[8] Because this literature review focuses on underrepresented students of Color at the undergraduate—and occasionally graduate—levels, I utilize the term "underrepresented students of Color" in this chapter. However, in the rest of the chapters, I still utilize the term "undergraduate students of Color" to refer to underrepresented undergraduate students of Color.

The Racialized Experiences of Underrepresented Students of Color in STEM

Research on the retention and attrition of underrepresented students of Color in STEM has highlighted a variety of factors that promote persistence in the STEM fields. Such factors include having peer supports such as study groups (Hilts et al., 2018; Palmer et al., 2011; Park et al., 2021; Ong et al., 2011), relationships with faculty (Cole & Espinoza, 2008; Park et al., 2019), positive campus climate (Eagan et al., 2010; Hurtado et al., 2007; Johnson, 2012), and STEM-related co-curricular experiences (Chang et al., 2014; Chemers et al., 2011; Ghosh-Dastidar & Liou-Mark, 2014). Furthermore, underrepresented students of Color who had early interest in the STEM fields (Perez et al., 2014, Pierrakos et al, 2009), identification with the discipline (Chcmers et al., 2011), strong high school academic preparation and achievement (Chang et al., 2014; Cole & Espinoza, 2008) and an easier adjustment to the academic demands of college (Chang et al., 2011) were more likely to persist in STEM majors.

However, much of the traditional research on the retention of underrepresented students of Color in the STEM fields has undertheorized the role of race and racism on students' experiences and persistence. Rather than only viewing race as a static category through which to group students for analyses, an emerging body of literature focuses specifically on how racialization and racism impact the experiences, persistence, and retention of underrepresented students of Color in STEM. Such research has highlighted the myriad forms of racism that these students face—including isolation and exclusion (e.g. Blosser, 2019; Ong et al., 2011), microaggressions and stereotypes (e.g. Beasley & Fischer, 2012; McGee & Martin, 2011), and more overt forms of discrimination and hostility (e.g. Basile & Black, 2019; McGee & Bentley, 2017)—all of which create an unwelcoming environment for underrepresented students of Color in STEM that can lead to attrition.

Due to their numerical scarcity in the STEM fields, many underrepresented students of Color describe their experiences of being one of few students who look like them to be an isolating and "othering" experience (Blosser, 2019; Lee et al., 2020; Dortch & Patel, 2017; Malone & Barabino, 2008). The hypervisibility of being underrepresented in STEM often facilitates a feeling that individual underrepresented students of Color are representative of their entire race, which creates a sense of pressure and constant observation (Dancy et al., 2020; Malone & Barabino, 2008; McGee & Martin, 2011). Furthermore, the lack of racial diversity in the STEM fields can also make it difficult to find support and community, especially given that they are often left out of study groups and excluded from other forms of social ties by their peers (Basile & Black, 2019; Blosser, 2019; Park et al. 2021).

Underrepresented students of Color in the STEM fields also face microaggressions and stereotypes that position them as intellectually and academically inferior to other students in the STEM fields (Basile & Black, 2019; Beasley & Fischer, 2012; Leyva, 2016; McGee, 2015; McGee & Bentley, 2017; McGee & Martin, 2011). These stereotypes enforce the idea that underrepresented students of Color do not belong in—and are not capable of performing well in—the STEM fields; such stereotypes are constantly reinforced through racialized microaggressions (Beasley & Fischer, 2012; Blosser, 2019; Dortch & Patel, 2017; Lee et al., 2020). This adds to the heightened sense of pressure that underrepresented students of Color feel to constantly perform well in courses and prove that they are worthy of being STEM majors. Additionally, the pressure of microaggressions and stereotypes, combined with the effects of isolation and exclusion, make underrepresented students of Color feel that if they fail, they will be confirming negative stereotypes about their race (McGee & Martin, 2011). However, even when underrepresented students of Color are high-achieving in STEM spaces, they are often characterized as the “exception” to the stereotypes about their race—in other words, the stereotypes persist despite their successes and achievements. For example, a Black female biology student in Basile and Black’s (2019) study told her white academic advisor that she was considering becoming a K-12 science teacher. Her advisor told her that she was “one of the *good* ones” (a Black student who persisted in the STEM fields), and that she should not “waste” her talents by teaching in the K-12 classroom.

The isolation, exclusion, microaggressions, and stereotypes that underrepresented students of Color face in the STEM fields create an unwelcoming environment for underrepresented students of Color in the STEM fields. However, as covert and normalized forms of racism (Bonilla-Silva, 2018), these experiences can be difficult to name and identify as racist experiences. While some underrepresented students of Color were able to name these experiences as being driven by racism—and in some cases, with the intersection of sexism—(Dancy et al., 2020; Dortch & Patel, 2017; McGee & Bentley, 2017) it was often difficult to do so. These covert forms of racism socialize students into thinking that they are not good enough to “make it” in the STEM fields, which in some cases, is further reinforced by more overt forms of hostility and discrimination. For example, participants in Lee et al.’s (2020) study, who identified as underrepresented students of Color, described being laughed at or made fun of by STEM instructors in office hours for not knowing how to do something, or being told by faculty or advisors that if they had to go to office hours for help, then they should switch majors.

The message being sent to underrepresented students of Color in STEM through these various forms of racism is that they are not expected to do well in the STEM fields because they are not “the ideal STEM student”. Moreover, these forms of racism signal that “the ideal STEM student” is compatible with white-dominant ways of knowing and being, and therefore, their existence as Black and Brown people of Color is not innately compatible with success and belonging in STEM. In other words, the racialized notion of "the ideal STEM student" positions underrepresented students of Color as outsiders to the STEM community. This racialized notion of the "ideal STEM student" is evident in Dancy et al.'s (2020) findings of bias from participants that STEM is for white people and males, as well as in findings from other studies that underrepresented students of Color often found that their racial identities were not congruent with normative STEM identities (Basile & Black, 2019; Carlone & Johnson, 2007; Malone & Barabino, 2008; McGee, 2016).

Thus, the depiction of "the ideal STEM student" serves to maintain racial exclusion in the STEM fields in a colorblind way that is hidden behind the meritocratic culture of STEM, which is in turn rooted in white norms. As McGee (2016) explains, STEM higher education was born from White male supremacy" (p. 1630). As such, people of Color were excluded entirely from participating in STEM spaces for over a century—the aftereffects of which can still be felt in STEM college environments, which remain predominantly white at both the student and faculty levels (Davis & Fry, 2019; Trapani & Hale, 2019). While STEM spaces no longer remain exclusive to whites at a physical, literal level, the culture of STEM remains exclusionary under "the idea that 'not everyone is good enough to cut it, and we're going to make it hard for them, and the cream will rise to the top'" (Epstein, 2006; par. 13). Such a mentality—that only some people are cut out for STEM—fosters a competitive, individualistic, and meritocratic environment that is rooted in colorblind racism and neoliberal ideologies (Leyva, McNeill, et al., 2021). Implicit in this mentality is that it is underrepresented students of Color who are "not cut out" for the STEM fields, which is reinforced by the marginalization that they face in STEM environments from faculty, peers, and advisors.

The Complexities and Cost of Success in STEM for Underrepresented Students of Color

Despite the racialized experience that serve to position underrepresented students of Color as intrinsically inferior and unwelcome in the STEM fields, underrepresented students of Color were able to persist in these environments through two main ways: finding affinity in race-based community, and assimilating or performing assimilation.

Finding Affinity in Race-Based Community

One way that underrepresented students of Color were able to persist in the unwelcoming environment of STEM fields was to find race-based community—oftentimes outside of the STEM department (Basile & Black, 2019; Blosser, 2019; Dortch & Patel, 2017; Ellington & Frederick, 2010; McGee, 2015). A Black male biology student in Black and Basile's (2019) study, for example, found support, advice, and affirmations from three diverse organizations outside of his department. The Black female engineering majors in Blosser's (2019) study emphasized the importance of finding community in student groups, organizations, and with other Black women in order to find validation and affirmations of their racialized experiences in the engineering major. These findings are similar to prior studies of underrepresented students of Color in STEM who participated in race specific scholarships programs (e.g., Fries-Britt, 1998; Treisman, 1992). Such programs were found to increase the retention of underrepresented students of Color in the STEM fields by providing resources, support, and race-based community.

While finding race-based community outside of STEM departments can be a helpful strategy in retaining underrepresented students of Color in the STEM fields, it is important to note that there are limitations to this strategy. Such forms of community must exist simultaneously with—rather than changing or shaping—the hostile and exclusive STEM culture.

This places more of a burden on underrepresented students of Color to find these communities and still positions them as outsiders to the normative STEM environments while alleviating departments of the responsibility of enacting meaningful change.

Assimilation and Performative Assimilation.

Another way that underrepresented students of Color in STEM successfully navigate hostile STEM environments is to either assimilate to the norms of STEM spaces (Basile & Black, 2019; McGee & Martin, 2011) or perform assimilation by engaging in "an imitation of stereotypical forms of Whiteness" (McGee, 2016, p. 1628), which McGee (2016) refers to as *frontin'*. However, frontin' is not limited to imitating whiteness; it can also be "an imitation of stereotypical forms of... anti-Whiteness" (McGee, 2016, p. 1628). The latter is a form of resistance to normative STEM culture that underrepresented students of Color—and in particular, Black students—students engage in to prove themselves and assert their racial identity alongside their successes in STEM. Although the definition of *frontin'* traditionally contains two components, McGee's (2016) study of 38 high-achieving Black and Latinx STEM students did not engage in frontin' as an act of resistance, which she posits is because "the very bodies of Black and Brown people are viewed by their STEM departments, ant to some extent by their universities and colleges, as acts of resistance" (p. 1652-1653). Instead, her participants largely engaged in frontin' as an act of performative assimilation in order to manage racial stereotypes and mitigate racial trauma.

Although assimilation or performative assimilation can be successful management techniques for underrepresented students of Color, engaging in these techniques still takes a psychological and emotional toll on students. Assimilation requires underrepresented students of Color to devalue their racial identities, and can result in tokenization (Basile and Black, 2019).

Moreover, assimilation does not solve or negate racialization, which underrepresented students of Color remain subjected to. Performative assimilation is an active and conscious choice that requires emotional and mental labor from students; it also requires sacrificing authenticity, which can lead to racial battle fatigue (McGee, 2016; McGee & Martin, 2011).

Moreover, as McGee (2016) notes, underrepresented students of Color who engage in these management techniques and successfully persist in the STEM fields are often characterized as resilient, strong, and perseverant. They are then lauded by institutional leaders for having grit and fortitude, which puts the onus of navigating these hostile climates on individual students—at great personal sacrifice —rather than on institutions and institutional actors to enact critical change. Thus, while assimilation, performative assimilation, and finding race based community and affinity are all ways in which underrepresented students of Color are able to persist and succeed in STEM spaces, critical scholars interested in the retention of underrepresented students of Color in the STEM field must look to ways that the norms and values of university STEM environments might change at a structural level, rather than focusing on how individual students might navigate these hostile environments.

A Focus on Mathematics Spaces

The studies described thus far in this section focus on the racialized experiences of underrepresented students of Color in STEM broadly, rather than in mathematics specifically. This is in large part due to the paucity of research on the racialized experiences of underrepresented students of Color in postsecondary mathematics spaces. The few studies that have focused on the racialized mathematics experiences of underrepresented students of Color in higher education have largely reflected the themes already discussed in this paper. Underrepresented students of Color race similar forms of racism in mathematics spaces as they do in broader STEM spaces, which frame them as innately mathematically inferior to white and Asian students and men, and thus, as outsiders to mathematics majors (Larnell, 2016; Leyva, 2016; McGee, 2015; Oppland-Cordell & Martin, 2016). Notably, the role of instructors in perpetuating these forms of racism—and the role of instructors as socializing agents to the normative and exclusive mathematics culture—was more salient in studies that focused specifically on mathematics spaces than on broader STEM spaces (e.g., Leyva, McNeill, et al., 2021; Leyva, Quea, et al., 2021; Oppland-Cordell, 2014).

Techniques in navigating these environments were also similar to the techniques that underrepresented students of Color used in navigating broader STEM spaces. Oppland-Cordell (2014) and Oppland-Cordell and Martin (2011) found that participation in an Emerging Scholars Program (ESP) helped Latinx students deconstruct the stereotypes that they faced; the lack of the external threat of racialization in the ESP workshops allowed them to reframe what it meant to be successful in math. The ESP workshops also allowed them to build community and develop strong peer support, and feel accepted and valued for their non-normative math practices and identities. Ellington and Frederick (2010) similarly found that participation in a scholarship program, as well as support from other Black community members, was a key factor in the persistence and success of high-achieving Black mathematics majors.

McGee (2015) found that while successful Black students were able to overcome racial stigmas in their mathematics courses, the racism they experienced nevertheless damaged their mathematics identity, and overcoming this damage required a great deal of work. Furthermore, as these students persisted in their mathematical careers, they realized that bias was enduring, and while finding support from peers and faculty was affirming in navigating this bias, constantly negotiating and decoding this system was ultimately incredibly draining.

Furthermore—and similar to broader STEM spaces—the onus is typically on individual students to enact management techniques and seek out community and affirmation in the face of racialized threats in mathematics spaces, rather than on the institutions and institutional actors to enact more structural change.

The Socializing Power of STEM Faculty

Structural change within the culture of a department can best be enacted by socializing agents. While faculty, staff, and peers are all institutional actors who can serve as socializing agents, Garibay (2018) notes that "faculty are considered to have major roles in the socialization process through their role in establishing the goals of undergraduate education, imparting knowledge to students, shaping the delivery of STEM curricula, and their social interactions with undergraduates" (p. 352). Whittaker & Montgomery (2013) also note that while many STEM diversity initiatives are driven by staff members at institutions, these are largely considered to be "isolated or 'add-on' initiatives" (p. 266) rather than embedded in "normal institutional practices and policies" (p. 265). As such, in order to enact meaningful, long-term change in STEM culture and climate, such change must integrate STEM faculty members, who have more permanence and institutional power than staff members (Whittaker & Montgomery, 2013). However, in order to understand how faculty as agents of STEM socialization might enact critical change, it is important to first understand the current state of STEM faculty values, and how current patterns of student-faculty interaction affect underrepresented students of Color.

Faculty Values and the Objectivity of STEM

Research on the influence of STEM faculty on the culture and climate of STEM departments has found that STEM faculty believe in—and promote—the objectivity of the STEM fields (Ferrare & Miller, 2020; Haynes & Patton, 2019; Johnson, 2007). In examining the attitudes and frames of STEM instructors, Ferrare and Miller (2020) found seven different interpretive frames of student persistence in STEM. However, consistent across several frames was "the perceived objectivity of STEM disciplines, a perception held widely among instructors regardless of their espoused frame" (p. 124). Faculty who believe in the objectivity of STEM also tend to believe that STEM content is more difficult than other subjects, and thus, that some students have the innate drive, intelligence, and talent that is required to do well in the subject, while others do not (Ferrare & Miller, 2020; Seymour & Hewitt, 1997). In other words, STEM faculty overwhelmingly believe in the "ideal STEM student," and continue to signal to students the types of qualities that are required to be one.

The belief that STEM is an objective set of disciplines with difficult content—where only certain students have the drive, persistence, and abilities to succeed—is a meritocratic ideology (Bonilla-Silva, 2018) that is often espoused through the structure of courses and the teaching practices of STEM faculty. Many introductory STEM courses are taught as large, "weed-out" courses where instructors primarily engage in lecture-style, transmissionist practices with little time devoted to class discussions or group work (Gasiewski et al., 2012; Johnson, 2007; Leyva, McNeill, et al., 2021; Seymour & Hewitt, 1997; Speer et al., 2010). These courses are often graded on a curve, where students are graded in comparison to their peers (Garibay, 2018; Seymour & Hewitt, 1997). In some cases, faculty who grade on a curve set a limited number or proportion of passing grades that can be received. The kind of competition that is cultivated by STEM faculty espouses the meritocratic belief that it is up to individual students to compete and work hard in order to be successful, and that only the top-tier and most deserving students will be able to do so. However, as Johnson (2007) astutely puts it, "the assumption that success in science is based on merit conflicts with the racial dynamics that govern how science students interact with one another" (p. 817).

In Ferrarre and Miller's (2020) study, only 7% of STEM instructors recognized and emphasized the prevalence of racism, sexism, and other forms of oppression in society, and their replication in the STEM fields—and the detrimental effects on equity and access in STEM. However, an overwhelming majority of STEM instructors in Ferrare and Miller's (2020) study believed that the STEM fields are a post-racial discipline, and that it is up to individual students to succeed. Indeed, many STEM faculty believe that STEM curricula are race-neutral, and that anyone can succeed if they work hard enough (Gasiewski et al., 2012; Haynes and Patton, 2019; Johnson, 2007), Some even believe that students of Color have more advantages than white students due to diversity initiatives (Ferrare & Miller, 2020). These beliefs invalidate the experiences of underrepresented students of Color, and can often even contradict the discrimination and racial stereotyping that they experience from faculty themselves—even as faculty continue to promote the ideas of neutrality and meritocracy in the STEM fields.

Beliefs about the neutrality of STEM curricula are often reflected in the acontextual way of teaching content that frames science as "a depersonalized abstraction" (Johnson, 2007, p. 814). Framing the STEM fields in this way disregards applications of the STEM fields, and some faculty express disdain for those who view STEM as more contextual for lowering the "disciplinary integrity" of the field (Haynes & Patton, 2019). This creates a hierarchical culture where those who study STEM because of their passion or interest in the subjects themselves are seen as more elite than those who have more altruistic, application-based, and people-centered motivations for studying STEM—often underrepresented students of Color (Carlone & Johnson, 2007; Johnson, 2007). Additionally, when developing relationships with students, faculty who view STEM as an objective and acontextual set of disciplines often seek to build their relationships around the science rather than the students (Johnson, 2007). This can often lead to students feeling as though they are unable to cultivate meaningful and supportive relationships with faculty, which can be particularly detrimental to underrepresented students—especially women—of Color.

The Importance of Student-Faculty Interaction for Underrepresented Students of Color

The ability to cultivate meaningful relationships with faculty has been found to be a key factor in the retention of students in the STEM fields. Conversely, negative interactions with faculty—or feeling like faculty are inaccessible, intimidating, or uncaring—are more likely to result in STEM student attrition. Unfortunately, the large, lecture-style courses that are common in introductory STEM levels create impersonal environments due to their teaching-centered nature (Gasiewski et al., 2012; Johnson, 2007). Students receive less individualized attention and affirmations from faculty due to limited opportunities for engagement; in turn, these limited opportunities for engagement fosters the sense that positive recognition from professors is a precious and limited resource that students have to compete for (Johnson, 2007).

However, competition for positive faculty recognition—at least in classes —is often skewed to the detriment of women and underrepresented students of Color. Typical transmissionist teaching practices position STEM faculty as authorities and experts who are exempt from learning processes (Haynes & Patton, 2019; Leyva, McNeill, et al., 2021), which creates an intimidating environment that discourages students from asking—or even answering—questions in class. Women and underrepresented students of Color are particularly unlikely to either ask or answer questions because they do not want to seem even more conspicuous in class than they already are due to their underrepresentation (Johnson, 2007); in speaking up in class, they also run the risk of confirming negative stereotypes about the abilities of their gender or race and being perceived as less smart in the eyes of their professor or peers.

The fear of confirming negative stereotypes is not an unfounded one, and in fact, many underrepresented students of Color who even answer questions correctly in class are still confronted with negative stereotypes and racial discrimination. For example, in McGee's (2015) narratives of two mathematically high-achieving Black college students, Tinesha—one of the participants—faced racial discrimination from her Calculus III professor upon answering several questions that he posed correctly. McGee (2015) describes him asking, "with an amazed look on his face… 'Wow, that's right. And Tinesha, no one helped you with the answer?'" (p. 615). The embarrassment Tinesha felt from this interaction prompted her to skip class for a week, which negatively impacted her performance in the course. In a similar vein, Park et al. (2019) found that while Black students are more likely than other students to approach faculty after class, they are also the most likely to feel racially discriminated against by faculty. The discrimination that they face "cancels out" the traditional positive benefits of student-faculty interaction; as such, higher rates of student-faculty interaction for Black students can actually result in lower rates of retention, as these interactions are more likely to be discriminatory (Park et al., 2019; Park et al., 2020).

Although opportunities to do so are less likely, when underrepresented students of Color are able to form positive, meaningful relationships with faculty, it can have a positive effect on the experiences and retention of underrepresented students of Color in the STEM fields. In their study of mathematically high-achieving Black students, Ellington & Frederick (2010) found that faculty support was instrumental in their participants' persistence in mathematics, and that the scholarship program that many of them were involved in granted them intimate access to faculty.

Similarly, Carlone & Johnson (2007) found that positive recognition and mentorship from faculty was important in women's of colors ability to recognize themselves as scientists, and thus persist in the STEM fields. Similarly, Johnson (2007) found that positive experiences with faculty in research labs was the most important positive factor that influenced persistence in STEM for underrepresented women of Color—however, the inverse was also true, in that negative experiences with faculty in labs was often the most important negative factor that influenced attrition from STEM.

Taken together, these findings suggest that it is imperative for faculty to understand the socializing power that they have on students—and in particular, underrepresented students of Color. STEM faculty must reflect on the types of beliefs that they espouse in their teaching, and how their beliefs and practice contribute to an unwelcoming culture and environment for underrepresented students of Color, and reproduce forms of colorblind racism. In particular, STEM faculty must work towards developing their racial consciousnesses, and examining how their beliefs—even ones they believe are neutral and objective—are founded in whiteness and contribute to racial exclusion in the STEM fields. Unfortunately, as the literature shows, this is a challenge given the current state of faculty beliefs and patterns of interaction with underrepresented students of Color, as well as constraints on faculty time and the mechanics of faculty reward systems (Haynes & Patton, 2019; Johnson, 2007; Whittaker & Montgomery, 2013).

Undergraduate Mathematics Faculty and the Role of Graduate Teaching Assistants

Research on the socializing power of mathematics faculty—particularly on underrepresented students of Color—is currently quite limited as compared to the literature on the socializing power of STEM faculty more broadly. However, specific attention to the socializing power of mathematics faculty is critical for scholars committed to racial equity and access in the broader STEM fields. Precalculus and Calculus are often considered “weeder” courses for higher-level math courses as well as for both introductory and higher-level STEM courses (Adiredja & Andrews-Larson, 2017; Leyva, Quea, et al., 2021). Because of this structure, and because of broader dominant narratives about math and STEM, innate mathematics ability becomes correlated with STEM potential (Leyva, Quea, et al., 2021).

The available literature suggests that mathematics faculty tend to espouse similar views as the broader STEM faculty on the objectivity of their discipline, and hold similar colorblind views of the discipline being only for the students with the highest abilities (Leyva, McNeill, et al., 2021; Leyva, Quea, et al., 2021). However, a slight difference between the views of broader STEM faculty and mathematics faculty is that while the broader STEM fields are framed as more meritocratic in nature—where both students with innate ability and students who work hard can succeed—mathematics ability is often framed by faculty as being innate. Accuracy and speed are typical markers of high innate mathematical ability, which mathematics professors communicate through their teaching practice. Leyva, Quea, et al. (2021), for example, describe several such incidences from undergraduate Precalculus and Calculus courses, including one where a professor laughed at a student who was struggling with an “easy” problem, and another where a professor advised a class that they should “drop down a course level or not take Calculus 2 if they cannot complete a problem quickly” (p. 10).

Introductory mathematics courses are also structured similarly to introductory STEM courses. Most courses are taught in traditional lecture and transmissionist styles (Speer et al., 2010); this style of teaching positions instructors as mathematical authorities, and students as observers and absorbers of knowledge (Adiredja & Andrews-Larson, 2017; Leyva, McNeill, t al., 2021). As a result—similar to many introductory STEM courses—there is a lack of meaningful opportunities for students to engage in their mathematics courses. As Leyva, Quea, et al. (2021) exemplify, instructors hold the power to gatekeep this engagement in several ways. In one example from their study, they noted that when a student pointed out a mistake during lecture, the instructor cut that student off to try to explain and justify their mistake, signaling not only that only the professor could be a legitimate holder and distributor of mathematical knowledge, but that mathematical authorities do not make mistakes. The consequence of the latter message is that students feel as though making mathematical mistakes is shameful and a signal that they do not have innate mathematical abilities (Oppland-Cordell & Martin, 2015)

Another way in which mathematics instructors gatekeep engagement in lecture-style courses is through choosing who to call on, and how to do so. Leyva, Quea, et al. (2021) found that underrepresented students of Color were often ignored when they raised their hands in class, which students attributed to racialized stereotypes about Black and Latinx people as loud, rude, troublemakers. Underrepresented students of Color also face low expectations from their professors about their mathematical ability due to racialized stereotypes, which are often communicated through microaggressions and discriminatory remarks from faculty (Borum & Walker, 2012; McGee, 2015; Oppland-Cordell, 2014). These types of stereotypes from faculty—and the subsequent ways in which faculty communicate these stereotypes through their actions (or inactions)—create an additional barrier for underrepresented students of Color to meaningfully engage in undergraduate mathematics courses. As a result, underrepresented students of Color are denied shared ownership of mathematical knowledge, and face racialized messaging that they do not belong in these courses or in mathematical communities.

In many ways, the values espoused in typical undergraduate mathematics courses run counter to the values that underrepresented students of Color hold, exacerbating the message that they do not belong in these courses. Aside from the examples already discussed thus far in this section, traditional, lecture-style mathematics courses also present mathematics as a solitary endeavor where collaboration and community building are neither expected nor encouraged in class (Leyva, Quea, et al., 2021; Oppland-Cordell & Martin, 2015). This can magnify the isolation that underrepresented students of Color already feel in their mathematics (and broader STEM) courses due to their underrepresentation in the field. Furthermore, peer support, engagement, helping others, and building community are often values are important to underrepresented students of Color, and in denying those opportunities, mathematics courses force underrepresented students of Color to assimilate to white male norms and devalue parts of their identities in order to be successful (Jett, 2012; Oppland-Cordell, 2014).

Some scholars have highlighted ways that mathematics faculty could have a positive impact on the experiences and persistence of underrepresented students of Color. Leyva, McNeill, et al. (2021) note that faculty must work to develop their own as well as their students' critical consciousness so that they can "engage in practices of critical instruction [McGee & Bentley, 2017], which create learning opportunities that develop… critical consciousness of structural inequities as well as the sociohistorical significance of race and gender in mathematics learning" (p. 809). Such learning opportunities must not only involve potentially reforming the structure of undergraduate mathematics courses to enable meaningful participation, but reflection on how faculty also create additional racialized barriers to engagement and belonging through racist stereotypes and colorblind ideologies of neutrality and meritocracy. In recognizing the biases and stereotypes they purport, as well as their power as socializing agents, mathematics instructors can work to create affirming environments that combat master narratives and racialized norms about who belongs in mathematics and STEM disciplines.

Mathematics Graduate Teaching Assistants (GTAs)

Within mathematics departments, graduate teaching assistants (GTAs) play a large role in the teaching labor force—particularly for lower division courses that serve as gateway courses for mathematics majors and the broader STEM fields[9] (Ellis, 2014; Speer et al., 2005). As Harris et al. (2009) note, "a significant portion of all lower division (first- and second-year) courses at doctoral-degree granting universities in the US are taught by GTAs" (p. 158). Undergraduate students of Color intending to major in the STEM fields thus come into high levels of contact with mathematics GTAs, and may enroll in several courses that are either taught by GTAs as the instructor of record, or in courses that have both a lecture and a discussion or recitation component. In the latter cases, mathematics faculty will typically teach large lecture sections, while GTAs teach smaller sections where they may review content, assist with homework problems, and review quizzes.

The format of the courses that GTAs typically teach—especially the small class sizes—provides GTAs with the ability to create meaningful opportunities for undergraduate students of Color to engage in mathematics content; it also provides GTAs with the ability to have a critical influence on their mathematics socialization and sense of belonging in the field. As such, GTAs—much like mathematics faculty—serve as agents of mathematics socialization for

[9] It is, however, important to note that lower division courses taught by GTAs can also include content courses for K-12 teachers, and general mathematics courses that are required for graduation from all majors—including ones in non-STEM disciplines (Speer et al., 2005).

underrepresented students of Color. However, GTAs occupy two other main roles within their mathematics departments aside from teaching: that of learners and doers of mathematics (Lue, 2022), and they must learn which of these three roles to prioritize, which they learn through the process of socialization within their department.

Literature on the socialization of graduate students discusses how GTAs must learn the normative values, attitudes, and norms of their departments, programs, and institutions upon entering their doctoral programs (Austin, 2002; Weidman et al., 2001). These normative values may differ or conflict with the values that GTAs enter their institutions with. However, as Speer et al. (2005) note, "graduate students must learn to function in their departments. To succeed, they need, or at least believe they need [Lacey, 1977], to adopt the habits and attitudes of their faculty mentors. Pressures to become part of the existing culture are strong" (p. 78). In other words, the success of GTAs as graduate students is often contingent—or at least, perceived to be contingent—on their ability to adapt to their institutional culture and adopt the dominant norms and values of that culture (Weidman et al., 2001). In mathematics departments, this adaptation often involves the devaluation of teaching, as it is not often institutionally or culturally prioritized by mathematics departments.

As Speer et al. (2005) write, "even TAs who arrive in graduate school with substantial concern for undergraduate education and strong motivation to teach may find that holding on to those ideals is incompatible with success as defined by their department, their faculty mentors, and the discipline as a whole" (p. 78). For many GTAs, good teaching is not a valued form of success, and thus, there are few opportunities to develop as instructors. Indeed, many GTAs do not even have full ownership over the courses that they teach, and are assigned courses close to the start of the semester, and are given faculty-created syllabi. These processes and norms signal to GTAs that teaching is not something they need to prepare for or develop skills in; rather, it is a task to get through and complete (DeFranco & McGivney-Burelle, 2001; Deshler et al., 2015). Although professional development programs for GTAs exist, it is common for these programs to emphasize local and institutional culture and preparation for disciplinary research, and these programs are structured in a way that minimizes the impact of the professional development on the timely completion of the doctoral degree (Harris et al., 2009). Thus, many professional development opportunities for GTAs still socialize them to prioritize their roles as doers and learners of mathematics over their roles as teachers of mathematics.

Over the last two decades, a small body of research has emerged with the goal of improving the teaching practices of mathematics GTAs, given the socialized devaluing of teaching that GTAs undergo, combined with GTAs' high rates of undergraduate instruction and interaction. This research has primarily focused on either assessing and improving GTA professional development (Deshler et al., 2015; Ellis, 2014; Harris et al., 2009; Speer et al., 2005), or better understanding GTA beliefs around teaching and learning mathematics (DeFranco & McGiveney-Burelle, 2001; Raychaudhuri & Hsu, 2012). Notably, while this research is situated in the socialization of GTAs as it relates to teaching practices for *all* undergraduate students, no research has yet emerged on the socializing power of GTAs through a critical lens that focuses on the racialized experiences of underrepresented students of Color in math and STEM spaces. Given the research that suggests how much of GTAs' teaching practices are adopted from faculty norms and values, and the research on how faculty values uphold a racially exclusive culture in STEM and math spaces, this is a critical area of research for scholars invested in the experiences, persistence, and retention of underrepresented students of Color to consider—which the present study seeks to build a foundation for.

CHAPTER 3: METHODS

The primary research question that guides this dissertation study is: *how do graduate teaching assistants (GTAs) serve as agents of mathematics socialization for undergraduate students of Color[10]?* Specifically, as I will outline later in this chapter, I focus on GTAs at a specific historically white [college and] university (HWCU). As discussed in Chapter 1, at the heart of this research question is how GTAs serve as gatekeepers into the dominant culture of a mathematics community at an HWCU, whether they align with or seek to diverge from this dominant culture, and the opportunities and constraints they face if they do seek to disrupt the dominant culture. In order to understand how GTAs serve as gatekeepers into the mathematics community at an HWCU, it is necessary to first understand how they interpret the shared values, beliefs, rituals, and practices of the mathematics community. How are these elements communicated to them through their own socialization process? Do they align with these elements, and uphold, normalize, and enforce them? Or do they disagree with the dominant culture of their mathematics community, and seek to shift and adapt these elements in their teaching practices? What contextual forces do GTAs navigate that may constrain their abilities to disrupt the dominant culture of mathematics communities and create a sense of belonging for undergraduate students of Color?

Thus, in order for my primary research question to be empirically investigated, I divided the primary research question into four subquestions that focus on the necessary understandings required to answer the primary research question. These subquestions are:

[10] As a reminder, I utilize the term "undergraduate students of Color" to refer to underrepresented, undergraduate students of Color for readability and ease of writing.

1. How do GTAs describe the culture (e.g., values and practices) of the mathematics department/community?
1. Do they align with this culture or want to break from it?
2. What opportunities do GTAs face in breaking from the normative values and practices of the mathematics department/community?
3. What constraints do GTAs face in breaking from the normative values and practices of the mathematics department/community?
4. Does the way that GTAs discuss their own values, practices, and goals reinforce whiteness and the consolidation of power along a racialized hierarchy in the department/community, or does the way in which they seek to change the normative culture of the department/community have the potential to make positive changes for undergraduate students of Color?

These subquestions focus first on understanding how GTAs describe the current culture of the mathematics department and community (and what they align with or disagree with), and then understanding the opportunities and constraints that GTAs face when trying to change the dominant culture of the mathematics community to be inclusive of undergraduate students of Color. The final subquestion then focuses on whether the changes GTAs might seek to create within the departmental culture might have the opportunity to create critical change in the mathematics community, or reinforce the systemic racialized exclusion of undergraduate students of Color from the mathematics community.

Note that within these subquestions, I do not always differentiate between the mathematics *department* and the mathematics *community*. As discussed in Chapter 1, the mathematics department and the mathematics community are not interchangeable, as the mathematics department is the power governor, while the mathematics community is the privileged space (Liu, 2017). However, I chose not to differentiate between the two in these subquestions for two main reasons. The first is that through the lens of my conceptual framework, the mathematics community is partially constructed by the forces of mathematics socialization at the department level; thus, the culture of the mathematics department influences and shapes the culture of the mathematics community; one cannot be understood without the other. The second reason I chose not to differentiate between the mathematics department and the mathematics community in my subquestions is because while my conceptual framework helped me in conceptualizing this study, the research questions, and the analysis, I did not want to complicate the questions I was asking participants by differentiating between the department and the community—particularly given how conceptual the mathematics community is as opposed to the department. In other words, I felt it would be easier for participants if I grounded my interview questions in the department, and to frame the community in my analysis, rather than in data collection.

Given this study's focus on understanding ways to disrupt the dominant culture of a privileged space, as well as this study's theoretical foundations in Critical Race Theory and Critical Whiteness studies, I utilized critical ethnographic methods in designing this qualitative study. The use of critical ethnographic methods in the design of this qualitative inquiry, as well as the data collection and analysis methods I used to address the research questions (the four subquestions as well as the overarching research question), will be detailed throughout the remainder of this chapter.

A Note on Methods

As Van Maanen (2011) writes, "ethnography is first and foremost a social practice concerned with the study and representation of culture" (p. 219). As a method, ethnography "is a qualitative design in which the researcher describes and interprets the shared and learned patterns of values, behaviors, beliefs, and language of a culture-sharing group" (Cresswell, 2013, p. 90). Typically, ethnography involves longitudinal fieldwork, in which the researcher immerses themselves within a culture-sharing group and builds deep relationships with participants (Cresswell, 2013; Jones et al., 2014). The researcher often becomes a participant-observer, taking fieldnotes, conducting interviews, and collecting artifacts and other research materials in order to create a "thick description" (Geertz, 1973) and portrait of the culture-sharing group in the final product (Cresswell, 2013; Jones et al, 2014; Palmer & Caldas, 2017). Additionally, "ethnography integrates both process (e.g., how data are collected) and product (e.g., written text that reflects a cultural interpretation)" (Jones at al., 2014, p. 98). Both process and product are integral to ethnography; as Merriam (2002) notes, "the mere use of data gathering techniques associated with ethnography does not result in an ethnography unless there is a cultural interpretation of those data" (p. 236). As Cresswell (2013) notes, this cultural interpretation can include the analytical theme of socialization, which is the focus of this dissertation.

Critical ethnography moves beyond traditional ethnography by foregrounding critical theory in order to challenge the status quo and asymmetry of power (Cresswell, 2013; Madison, 2020). As Madison (2020) notes, "what is distinctive about critical ethnography begins with an ethical responsibility to address processes of unfairness or justice within a particular *lived* domain… the conditions for existence within a particular context are not as they *could* be for specific interlocutors; as a result, the researcher feels an ethical obligation to make a contribution toward changing those conditions toward greater freedom and equity" (p. 4). Critical ethnographers do not merely seek to understand and portray a culture-sharing group; rather, critical ethnographers seek to illuminate existing imbalances and injustices in how power is concentrated within culture-sharing groups, in order to disrupt marginalization and move towards "freedom and equity" (Madison, 2020, p. 4).

Given that this study is grounded in addressing the asymmetry of power within a shared culture, and foregrounds critical theories in order to do so, critical ethnographic methods align neatly with this study. Furthermore, the purpose of this study is to illuminate the possibilities for equity, justice, and radical change in mathematics communities at HWCUs, by making explicit the ways in which privilege, power, racism, and whiteness operate in these spaces—and how they might shape the values and beliefs that GTAs uphold in their roles as agents of mathematics socialization. My ultimate goal in the work that I do is to explore, understand, and *disrupt* the ways in which power dynamics and asymmetry reproduce racialized hierarchies within university mathematics education, and how this reproduction reifies whiteness. This study is one way to begin the exploratory phase of the work that I hope to do, and it is clear that critical ethnographic methods are fitting—both for the research questions I am asking, and my purpose in asking such questions.

However, it is necessary to clarify that while I utilize critical ethnographic methods for this dissertation study, it cannot be accurately defined as a critical ethnography in and of itself. As Palmer and Caldas (2017) note, critical ethnography typically legitimizes and centers the stories and voices that are traditionally marginalized and silenced by dominant narratives. While an ultimate goal of this dissertation study is to "advocate for the emancipation of groups marginalized in society" (Cresswell, 2013, p. 93), which is in line with critical ethnography, I did not do so by working directly with undergraduate students of Color—which is the marginalized population this dissertation study is indirectly in service of. Rather, my participants were all GTAs, who are authorized to hold power in mathematics departments, and who belong to mathematics communities (albeit differentially, which will be discussed later in this chapter) at HWCUs.

The second reason this study is more accurately defined as a qualitative inquiry that employs critical ethnographic methods—rather than as a critical ethnography itself—is because of the length of time over which this study was conducted. Ethnography typically requires extensive, long-term fieldwork and immersion beyond the scope and capability of a single dissertation (Cresswell, 2013; Jones et al., 2014). Indeed, as Jones et al. (2014) write, "few good examples of ethnographic research exist in higher education… Most likely this is due to both the intensive immersion in the field and the extensive time required to complete an ethnographic study" (p. 10). Thus, it is more accurate to define this dissertation study as a critical qualitative inquiry that utilizes critical ethnographic methods; the use of these critical ethnographic methods will become clear in the following sections, which outline the design of this study.

Study Design

My intention in employing critical ethnographic methods in this study was to be able to identify and name the values, norms, and practices within a culture-sharing group (a mathematics department and community), as well as the values, norms, and practices of a subculture within that group (GTAs). In order to do so, I utilized common ethnographic data collection techniques for the *process* of this study, such as fieldwork, interviews, artifact collection, building deep relationships, and positioning myself as a participant-observer (Cresswell, 2013; Jones et al., 2014; Van Maanen, 2011). I also grounded my analysis in cultural interpretation of my data for the *product* of this study. However, in line with *critical* ethnographic methods, my analysis foregrounded Critical Race Theory and Critical Whiteness Studies to explicitly name the ways in which privilege, power, racism, and whiteness created power asymmetry within the mathematics department and community, and inform the ways in which GTAs act as agents of mathematics socialization for undergraduate students of Color.

Positionality and Reflexivity

A key component of beginning critical ethnographic work is to start with who we are, and examine our positionality (Madison, 2020). In qualitative research, the researcher is explicit in naming that they are the analytic instrument through which data is interpreted. Reflecting on our positionality pushes us to examine what brings us to our work (Jones et al., 2014; Lin, 2015; Madison, 2020; Merriam et al., 2001). Who is our work for? Who benefits from our work? What are our intentions for this work, and what are the possible effects and consequences of this work? What power dynamics exist between us—the researcher—and participants? What is our relationship to our participants and the culture-sharing group? How do our experiences inform the ways in which we make sense of the world? What biases and power do we bring to our work? How might the answers to these questions inform the ways in which we interpret our data and (re)present our participants?

Although critical ethnographic work begins with positionality, the work of examining our positionality is continuous throughout the research process. Critical ethnographic work—as well as critical qualitative work more broadly —requires us to engage in continuous reflexivity, in which we are "intentionally thoughtful about the how, why, and what of [our] thoughts" (Madison, 2020, p. 23), and where we "ask questions of research interactions all along the way, from embarking on an inquiry project to sharing the findings" (Glesne, 2016, p. 145). Thus, while I provide a brief overview of who I am and what brings me to this work in this next section, the work of engaging in reflexivity was (and is) a continuous process in all stages of this dissertation, and in my work as a scholar.

In Chapter 1, I detailed the experiences that brought me to my doctoral program and shaped my research interests in how mathematics identity and socialization were racialized and informed by systemic racism and white supremacy. I also discussed how my research focus changed throughout the tenure of my doctoral program as my own critical consciousness developed and grew. While I alluded to how—as a result of both this critical reflexive shift, as well as my own experiences as a GTA—my research focus turned towards GTAs, I have not yet discussed my experiences as a GTA in a mathematics department at an HWCU, and how my positionality as a light-skinned, East Asian woman of Color who majored in mathematics at a prestigious HWCU, and served as a mathematics GTA at another HWCU (where I was also enrolled in a graduate level mathematics course with first-year doctoral GTAs in that mathematics department), positions me within this study.

I am aware of the privilege and power that my degree in mathematics from UC Berkeley—combined with my skin tone, race, and lack of accent—affords me in being able to access mathematics communities. Although I am a mathematics education doctoral student, and not a mathematics student, my disciplinary background and the perceived prestige of my undergraduate training program means that members of mathematics communities will often afford me contingent membership and see me as a "math person". My credibility as a contingent member of mathematics communities at HWCUs has been reinforced by my enrollment in a graduate-level mathematics course in my doctoral program, where I socialized with mathematics doctoral students and GTAs at my current institution. Even though I am not a mathematics doctoral student, my background in mathematics and enrollment in a mathematics course allowed me to share experiences with mathematics GTAs at my institution, and be seen as a contingent, temporary member of the mathematics community they belonged to.

During the semester I was enrolled in a graduate-level mathematics course, I was invited into a class GroupMe where we would discuss homework assignments and frustrations with the class and content. Occasionally, my classmates would share frustrations with their graduate assistantships and working with undergraduate students. These frustrations would often be framed in ways that made it clear that there were norms in the mathematics community at our institutions that they expected their undergraduate students to ascribe to. These norms were also alluded to when the GroupMe conversations would turn to stress about qualifying exams or advice on how to manage other courses.

This graduate-level mathematics course was not my first introduction to the mathematics community at my institution. I also served as a GTA during my second year of my doctoral studies, and taught an undergraduate mathematics content course for elementary education majors. There were two sections of the course; I was the instructor of record for one section, and a GTA from the mathematics department was the GTA for the other. We had a course supervisor in the mathematics department who provided us with our syllabi and weekly lesson plans, and coordinated the writing and grading of our exams, which were uniform across both sections. While both my course supervisor and the other GTA were helpful and kind people who truly wanted our students to be supported and successful, I found myself often frustrated with the contextual factors that constrained our teaching practices. For example, we did not have our first meeting until the week before the semester started, which is when we also received course materials and the syllabus. I felt that there was limited time to prepare for the course and take true ownership over it, but understood that the reason for meeting so close to the start of the semester was because GTA assignments for the math department could not be finalized until quite late due to the large number of international doctoral students who were waiting on visas to be approved.

Moreover, while my fellow GTA cared a lot about their students and wanted them to be successful, he expressed to me that he did not have a genuine interest in teaching, and was looking forward to the following semester, when he would be able to work full-time as a research assistant and would not have to be teaching a course. In observing his section of the course for one of my class research projects, I noticed how —in his attempts to uplift and support his students—he promoted both meritocratic beliefs (of how anyone could master the material if they worked hard, paid attention in class, and studied) and beliefs about the innate mathematical ability (at times, he would say to frustrated students that it was okay if they did not understand the content and that some people were just “math people” while others needed to work a little hard to understand concepts). These messages—while grounded in good intentions — communicated colorblind, neutral ideologies (Bonilla-Silva, 2018) that reinforced exclusion from the mathematics community. Moreover, he facilitated racialized exclusion in his class which he perceived as neutral—there were times when I noticed that the white women in the class were more likely to raise their hands, flag him down verbally, and dominate his time with their questions, while the few students of Color would give up on trying to ask for help and work quietly, despite struggling at times with course content.

My own prior mathematics experiences at HWCUs overlap with several mathematical experiences that my participants also have, giving me a common ground with my participants due to our shared mathematics experiences. Thus common ground gave me a certain level of credibility with my participants, and allowed for some openness and trust between us since we had "an assumption of understanding and an assumption of shared distinctiveness" (Dwyer & Buckle, 2009, p. 58). As such, I was able to gain access to the mathematics community by the nature of my prior mathematics experiences at HWCUs, which positioned me as somewhat of an insider to the mathematics community I examined in this study. However, I was also an outsider to the mathematical community at my study site, since I was not a mathematics doctoral student there, and because of the influence of context in shaping mathematics communities. As such, there were many experiences that my participants had as mathematics doctoral students and GTAs at my study site that I could not relate to.

As an insider-outsider, I strove to be aware of my own biases—about mathematics communities, departments, and GTAs—that had developed from my past experiences with mathematics communities at HWCUs and my theoretical perspectives. While I cannot claim that I will ever be an objective researcher—nor do I believe that is possible based on my own epistemological views—I engaged in bracketing (Jones et al., 2014) and memoing to be able to name and stay aware of my assumptions throughout the data collection and analysis process. In continuously reflecting on my positionality, I also kept in mind the asymmetric power dynamics between my participants and myself, even as I sought to understand and critique the ways in which they might either contribute to or fight against asymmetric power dynamics in their roles as GTAs. As Madison (2020) writes, an important part of focusing on our positionality is recognizing that as researchers who ultimately represent the communities we study, we must be aware of and be accountable for the power we have in our roles. She writes that "positionality is vital because it forces us to acknowledge our own power, privilege, and biases just as we are denouncing the power structures that surround our interlocutors" (Madison, 2020, p. 6). Central to my positionality is the recognition of not only my biases, but my power as a researcher, and intentionally humanizing my participants, even if I had critiques. Thus, my positionality as an insider-outsider provided me with many affordances in this dissertation study, but also required intentionality and accountability in navigating tensions that came with occupying “the space between” (Dwyer & Buckle, 2009, p. 61)

Study Site

The participants for my study were all GTAs in the mathematics department at Mid-Atlantic University (MAU), a large, public, research-1 institution in the Mid-Atlantic region of the United States. As such, the mathematics community I sought to explore and understand in this study was constructed and governed by the mathematics department at MAU. As an HWCU, MAU was originally an exclusively white institution built by slaves. It remained exclusively white for more than half of its existence; the first Black undergraduate student was not admitted to the university until 1951. Today, MAU is rapidly racially diversifying, and sits on the precipice of no longer being considered a predominantly white institution (PWI). However, despite the increased racial diversity at the institution, Black, Latinx, and Indigenous students are still underrepresented in STEM degree programs at MAU. I selected MAU as a study site due to its characterization as an HWCU, as well as the institution’s written commitment to improving racial diversity and inclusion—both across campus broadly, as well as within STEM degree programs more specifically. MAU also has a large mathematics department that nearly all undergraduate students take at least one course in; many lower-level courses have discussion sections that are taught by GTAs (and in some cases, the entire course is taught solely by GTAs). Thus, GTAs play a key role as agents of socialization within the mathematics community at MAU, and the mathematics department plays a key role in diversity and inclusion in STEM fields at MAU, making the institution an ideal study site. As this study utilizes critical ethnographic methods, rather than describe the study site in further detail here, I instead provide a written portrait of the mathematics department at MAU in the first half of my findings in Chapter 4.

Data Collection

Data collection for this study consisted of three phases: initial fieldwork, narrative interviews, and focus groups. The purpose of the initial fieldwork was to gain familiarity with the mathematics department at MAU, and understand both the historical and current context of the mathematics department, particularly as it related to issues of race, representation, access, and belonging. As such, phase one helped to answer RQ1. The purpose of the interviews in the second phase of this study was to build individual relationships with participants, and learn about their mathematics histories, their perceptions of the culture of the mathematics department at MAU, and their own mathematics beliefs and teaching practices. The third phase of the study consisted of six weekly focus groups with the GTAs from the second phase of the study. These weekly meetings provided a space for GTAs to share and discuss challenges they faced in their teaching, and allowed us to build community as we explored themes that emerged from the individual interviews.

Fieldwork

Phase one of data collection consisted of initial fieldwork in the mathematics department at MAU. During this phase, which took place during January and February of 2022, I sought to "gather information in the context or setting where the group works" (Cresswell, 2013, p. 95). The purpose of gathering this information was to understand and establish the context of the mathematics department at MAU, particularly as it related to the socialization of undergraduate students of Color through the lens of systemic racism and white supremacy, and the role of GTAs in this socialization process. As Madison (2020) cautions, "it is generally advised that researchers should have a basic level understanding of the field—the general history, meanings, practices, institutions, and beliefs that constitute it—before they plunge full force into the actual face-to-face interviewing" (p. 35). Thus, this initial fieldwork was necessary before recruiting and interacting with participants.

During this phase, I spent time physically exploring the mathematics department at MAU, observing and documenting (via photographs and field notes) how the physical space was set up, as well as the general dynamics of the space. In particular, I observed how classrooms were set up, where lounges and offices were located, and the types of decorations that were displayed throughout the department. I also conducted informational interviews with students, faculty, and staff members to understand departmental processes and policies, and to help me begin to contextualize the role of GTAs in the mathematics department at MAU. I also examined a variety of other sources and artifacts during the first phase of this study, including the department website, the official teaching handbook sent out to instructors, guidelines for GTAs, and institutional reports about the racial demographics within the mathematics department (at the undergraduate, graduate, and faculty levels).

The data I collected in the first phase of this study contributed towards the first part of my findings in Chapter 4, wherein I provided a written portrait of the department in order to contextualize the thematic findings from this study. Additionally, the data from this phase of the study helped me to begin to understand the normative values and practices related to teaching and socializing undergraduate students of Color within the department. I also began to understand the context in which GTAs are trained as instructors, and the myriad of responsibilities they have as doctoral students who also serve as GTAs; these understandings then helped me formulate my interview questions for the second phase of this study. As Madison (2020) writes, "greater knowledge and familiarity before you begin your interviews will inspire your questions," (p. 36), and so it was necessary to begin this study by gaining this knowledge and familiarity.

Interviews

Phase two of data collection consisted of individual interviews with participants in the mathematics department at MAU. These interviews were conducted virtually over Zoom in February and March of 2022, prior to phase three of the study. Interviews were scheduled to be 60 minutes long, though the actual length of each interview varied between 45 minutes and an hour and 40 minutes.

Madison (2020) writes that there are three distinct, but often overlapping, types of ethnographic interviews:

> (1) *oral history*, which is a recounting of a social historical moment reflected in the life or lives of individuals who remember them and/or experienced them; (2) *personal narrative,* which is an individual perspective and expression of an event, experience, or point of view; and (3) *topical interview,* the point of view given to a particular subject, such as a program, an issue, or a process (p. 35).

The purpose of these interviews was to begin to build rapport and individual relationships with each participant. I sought to learn about their mathematical histories and stories, as well as how they navigated their role as a doctoral student and GTA in the mathematics department at MAU. Moreover, I hoped to learn about their perceptions of the culture of the mathematics department at MAU, and the elements of this culture that they either aligned with or sought to diverge from, particularly as it related to the socialization of undergraduate students of Color. As such, these interviews ultimately encompass all three forms of ethnographic interviews that Madison (2020) describes.

The interviews were semi-structured, as Glesne (2016) advises to "try thinking of your role as that of a collaborator whose conversational actions facilitate others in the telling of their stories" (p. 113). While I had a set of interview questions that helped to prompt the conversations that participants and I had during these interviews, I also allowed room for conversation to flow and build organically. The questions I used to guide the interviews were divided into four different categories: learning about participants and their mathematical histories, understanding their experiences in the doctoral program at MAU, discussing their perceptions of teaching undergraduate students, and then exploring their views of race and diversity in the mathematics department, as well as teaching undergraduate students of Color. Examples of individual interview questions include:

1. When did you first become interested in mathematics? What drew you to the subject? Was there anything, or anyone, that encouraged you to pursue mathematics? Was there anything, or anyone, that discouraged you from mathematics? What about other subjects?
2. How have your perceptions of mathematics changed over time? How have your feelings towards mathematics changed over time? What shaped or influenced these perceptions?
3. What do you think are the qualities of a "math person"? How do you know when someone is—or isn't—a math person?

4. Can you recall a time where you had a student who wasn't a "math person"? How did you support that student? What do you think is the best way to support students who aren't "math people"?
5. Tell me about your degree program. How did you come to the decision to pursue a PhD in math? Why did you choose MAU?
6. Can you name a fellow graduate student in your program that you would describe as successful? Why would you describe them as successful?
7. How would you describe the departmental culture of the mathematics community at MAU?
8. Tell me about your experience in the Math Teaching Seminar 101 provided by the department. In what ways did the seminar prepare you to teach students? In what ways did it not prepare you?
9. What other forms of teaching support (if any) have you received or sought out — either from peers, the mathematics department, (i.e. first-year observations) or from the university (i.e. the campus Teaching Center)?
10. Racial and gender diversity in STEM departments is a hot topic across the country. Can you talk to me about racial diversity, or the lack thereof, in the mathematics department at MAU? What about other forms of diversity?
11. Undergraduate students of Color—particularly Black, Latinx, and Indigenous students—often face discrimination and exclusion from mathematics spaces and communities at institutions of higher education. Can you describe a time when you knew that a student of Color felt marginalized or uncomfortable in a mathematics course at MAU? How did you know?

12. How do you see race influencing someone's experience in the mathematics department at MAU?
13. What does it mean to you to be [insert race from demographic survey] and a PhD student in math? What does it mean to be [insert race from demographic survey] and a GTA in math?

The full set of individual interview questions can be found in Appendix A.

It is important to note that I chose to wait until the later part of the individual interviews before directly asking participants questions about race, diversity, and undergraduate students of Color. Part of this choice was because racism and white supremacy are often normalized, and thus, invisible (e.g. Bonilla-Silva, 2018, Battey & Leyva, 2016). As such, in asking participants about their mathematics beliefs, histories, and perceptions of teaching and learning in the mathematics department at MAU, it was not always necessary to ask participants directly about their perceptions of race and diversity in order to understand their views—or normative views in the department—on these subjects. Another reason I waited until the end of the individual interviews to ask directly about race, diversity, and undergraduate students of Color was because these questions had the potential to invoke race-based stress (DiAngelo, 2011) for participants; there is also a degree of ego threat (Madison, 2020) when talking about race with those who have racial privilege or proxy privilege in white spaces—which characterized all of the participants in this study (as I will describe later in this chapter). Building rapport throughout the first three sections of the individual interviews served to mitigate some of the racial stress and ego threat that participants may have experienced during the final section of the interview.

Focus Groups

The third phase of this dissertation study consisted of six weekly "focus groups" during March, April, and May of 2022. Each focus group lasted 60 minutes, and took place virtually over Zoom. As stated earlier, one purpose of these weekly meetings was to provide a space for participants to share and discuss challenges that came up in their undergraduate teaching. The first few focus groups opened up with an opportunity for participants to share any challenges they faced during the prior week that they wanted to discuss with the group, allowing for opportunities to problem-solve together and build community with each other. After checking in on how the prior week had gone for participants, we discussed particular topics and themes that had emerged during the individual interviews. Each of these themes were related to the research questions that guided this study, as the primary purpose of these focus groups was to understand community perceptions of the culture of the mathematics department at MAU, and the socialization of undergraduate students of Color. Similarly to how the interviews were constructed, however, the later focus groups more explicitly discussed diversity, race, and racism. As these were complex topics, we spent the later focus groups fully focused on these topics, rather than checking in on how teaching had gone for participants that week. Examples of focus group questions include:

1. What brought you to this study? What made you decide to sign up and participate? What are you hoping to learn?
2. If you could change one thing about how math is taught at MAU (whether it be common practices you've seen from faculty or peers, a policy or procedure, something about the structure of TAships or what you receive from your course

chair, etc.) what would it be, and why? What do you think the consequences for students would be?

3. Where do you feel you have ownership over the courses that you TA for? Where do you think you have power as a TA, whether that's in your specific class (and students), or in the department?
4. What norms do you think you set around mathematics as an instructor (or TA), whether intentionally or unintentionally? What consequences might this have for undergraduate students of Color?
5. What do you think undergraduate students of Color (particularly Black and Brown students) need from their math instructors?
6. In what ways does racism show up in mathematics classrooms and spaces, especially at MAU? How do you define racism?

A full list of the topics and questions that guided each focus group can be found in Appendix B.

My role in the focus groups was that of a participant-observer; while I came to each focus group with guiding questions on a particular topic of focus, I also sought to share ownership over the space and build community with participants. As such, although I had a few guiding questions, part of my role as a facilitator was to also allow the conversation to shift in directions that participants found meaningful and important within (or adjacent to) the topic of focus. As such, participants had ownership in guiding our conversations and co-creating a space for critical learning and reflection. While I occasionally participated in conversation, it was often only to ask clarifying questions or to try and synthesize or reflect what participants were sharing. In doing so, I checked my own understanding of what participants were sharing in our focus groups. As an observer in the space, I also took note of the dynamics of our community and how participants interacted with each other. I documented who tended to take up more space, and whose ideas were often built upon or agreed with—versus those who did not share as frequently in the large group, or those whose ideas were pushed back on. In this way, I sought to examine who had power and authority within our community, and what those dynamics might illustrate about the subculture of GTAs in the mathematics department, and perhaps in the broader mathematics community at MAU.

Participants

Eligible participants for this study had to be current doctoral students in the mathematics department at MAU who had been GTAs for a lower-level undergraduate mathematics course for at least one full semester. Participants were purposefully recruited both through departmental email listservs (both administrative listservs and graduate student association listservs), and through institutional gatekeepers who helped me to identify potential participants for this study. These institutional gatekeepers included faculty and lecturers who had supervised GTAs and reached out to potential participants directly via email. All email communication included the purpose and scope of this study, as well as a demographic survey that I used to confirm participant eligibility and schedule times for the weekly focus groups for the third phase of this study. I incentivized participation in this study by compensating participants with gift cards for each phase of the study that they completed; participants received $20 for completing the individual interview, and $60 for completing the focus groups. As some participants had occasional conflicts during the focus groups, participants who were not able to make all six focus groups were compensated $10 for each focus group they were able to attend. I also sent out an email after each focus group that included the questions we had discussed, in case participants wanted to share any thoughts that they were not able to during the focus group; participants who were unable to attend the focus groups were also able to respond to those emails with their thoughts. Participants were compensated $5 for their email responses, regardless of whether or not they had attended the focus group preceding the email.

In total, I recruited ten participants for this dissertation study. All ten participants were involved in both phase two and phase three of this study. All participants completed an individual interview, and attended at least three focus groups in phase three of the study. On average, participants attended five out of six of the focus groups. Additionally, attendance for the focus groups never dropped below six participants, with eight participants being the average number of participants in attendance for each focus group. Among the participants, half of them identified as white, while the other half identified as Asian. All of the Asian students were also international students, while none of the white students were international students. Seven of the participants identified as male, while two identified as female, and one identified as nonbinary. All participants had served as a GTA for at least one semester, though they had a range of specific degree programs and years in their program. Additional participant demographics, including pseudonyms, are listed in Table 1 below. To protect participant anonymity, rather than include participants' years in the program, I classified them as early-stage (first or second year), mid-stage (third or fourth year), and advanced-stage (fifth year and beyond).

Table 1

Participant Demographics

Pseudonym	Gender	Home Country	Stage	Major	# of Completed Semesters as a GTA
Aditya	Male	India	Mid	Pure Mathematics	4
Caleb	Male	United States	Early	Applied Mathematics	3
Cody	Male	United States	Mid	Applied Mathematics	3
Declan	Male	United States	Early	Pure Mathematics	1
Eunji	Female	South Korea	Mid	Pure Mathematics	6
Jun	Male	South Korea	Mid	Pure Mathematics	8
Lin	Female	China	Mid	Statistics	6
Logan	Male	United States	Advanced	Applied Mathematics	9
Quin	Nonbinary	United States	Advanced	Pure Mathematics	10
Yuanjun	Male	China	Mid	Pure Mathematics	3

Trustworthiness and Validity

In order to bolster trustworthiness and validity in my data collection, I utilized several validation strategies recommended by Cresswell (2013). These strategies included prolonged engagement with participants (including checking for understanding during the interviews and focus groups), triangulation of data, peer debriefing, and clarifying researcher bias from the outset of this study. I also sought to provide rich, thick description (Merriam, 2009), through providing a written portrait of the mathematics department at MAU in the first half of my findings chapter, in order to contextualize the thematic findings in the second half of the findings chapter. Through memoing and keeping daily written notes during analysis, I also created an audit trail (Merriam, 2009) to account for decision points during the course of this study. I feel it is important to note that my intention in providing these strategies to increase trustworthiness and validity in my dissertation study is not to provide any evidence of neutrality or objectivity in my findings. Who I am, and the assumptions I come to this work with, deeply influence my cultural interpretation of my data. As Madison (2020) contends:

> Our position as ethnographers is to understand that we bring out belongings into the field with us… we understand that our subjectivity is an inherent part of research, but in critical ethnography it is not my *exclusive* experience… *critical* ethnography is always a meeting of multiple sides in an encounter with and among others, one in which there is negotiation and dialogue toward substantial and viable meanings that make a difference in others' worlds (p. 8-9).

As such, my intentions in being explicit about the validation strategies I utilized is to highlight the ways in which I sought to ensure that this "meeting of multiple sides" grounded how I carried out this study.

Data Analysis

Both the interviews and the focus groups were audio recorded using Zoom's recording capabilities. Initially, I had planned to use Zoom's audio transcript feature to transcribe the interviews. However, I found that the audio transcript feature was not very accurate for my international participants. The amount of transcript cleaning required proved to be an arduous task with the Zoom audio transcripts, so I decided to send the audio recordings to an external company for transcription. I then reviewed the transcripts for accuracy before beginning the coding process. In large part, data analysis was ongoing, as “analytical connections need to be made while you are still collecting data to make full use of the possibilities of fieldwork” (Glesne, 2016, p. 189). Indeed, because each phase of my study built upon the previous phase, ongoing data analysis was necessary. Most of this ongoing analysis was conducted through analytic memoing and careful review of fieldnotes and interview notes. I memoed throughout each phase of the data collection and analysis process; I also intentionally memoed directly after each interview and focus group in order to track my thoughts, be explicit about my own assumptions and biases, and note emerging patterns and noticings.

Once data collection and cleaning ended, I uploaded all transcripts, as well as all notes, photographs of the study site, email correspondences, documents, and artifacts to NVivo, a qualitative data analysis software. As data from the first phase of the study was to build context, and did not directly pertain to any of my research subquestions, I did not formally code this data, or use it to formulate the thematic findings of this study. Instead, I used the data from the first phase of this study to develop a written portrait of the mathematics department. This written portrait constitutes the first part of my findings chapter, while the second part of my findings chapter consists of the themes that emerged from this study, and respond directly to my research sub questions.

Since the interview and focus group data directly address the research subquestions, I conducted multiple rounds of coding on these transcripts. I began with the individual interview transcripts, as the focus groups topics were based off of data from the individual interviews. Additionally, because my conceptual framework attended to racialized membership levels into the mathematics community, I only coded the individual interview transcripts for my white participants in this first round of coding. As my goal was to be as close to the data as possible, I conducted line-by-line coding (Strauss & Corbin, 1998). Furthermore, Merriam (2009) advises researchers to "be as expansive as you want in identifying any segment of data that *might* be useful [when beginning coding] ... [and] being open to anything possible at this point" (p. 178). As such, my first round of line-by-line coding consisted of open coding. More specifically, I utilized eclectic coding (Saldaña, 2021), which is a form of open coding that "employs a select and compatible combination of two or more first cycle coding methods" (p. 223). As Saldaña (2021) explains, "the methods choices should not be random but purposeful to serve the needs of the study and its data analysis" (p. 223).

For this first round of eclectic coding, I chose to use a mix of versus and invivo coding. As Saldaña (2021) explains, versus coding is particularly appropriate for critical ethnographies; citing Agar (1996), he writes, "a contemporary ethnographer 'looks for patterns of social domination, hierarchy, and social privilege. He or she examines the power that holds patterns in place, how people accept or struggle against them. The focus is on patterns that reveal injustice' [p. 27]" (p. 174). As I was looking at the dominant departmental culture, and how participants might align or diverge from this culture, versus coding was an appropriate method for this first round of open coding. I chose to utilize invivo coding as Saldaña (2021) writes that it is an appropriate first-choice method for most interview transcript data, particularly for studies "that prioritize and honor the participant's voice" (p. 138), which was important for me to do given my positionality.

The first round of open, eclectic coding resulted in 218 initial codes, such as "bad score" vs. "hopeless math students", computation vs. creativity, math as "abstract curiosity," "so much depth and so many different directions," "you like the things you're good at", and teaching vs. research. I then sorted the initial codes into broad categories and subcategories using code mapping (Saldaña, 2021). I then used the refined codes to recode the five individual interviews of my white participants, and wrote an analytic memo to track what I was thinking about and the connections I was noticing between my codes and the research subquestions for this study. After recoding the individual interviews of the white participants in this study, I refined my codes one more time, and then coded the five international participant interviews using line-by-line open and deductive coding. As I already had codes from the first two rounds of coding, I wanted to utilize these codes to look for shared experiences among all GTAs, regardless of race. However, I also utilized open coding, as I wanted to be open to any differences between the experiences of white GTAs and Asian international GTAs.

After coding my international participants' interviews, I refined my codes once more, which resulted in seven parent codes and 56 subcodes. The seven parent codes were:

1. Being a PhD Student
2. Cultural Differences
3. Departmental Climate
4. How to Teach
5. Undergraduates
6. Views on Math
7. Views on Race

Examples of subcodes included "here to do research" (Being a PhD Student), "attitudes towards teaching" (Departmental Climate), "my goals" (How to Teach), "how to be good at math"

(Views on Math), and “from my limited perspective” (Views on Race). I then recoded all of the interviews one final time using this revised codebook, and continued to memo.

Since the focus group topics were derived from the themes in the individual interviews, I then coded the focus group data (both the focus group transcripts and participants’ email responses to focus group questions) using a mix of open and deductive coding, similarly to how I had coded the international participants’ individual interview transcripts. As I coded the focus group transcripts, I took copious notes that I used to continue memoing. After coding the focus groups, I refined my codebook one final time, which resulted in the same seven parent codes, and 57 subcodes. The final codebook can be found in Appendix C.

After coding all of the interview and focus group transcripts, I used the final iteration of my codebook, along with my guiding concepts, to conduct codeweaving (Saldaña, 2021). Codeweaving is an interpretive technique to help relate multiple codes and concepts into a broader, integrated narrative. While my codes helped me to organize the patterns I found in the data, codeweaving helped me to interpret and make sense of my findings through the lens of my guiding concepts, to provide a cultural interpretation of the mathematics department at MAU, and the role of GTAs within this culture (including opportunities and constraints they face in their role). As such, utilizing codeweaving as an analytic method resulted in the emergence of four themes that formed the basis of my cultural interpretation; these four themes are explained in the second part of my findings chapter. The themes that emerged from codeweaving, along with my conceptual framework, then formed my analysis in Chapter 5 of how GTAs at MAU serve as agents of mathematics socialization for undergraduate students of Color.

Limitations

There are a few important limitations of this study to consider. The first limitation is that this study was conducted at a specific research site. Therefore, my findings cannot necessarily be generalized to other sites and mathematics communities. Additionally, although mathematics communities are made up of several other actors and agents aside from GTAs, I only sought out the perspective of GTAs in this study. Thus, my analysis of the culture of the mathematics community at MAU, as well as the role of GTAs as agents of mathematics socialization into this community, is limited by the perspective of the participants in this study. While prolonged fieldwork and observation of GTAs' practices may have been beneficial in more sufficiently and completely understanding the ways in which GTAs serve as agents as mathematics socialization, my data collection was limited by time and resources. As such, it is necessary to bear in mind that the findings of this study—and the examination of how GTAs serve as agents of mathematics socialization for undergraduate students of Color—are primarily based on the perspectives of my participants, and that these perspectives were gathered over a relatively short duration of time.

CHAPTER 4: FINDINGS

The purpose of this critical qualitative inquiry was to understand how graduate teaching assistants (GTAs) serve as agents of mathematics socialization for undergraduate students of Color at a historically white [college and] university (HWCU). Specifically, this study focused on GTAs' perceptions of the culture of a mathematics department at an HWI, and whether they aligned with or broke from this culture. This study also sought to examine the opportunities and constraints that GTAs faced in trying to break from the normative values and practices within the mathematics community, and how their own values and practices might impact underrepresented undergraduate students of Color[11]. As such, the following research subquestions stemmed from the overarching question in order to ground this study:

1. How do GTAs describe the culture (e.g. values and practices) of the mathematics department/community?
    a. Do they align with this culture or want to break from it?
2. What opportunities do they face in breaking from those values and practices?
3. What constraints do they face in breaking from those values and practices?
4. Does the way that GTAs describe their own values, practices, and goals reinforce whiteness and the consolidation of power along a racialized hierarchy in the department, or does it have the potential to make positive changes for undergraduate

[11] Recall that I refer to underrepresented undergraduate students of Color as "undergraduate students of Color" for the sake of simplification of writing—and ease of reading—this dissertation.

students of Color and thus, broaden access to membership in the mathematics community?

In this chapter, I discuss the key findings from this study and their relation to these subquestions. However, because context is central to this study, I organize this findings chapter into two different parts. The first part of the findings consists of a written portrait of the mathematics department at MAU, using data from Phase 1 of the study. This portrait is intended to provide a contextual understanding of the structure, staffing, and mechanics of the department and how it operates on campus, in order to help the reader better understand the second part of this chapter. The second part of this chapter details the four themes that emerge from Phases 2 and 3 of the data collection. These four themes, and their connections to the first three research subquestions, provide an understanding of how the mathematics community at MAU is constructed, the racialized conditions for membership into the community, and the opportunities and constraints that GTAs face in trying to change the conditions for membership in order to be more accessible for undergraduate students of Color. The themes are organized using the contextual forces of mathematics socialization from the conceptual framework, though the framework—as well as the construction of the mathematics community through the lens of this framework—will be discussed in more detail in Chapter 5. The fourth research subquestion will also be discussed in Chapter 5, based on the findings from this chapter and the theoretical perspectives discussed in Chapter 1.

Part 1: A Written Portrait of the Mathematics Department of MAU

Mid-Atlantic University is a research-1 university located in a suburb of a metropolitan area in the Mid-Atlantic region of the United States. The campus, which spans over two square miles, sits on a large hill that can make walking across campus quite the trek for students and faculty. The campus is somewhat divided into different regions. Athletic fields are mostly clustered at the top of the hill to the northwest, while the business school is at the bottom of the hill to the south of the athletic fields. Social science and humanities departments are sprinkled along the hill between the athletic fields and the business school, while a large, grassy park flanked by other departments, the main library, and the student union sits just south of the geographic center of campus. The mathematics department is located in the northeast quadrant of campus, at somewhat of a midpoint on the hill, surrounded by other STEM departments such as physics, chemistry, and one of the many engineering buildings.

There are several entrances to the mathematics department, though the main one opens up to the center of the building, which is a large, open rotunda with some sparsely placed benches and a few television monitors. Various announcements are displayed on the monitors, most of which spotlight mathematics department alumni, faculty, and students who have received mathematics honors, awards, or grants. A few reminders about social distancing and the department's lost and found location are also interspersed throughout the accolades. There are not many places to sit and work, though it is a beautiful space, with red marble columns, a tiled floor in shades of cream and green, and an open ceiling that allows both the ground floor and the second floor to be viewed if you stand in the middle of the room. The mathematics department's central administrative office is located on this ground floor adjacent to the rotunda, as are the offices of the department chair, the academic advisors, other administrative offices, and one of the campus's many libraries. Around 15 administrators—from program and office managers to academic advisors to business and finance coordinators—work on this floor. Most of them are women, and about two-thirds of them are women of Color.

The rotunda on the first floor where the administrative offices are is named after one of the department's doctoral alumni who stayed at MAU as a professor for over 50 years after he graduated; a plaque is displayed in one area of the rotunda with a description of his work at MAU, and some of his quotes about success, research, and mathematics. The professor is still listed on the mathematics department's faculty webpage as a distinguished university research professor alongside about 60 other current tenure-track faculty, and about 10 more professors emeriti. The large number of faculty is a point of pride for the department, who list the size of the department's faculty and the vast span of research interests and expertise as a draw for potential doctoral students. Aside from the tenure-track faculty, who both teach classes and conduct research, the department employs around 30 lecturers who primarily focus on teaching rather than research. From a cursory glance at the faculty and lecturer webpages, the faculty are noticeably less diverse than the lecturers; most of the faculty members in the department appear to be white and male, while there seems to be slightly more racial and gender diversity among the lecturers.

On the third floor of the mathematics department—which is primarily home to faculty offices, but also houses a colloquium room and the mathematics lounge—there is an undated, but clearly aged photo of the mathematics faculty. While the current faculty listed on the website do not appear to be particularly diverse along racial and gender lines, it is clear from this photograph that gender and racial diversity has improved over the years. Only three people presenting as women appear in this photograph; they all stand together at the front and center of the group. Almost all of the faculty also present as white—out of the 60 or so people pictured in this photograph, there is only one Black professor, and two Asian professors.

It is unclear why this undated, but clearly aged photo is still framed and hung on the third floor, or why there are no other photographs of all the faculty. However, most of the hallway decor on the third floor is also fairly dated. Several framed posters from World Mathematical Year 2000 that were featured in the London Underground are hung throughout the halls, and thematically seem to try and explain the beauty and utility of math in the everyday world. Similarly aged and themed posters—from mathematics awareness weeks in the 1990s—are framed and hung on the first floor.

Also on the first floor is a photograph tacked to a glass-encased bulletin board that is posed similarly to the faculty photo on the third floor, though there are about twice as many people in it. This photo is only labeled with a date from the beginning of the 2012-2013 academic school year. A hundred or so people stand on the steps to the main entrance of the mathematics department, backdropped by the large white pillars and the red brick that are characteristic elements of the MAU's Georgian architecture. The people in the photograph appear to be more diverse than the current faculty and lecturers, and while there are some recognizable tenure-track faculty members in the photo, others look quite young, and may be undergraduate or graduate students.

It is possible that this photograph could be a mix of faculty and graduate students, as the graduate students seem to be slightly more diverse in terms of race and gender than the professors (both tenure-track faculty and lecturers) in the department; on the first floor of the department, there is an encased bulletin board entitled "Graduate Students and TA's" with nearly 200 (mostly) smiling photographs of the graduate students in the department; according to the department website, there are around 230 full-time graduate students enrolled in the department, so this bulletin board likely pictures all of them. These graduate students are pursuing degrees in one of three programs of graduate study: Pure Mathematics, Statistics, or Applied Mathematics. While the department grants doctoral degrees in all three programs, students can only receive a master's degree in either Statistics or Applied Mathematics; the department does not grant degrees in mathematics at the master's level.

The undergraduate program is organized slightly differently; the mathematics department offers only one undergraduate major, and three minor programs in mathematics, statistics, and actuarial mathematics. While there is only one mathematics major that undergraduate students can declare, they can then choose between four different tracks that mirror the doctoral degree programs—though undergraduate mathematics majors can also choose a secondary education track if they want to pursue their teaching certification. Approximately 350 undergraduate students are enrolled in the mathematics major; according to campus datasets, about half of those students are white, and two thirds are male.

While there are a few hundred undergraduate mathematics majors at MAU, they only make up about one percent of the 30,0000 undergraduate students currently enrolled at the university. However, the mathematics department is still one of the largest—if not the largest—departments on campus, given its nature as a service department. In the Fall of 2022, approximately 10,000 undergraduate students were enrolled in a mathematics course at MAU—about a third of the total enrolled undergraduate students. Most of these students are first- and second-year students who are enrolled in courses they need to graduate—whether because they need to satisfy the general education requirement for the university, because their major directly requires specific mathematics courses, or because their major requires other STEM courses that have mathematics prerequisites. As such, nearly every undergraduate student at MAU will end up taking at least one course in the mathematics department, even if they are not a mathematics major.

Part of the general education requirements for all undergraduate students at MAU is to take a mathematics course at the level of Precalculus; while students can test out of the requirement through AP exams, nearly every undergraduate student at MAU will still end up taking at least one course in the mathematics department, either to satisfy the general education requirement, to take required courses for their major, or to take prerequisite mathematics courses for other STEM courses they need to take.

The Undergraduate Experience in the Mathematics Department

Part of the reason why nearly every undergraduate student enrolled at MAU will take at least one course in the mathematics department is because the general education requirements at MAU require a mathematics course that they define as being "at the level of Precalculus." Incoming students can receive credit for the mathematics requirement through a prior learning credit, such as AP or IB exams, though the mathematics department also offers credit-by-exams for mathematics courses at the level of calculus or higher. Thus, incoming students who have taken Calculus, and who do not need to take any other mathematics courses during their tenure at MAU, have the ability to receive credit for their general education mathematics requirement through various means, and do not have to enroll in a mathematics course at MAU. Undergraduate students who have not taken Calculus, however, likely have to enroll in a mathematics course to satisfy the general education requirement, unless they took a college-level course at the level of Precalculus—such as a dual enrollment course or a summer course at a university or community college—that can satisfy the prior learning credit requirements.

All incoming students at MAU—regardless of if they have prior learning credits and are not planning to enroll in a mathematics course at MAU—are required to take the math placement test prior to freshman orientation. The placement test is an online test comprising 67 questions that span four different mathematical topics: arithmetic, elementary algebra, intermediate algebra, and trigonometry. Students receive a score in each of these topics, and then an overall score that determines their placement in an entry-level math course. While students can then enroll in any course at or below their placement, they cannot enroll in a course above their placement unless they retake the exam, which is allowed only once per semester. The mathematics department's website provides resources for students to review before the placement test, as well as resources for students who are re-taking the exam to study.

Math Placement Options for Incoming Students

The entry-level courses that students can be placed into based on the results of the placement test, from lowest to highest, include developmental courses, Math Modeling, Algebra and Trigonometry, Elementary Statistics, Precalculus, Elementary Calculus, Discrete Math for Life Sciences, and Calculus. All of the courses on this list, with the exception of developmental courses, which are non-credit bearing courses, are considered to be either at or above the level of Precalculus, and thus, satisfy the general education mathematics requirement for graduation. Students intending to major in the STEM fields, however, or who need to take STEM courses for their majors, typically end up having to take either Discrete Math for Life Sciences or Calculus. While Elementary Calculus is a prerequisite for some STEM courses such as Introductory Biology, STEM majors are not allowed to take Elementary Calculus, and must take either Discrete Math for Life Sciences (if they are majoring in the biological sciences), or Calculus (if they are majoring in any other STEM field). This is because only the highest possible placement on this list, Calculus, allows students to go on to take higher levels of mathematics, such as Calculus III and Linear Algebra. Students who need to take Calculus, but who do not place into it from the exam, must take and pass Precalculus before they are allowed to enroll in Calculus; students who take Algebra and Trigonometry are not eligible to take Calculus, and can only go on to take either Elementary Calculus, or Precalculus. Thus, if a student does not place into Precalculus, but needs to take the course so that they can then take Calculus, they must first either take a developmental course, or take Algebra and Trigonometry.

The majority of the entry-level courses in the mathematics department are taught as large lecture courses that are then divided into smaller supplemental discussion courses. When registering for classes, students sign up for both the lecture, and one of the smaller discussion sections. Between 100 and 300 students are typically enrolled in the larger lecture course, while the smaller discussion sections are typically capped around 30 students. Some of the entry-level courses, such as the developmental courses, Math Modeling, and (at the time of this dissertation's data collection), Algebra and Trigonometry, do not have a large lecture component, and are instead only taught in several small course sections that are the same size as the discussion sections for the larger lecture-based course.

Discussion sections, as well as the smaller sized courses, are typically taught in the basement of the mathematics department. The basement can be accessed through a variety of staircases, though there is a main staircase that is accessible through the rotunda on the first floor. The classrooms in the basement all have large chalkboards at the front of the classroom, and are filled with individual, heavy wooden chairs with small desks attached to their arms. These chairs are tightly spaced, making it difficult to try and move them into any other configuration than an organized grid facing the front of the room. As such, group work is somewhat difficult, and is made even more so by the slight angling of the desks, as well as their small size—a single standard notebook is enough to take up the entirety of the desk's surface area. Although the classrooms in the basement also are equipped with projectors and small, red document cameras, there are no classroom computers, and instructors are expected to bring their own computers to hook up to the A/V system if there is any electronic supplement to their instruction. Despite being in the basement, most classrooms have a few windows that let in natural light.

The basement of the mathematics department is also where the math tutoring offices and the undergraduate math major lounge are located—though the undergraduate lounge is noticeably sparser than the math lounge on the third floor, and the furniture is also much older than the furniture in its third-floor counterpart. Unlike the first and third floors of the department, the basement also does not have any posters about the beauty or utility of mathematics. Instead, the walls are decorated with photographs that were taken by the professor for whom the main rotunda is named. These photographs—many of which have captions and dates—include pictures of the campus, plants, animals, and places and people from the professor's travels. Notably, there is a photo of two Japanese women grinning on the Tokyo subway, dressed in "traditional garb out on the town," and a photograph of smiling Indian women "at the mathematics building of the Indian Institute of Science in Bangalore." There is also a photo of a delighted, blue-eyed child covered in cake, captioned "first birthday." These are the only photos of people posed and looking directly at the camera; all of the other photographs lining the halls appear to be more candid in nature.

There are far more places to sit in the basement hallway than there are on the main level or the third floor of the mathematics department, which is ideal for students or instructors waiting for the class prior to theirs to leave the classroom. Most of the instructors who teach courses down in the basement of the mathematics department are graduate teaching assistants (GTAs), who are often assigned to teach either the smaller sections of entry-level mathematics classes, while professors (both tenure-track faculty and lecturers) teach the larger lectures for entry-level classes, advanced courses for upper-division undergraduate students, or graduate courses.

The Experience of Graduate Teaching Assistants (GTAs)

Most doctoral students at MAU are funded through some type of graduate assistantship that provides tuition remission, health insurance, and a small salary that is intended to help cover living expenses. Many graduate assistantships are teaching assistantships, wherein doctoral students teach courses for the university, though research and administrative assistantships also exist. The majority of doctoral students in the mathematics department at MAU are funded through teaching assistantships, and this is customary for doctoral students in the field of mathematics. While some doctoral mathematics students at MAU come in with outside scholarships or research funding, this is seen as something that is very rare and an indicator of an "advanced" incoming doctoral student, as most doctoral students at MAU do not receive research assistantships until later on in the program.

Teaching assignments for GTAs are distributed a few days before the start of each semester, and are generated by a form that GTAs fill out with their course preferences and their availability for the semester, in order to ensure that they are not assigned to teach a class during their own classes. GTAs are usually assigned to teach discussion sections for larger lecture courses, though there are also "sole contact" assignments (for the courses without a large lecture section), and grading assignments. GTAs teaching a discussion section are typically assigned to teach 4 one-hour sections per week, while sole contact GTAs typically are assigned to teach 6 contact hours per week. In some cases, GTAs may be given grading positions rather than instructional positions; participants shared that grading positions are typically assigned as a "break" from teaching—either to advanced doctoral students, or GTAs who received particularly low student evaluations in the prior semester. All of the GTA assignments are compensated the same amount, and there are no formal prerequisites for any of the teaching assignments, as it is assumed that any doctoral student has enough content knowledge to teach an entry-level undergraduate course—whether as a discussion leader or a sole contact instructor.

All GTA assignments have a course supervisor, who coordinates the exams for the course, and who is expected to meet with the GTAs for the course to ensure that the class is running smoothly. Course supervisors may also dictate the curriculum and the assignments for a given course—such as requiring specific worksheets or homework assignments—and determine the grading mechanisms for the course. For large lecture courses, the professor teaching the lecture is the course supervisor. For sole contact courses, the course supervisor may not be providing any direct instruction to undergraduate students, and may have fewer requirements for how GTAs teach the course.

Aside from being assigned a course supervisor, the department supports GTAs in two other primary ways. Both of these forms of support happen during GTAs' first years. During the first semester of the program, all doctoral students have to take Math Teaching Seminar 101, which was developed by a lecturer in the department in the mid-2000s. The course was taken over by a different lecturer—who was a doctoral student at MAU and took the original course—in 2020. The main component of the seminar takes place the week before the fall semester, during a "bootcamp" of sorts where GTAs learn about the mechanics of teaching. They practice giving mini-lectures, as well as grading sample quizzes, and are given feedback on both exercises. Once the semester starts, the seminar meets in the evening every few weeks, and provides an opportunity for new GTAs to reflect on their classroom experiences. The other main form of support that GTAs receive during their first year of teaching are classroom observations. Lecturers in the department observe each first year GTA once per semester during their first year, and provide them with feedback. After the first year, GTAs typically do not receive support from the department aside from their course supervisors, unless they receive particularly negative reviews or complaints from students, in which case they may receive more observations from lecturers.

While there is very little formal teaching support for GTAs from the department beyond the first year, the undergraduate department chair does send out a teaching manual to instructors every semester, including GTAs. This manual, which was last updated in 2018 and is password protected, provides campus resources for teaching—such as the Teaching Center on campus—as well as expectations and requirements of instructors. The manual also encourages more active forms of instruction, and opens with the following paragraph:

> Students learn by thinking and *doing*, not by watching and listening. Learning is an active process; it is something the students must *do*, not have done to them. Students learn by *working together*. They are encouraged when they see classmates having to work to understand; they are rewarded when they have a good suggestion or a sudden insight. Problems seem less daunting when there are study partners. Students learn by *talking* about what they are doing—by explaining what they have discovered, by discussing a common strategy to attack a problem, by asking questions. Students have little experience talking about mathematics; talking takes time and practice. Students learn by *writing*.

> Writing forces students to organize their ideas and experience. Often, real learning begins only when students begin to write out the meaning of a particular problem. The more students are required to write and the more they see other students' writing, the better they become in expressing their ideas and understanding mathematics. Students learn by *reading*—when they are *actively engaged* in the reading. You may need to discuss with students how to go about reading a chapter and how to best learn from the reading. Don't try to *cover* everything in the book in class. This discourages students from reading the book on their own and does a disservice to the students.

Aside from this manual, which does mention the campus's teaching center and promotes active learning styles, few resources for teaching are shared with GTAs outside of what they learn in the Teaching Seminar.

Other GTA Responsibilities

While teaching takes up a substantial amount of GTAs' time, they have many other responsibilities related to their doctoral program. GTAs typically take courses for the first two years of their program, and must pass two qualifying exams by the middle of their third year. Qualifying exams are written exams that are administered in January and August of each year, and students can retake the exams if needed, as long as they pass both by January of their third year. Once they complete their courses and qualifying exams, doctoral students must pass their Oral Candidacy examination, which they also must write a candidacy prospectus for. GTAs typically work on their dissertation after reaching candidacy, and graduate after five years in the program—though they can receive departmental funding as a GTA for six years, and have up to ten years to complete the PhD. Aside from academic and teaching requirements, GTAs also sometimes have research requirements, such as participating in topic seminars, giving presentations for their research teams, and reading papers or working on projects with their advisors, or their lab if they are part of one. GTAs typically become more involved in their research and have more research responsibilities later in the program, after coursework and qualifying exams are completed. At this point, many GTAs also may no longer need funding from teaching assistantships, as they may have research funding instead.

Part 2: Key Themes

Now that a contextual overview of the mathematics department at MAU has been provided, the thematic findings of this study can be presented. Four key themes emerged from the interview and focus group data that I collected in Phases 2 and 3 of the study:

- Theme 1: A Culture of Individualism and the Hidden Necessity of Social Ties
- Theme 2: The Valuation of Teaching as a Means of Doing Research
- Theme 3: Attempts to Shift Narratives of Mathematical Success
- Theme 4: Identity Tensions in Supporting Undergraduate Students of Color

The first theme, which is connected to the department level of mathematics socialization, describes the individualistic culture of the department, and how participants had difficulty naming this culture due to how large and decentralized the department was. The second theme, which is related to the university level of mathematics socialization, describes the ways in which the department being situated within a research-1 institution led to a deep love of research, and a deprioritization of teaching. These first and second themes help to answer the first research question, which is how GTAs view the values, norms, and practices of the mathematics community at MAU. The third theme, which is connected to the sociohistorical level of mathematics education, provides an overview of the opportunities and challenges participants had in their role as GTAs to reshape traditional norms and narratives of membership into the mathematics community. The fourth theme, which is connected to how the contexts of socialization are situated in a racist and white supremacist society, details how participants struggled with structural racism and their own racial identities when it came to supporting and serving undergraduate students of Color specifically, as opposed to undergraduate students more broadly. The third and fourth themes help to answer the third research question, and foreshadow how the fourth research question will be discussed in Chapter 5.

A Brief Note on Race

Before presenting the major themes that came out of the interview and focus group data, it is necessary to clarify two things. The first is that while the intention of this study is to focus on undergraduate students of Color, undergraduate students of Color are not specifically centered in the first three themes. The reason that undergraduate students of Color are not specifically centered until the fourth theme is because participants did not focus on race in describing the culture of the mathematics department, or in describing the opportunities and constraints they had in their role as GTAs to diverge from this culture. While the culture of the mathematics department and attitudes towards teaching were particularly detrimental to undergraduate students of Color, participants struggled in connecting their issues with the norms and values of the mathematics community to race and racism. Participants largely spoke about the culture of the mathematics department, and what they wanted to change, in ways that focused on all students, rather than students of Color more specifically. Additionally, although participants discussed issues around and in connection to the lack of racial diversity in the mathematics department at MAU, they typically only did so when prompted; moreover, they were reluctant to specifically and directly discuss the needs of undergraduate students of Color until the later focus groups. As such, these findings reflect what participants shared, and start out by focusing broadly on the culture of the mathematics department through the first two themes, without an explicit participant focus on race. The third theme—participant's perceptions of opportunities and constraints in creating change in the departmental culture—focuses on how participants saw those changes as being beneficial or consequential for undergraduate students more broadly, before focusing specifically on undergraduate students of Color in the fourth theme. While connections were ultimately made by participants between the broader culture of the mathematics department and community, and consequences for people of Color (and students of Color) in the first and third themes, connections that center the racialized nature of the departmental culture, and impacts on undergraduate students of Color, will be discussed more in depth in Chapter 5 utilizing the theoretical perspectives that guide this study, as participants themselves did not always make the analytical connections necessary to fully answer the fourth research subquestion, or the overall research question.

The second important note to address before delving into the major themes of this study is how undergraduate students of Color were defined by participants. During the interviews and the focus groups, I specifically named underrepresented students of Color as being Black, Latinx, and Indigenous students, and for the most part, when "students of Color" are referred to in these findings, participants and I are specifically talking about underrepresented undergraduate students of Color, except in the fourth theme, where we discuss how Asians are racialized in the United States. Consistent with the earlier chapters of this dissertation then (with the exception of Chapter 2), "undergraduate students of Color" as well as "people of Color" refers to underrepresented students of Color, except when specified otherwise. Moreover, although "students of Color" was intended to encompass Black, Latinx, and Indigenous students, participants also often used the phrase to specifically refer to Black students.

Theme 1: A Culture of Individualism and the Hidden Necessity of Social Ties

I think I don't think of math department as a centralized thing. Of course there's a department chair who could reach all the graduate programs and stuff. But other than that I think most people are on their own, doing their things, like, what they like to do.

-Aditya

In describing the mathematics department at MAU, participants expressed difficulty in trying to define the values and culture within the department, due to the size and scope of the department. They described the mathematics department as large and decentralized, where people often worked in small silos due to the way that the field of mathematics was structured. The field of mathematics had so many different disconnected subfields that participants felt that people in the department tended to identify with the specific subfield that they researched, rather than the broader mathematics department. The lack of identification as a cohesive departmental community led participants to describe the mathematics department individualistic; the culture of individualism in the department also shielded the ways in which power operated in the mathematics department. For participants, this meant that they did not think that there was any real power in the department, and thus, no one telling them what they should be doing or prioritizing, as everyone was left to their own individual projects and priorities. Interestingly, despite the culture of individualism that participants described, there was also a hidden reliance on having social ties in order to be successful in the department. Participants felt that the necessity of social ties to navigate the department was not intuitive, given the individualistic culture of the department. They also noticed some of the ways in which people of Color within the department—particularly underrepresented people of Color—may face structural barriers in forming social ties, and thus, may feel a lack of ownership and sense of belonging in the department as a result.

Parallels Between the Departmental Climate and Math as a Field

In many ways, participants spoke about how the size and scope of the mathematics department at MAU —as well as the separation within the department —is due to the composition of mathematics as a field, and the ways in which the mathematics department at MAU reflects the discipline. When discussing the field of mathematics, Logan, a white, male, advanced-stage student in the Applied Mathematics program, expressed:

> One of the interesting things about mathematics as compared to many, many other fields is that it goes so far, in so many different directions, that most people don't even have the beginnings of an understanding of. You know, someone who's pretty bad at number theory versus someone who's at the very cutting edge of number theory, those two people are very far from each other in mathematics. But they're—both of them are way further than that from everyone else… and so I think one of the coolest properties of mathematics is just that it has so much depth and so many different directions.

As Logan explained, the field of mathematics is divided into a vast sprawl of subfields, many of which are very far removed from each other. Each of these subfields also has a lot of depth and levels of mastery and understanding. As a result, two people who are studying higher-level mathematics may both technically fall within the same discipline, but in actuality are involved in entirely separate areas of research—to the point where they may not be able to grasp or comprehend each other's work.

As a result of the breadth and depth of mathematics that Logan described, most of the faculty and graduate students at MAU focused on a very specific area of math, as it was rare for someone to have comprehension—much less expertise—across the entirety of mathematics as a field. As a result, participants tended to identify more closely with their specific area of research, rather than with mathematics as a whole. For example, Eunji, a female, mid-stage, international student from South Korea in the Pure Mathematics program, shared that despite pursuing a doctorate in mathematics, she didn't really see herself as somebody who is good at *math*. She elaborated:

> Because, I mean, there's so many different fields in math, and I'm really bad at some of the fields. Like geometry *[laughs]*... I may be above average for certain, in some of the undergraduate level or those common education in math. But like, the graduate math and real math is kind of different, I think. You can't really be good at all of those *[laughs]*.

Eunji's statement reflects how—because it is uncommon for any one person to be able to have a deep understanding of mathematics as a monolithic field—participants saw themselves as "good" at some subfields of mathematics, and "bad" at others, which led them to align more closely with specific topical areas of mathematics rather than seeing themselves aligned with mathematics in a broader sense.

The identification with distinct, separate subfields of math, rather than mathematics as a whole, was also reflected in how participants identified with specific people or groups in the mathematics department at MAU, rather than the department as a whole. For most participants, the identification with a smaller part of the mathematics department—rather than the department in its entirety—began during the doctoral application process. As most participants explained, the reason they came to MAU in the first place had little to do with the mathematics department as a whole; rather, most participants came to MAU in order to work with their advisor on a very specific area of research. For example, Eunji shared that she came to MAU because "I was going to continue doing logic. So. And then I found some people I want to work with. Like, based on the—their interests and the research they'd been doing and those things." In a similar vein, Declan, a white, male, early-stage student in the Pure Mathematics program, explained that he came to MAU "to work with my advisor. That's exactly why. Because I wanted to study model theory, and he's a model theorist, and he does the exact type of math that I wanna do." Most participants echoed similar sentiments; they either came to MAU to work specifically with their advisor, or they knew that there were people at MAU doing research that they were interested in.

Due to the focus and specificity of mathematical research—and that specificity being a driving force behind why participants chose to come to MAU—it was common for participants to work very closely with their advisors, and very few others. Aditya, a male, mid-stage, international student from India in the Pure Mathematics program, shared:

> So in math we don't really have like, teams, as such. Research labs, as such. We usually like, work with our advisors very closely, and report to our advisors like, what we have been up to. What kinds of things we are thinking about. And based on that, they give us advice on where we should be looking next. So yeah. That has been for a year now. Yeah, about a year now…so my research basically is like, meeting with my advisor once in a week.

Aditya's quote implies that the nature of research in the mathematics department at MAU is often very siloed and individualized, and as such, doctoral students tend to be heavily reliant on their advisors, and less connected to others in the department.

While some participants worked on research with people besides their advisors, research teams still tended to be very small and somewhat disconnected from the broader mathematics community due to the specificity of their topical area, and the breadth of research being conducted in the mathematics department at MAU. In describing his research, Logan explained:

> We work in very small little groups of one or two people, and then uh, present our work to each other in sort of, uh, semi-larger settings of 10 to 15 people, I don't know, once a month or something, or maybe you would present once every two months or something like that. Um. And so it doesn't lead to a lot of like—like it leads to tons of, you know, interesting discussion between you and the people you're working with, but there's not a lot of feedback from the larger, uh, community that you're in, except maybe, "oh, nice presentation," you know?

Logan's quote showcases how the specificity of mathematics research led to a "shared language" of sorts that served to connect smaller groups of people working on similar research, while simultaneously separating them from people doing different research. In other words, the structure of mathematics as a field, and the breadth of mathematics research being conducted at MAU, served to create subgroups and subcultures in the mathematics department at MAU that felt disconnected from each other, and thus, the broader mathematics department and community.

A Culture of Individualism and the Obfuscation of Power

The size of—and separation within—the mathematics department at MAU led participants to find it easier to identify subcultures in the department. However, they struggled in identifying the shared culture and values of the mathematics department as a whole, rather than focusing on subcultures. For example, when asked about the culture and shared values within the mathematics community at MAU, Yuanjun, a male, mid-stage international student from China in the Pure Mathematics program, stated that "that's a hard question because I think math department is—it's diverse, you know? So what people value as important, I guess is different from person to person." In a similar vein, Quin, a white, nonbinary, advanced-stage student in the Pure Mathematics program, also felt like identifying shared values was "hard to say like, with everyone, because it's a big department." Later, in a focus group, they reemphasized that finding common ground and both naming and finding shared values in the department was difficult, reiterating that "it's a big department. Yeah, there's a lot of reasons why, not everyone's gonna be as like, connected to the same extent." Both Yuanjun's and Quin's sentiments hint at a culture of individualism, which Triandis (1995) define as "a social pattern that consists of loosely linked individuals who view themselves as independent of collectives" (p. 2). In individualistic cultures, independence and personal choice—rather than adherence to group norms and shared values—are promoted. The ways in which participants described the separation, disconnect, and decentralization of the mathematics department at MAU points to an individualistic culture, which by its very nature is obscured, making it difficult to identify individualism itself as a shared value.

Examples of how individualism showed up in the mathematics department were expressed more directly by some participants. For example, when asked about shared values in the mathematics department at MAU, Declan shared:

> I don't really know. Um, I guess maybe because I have such strong personal values or because I… because of—because I have such strong personal values, I've kind of ignored values that have been transmitted to me… I don't think I've really picked up on it… [but] I mean like, I'm not sure that MAU is broadcasting like, "There are our institutional grad student values."

Declan’s statement highlights how the individualistic culture in the mathematics department at MAU allowed him to maintain his autonomy and personal values, and thus, how he in turn contributes to the maintenance of the culture of individualism in the mathematics department at MAU. Interestingly, Declan’s quote also implies that the decentralization of the department makes it difficult to identify where power in the department is located—which in turn seems to foster and support individual choice and autonomy and the culture of individualism in the department.

The way in which the decentralization of the math department at MAU made it difficult to identify who had power was also indicated by other participants’ views on who in the department was most influential or powerful. Aditya, for example, expressed:

> I think I don’t think of math department as a centralized thing. Of course there’s a department chair who could reach all the graduate programs and stuff. But other than that I think most people are on their own, doing their things, like, what they like to do.

While Aditya acknowledged that the department chair had power in terms due to their connection to all of the different programs, he believed that because people were often working on individual or siloed projects, they were not necessarily beholden to a centralized power in the department that dictated what they should do, or what they should value or prioritize.

A few other participants also stated that the department chair was someone who had power and influence in the department, but overall, there was no real consensus due to the variety of different answers to the question, including “the program coordinator and the administrative assistants”, “the professors,” and “the advisor level”. One participant, Cody, a white, male, mid-stage student in the Applied Mathematics program, laughed and said “that’s a good question. I don’t know who they are. I wish I did.” The variety amongst participants’ guesses as to who had power in the department points to how the decentralized nature—and thus, individualized culture—of the department made it difficult for participants to name any centralized form of power in the mathematics department, and thus, articulate how power operated in setting and maintaining the norms and values in the department.

In fact, even participants who were able to name people in the department who had power and influence shared some doubts about their answers, because they did not feel that the people who did have any power in the department had control over setting priorities, norms, and values within the mathematics community at MAU. For example, Eunji, who had posited that the professors might be people with the most power and importance in the department, then elaborated, "but I don't really think that we have like, much a power concentration in some people." Similarly, Declan, who named advisors as people who have power, said "nobody talks that way. I mean, nobody says [for example] that you have to focus on your research, not teach." Although Cody had said he did not know who had power in the department, he echoed the sentiments of others surrounding how priorities and values are left up to individuals, stating that "no one [in the department] really reaches out to be like 'Hey, you need to do this,' or like, 'you need to do that.'" Thus, while some participants were able to name people who they felt had some power and influence in the department, the culture of individualism—and how it obfuscated the mechanisms of power in the department and how that individualistic culture was maintained—was evident in their responses.

The Hidden Necessity of Social Ties

The culture of individualism and lack of centralized power in the mathematics department at MAU also meant that there was often a lack of centralized support in navigating the mathematics department and participants' associated responsibilities as GTAs. As such, participants discussed the ways that a reliance on social ties was part of the culture at MAU. One way in which the importance of social ties showed up was in learning the mechanisms of teaching at MAU. Several participants noted the lack of departmental teaching support, and in one of the focus groups, Declan shared:

> When I think about it, what I've actually learned about just, Mid-Atlantic University, and teaching here, and like, maybe not like, literally in classroom skills, teaching experience, but, just all other aspects of being a TA, I've gotten almost exclusively through word of mouth, just talking to a huge variety of people, and, you know, I know I'm socially well-connected enough that—I have like, multiple, multiple sources of various upperclassmen and whatnot, and my other first-year TAs—but like, it could be so easily that I was not as well-connected through word of mouth, and if I wasn't connected through word of mouth, I don't know where I would get this information, because, you know, the department tries... I mean, barely. I mean, I don't know, I don't think, I don't think—it's, it's really all word of mouth.

In the same conversation, Logan concurred, acknowledging that while there was a teaching seminar that all first-year doctoral students in the mathematics department at MAU were required to take, that "that was it in terms of formal teaching—training, if I recall. Um, and then it was learn on your feet and learn from your friends." This discussion highlighted the importance of social ties for GTAs in learning how to navigate their roles as GTAs, due to the size of the department and how decentralized it is. Additionally, Declan's sentiment—that "it could be so easily that I was not as well-connected," implies that although social ties were important in the mathematics department at MAU, having strong social ties was certainly not a given for all GTAs.

Perhaps part of the reason having strong social ties was not necessarily a given for all GTAs was because it was not intuitive to them that social ties were necessary in order to be successful in the department. For example, in Quin's individual interview, they shared that:

> I wasn't having any luck [passing quals] until I started studying with other grad students summer after my second year. And then one of my year-mates gave me this like, packet of solutions to one of the quals—like, like past quals that like, he'd created while he was studying. So, like that—like, kind of working with that over the fall semester—kind of got me over the hump and actually pass them…I think among the grad students there's like, you know, at least when, when I was there, like, being collaborative—like helping each other out—is, is something that's prioritized. And I think—I do think people like, try to continue emphasizing that. To like, the incoming grad students. That like yeah, you are, you are not going to survive this alone. You need to work together.

Quin and I then discussed how the necessity of working with others in order to be successful in mathematics was not something that felt intuitive due to how the nature of studying math was always portrayed as something more individualistic; in some ways, the necessity of social ties to be successful in mathematics was something that felt counter to the individualistic culture of the department, and the way that math is portrayed as a field.

The importance of social ties in mathematics when it came to academic success was also reflected in both participants' perceptions of undergraduate student experiences at MAU, as well as their perceptions of professional mathematician networks. In talking about undergraduates, Cody shared that it was important for them to have friends in their courses, stating:

> Like if you don't have friends in the department for whatever reason, you're like, "Oh, like I don't—" you, you hear plenty of stories from stuff, like, "I don't think I could have

> gotten through the class without this study group or talking to so and so, or like doing whatever."

On the faculty side, Eunji expressed that she "was really surprised to see that when you go to some modern math seminars like, anywhere in the field, the interaction is really important." Thus, it was clear that social ties were consistently important for people studying mathematics at all levels—from undergraduate courses up through tenured faculty. While not necessarily easy or intuitive because of the individualistic culture of the mathematics department at MAU (and how mathematics was portrayed as a field), social ties were necessary for success.

When it came to building social ties, some participants already had relationships with people at MAU prior to officially beginning their doctoral journey. For example, Logan shared that part of why he came to MAU was because:

> I also knew people here, cuz I'd been at the REU [NSF's Research Experience for Undergraduate Students] program twice, so I knew Reid Zeta, cuz I'd worked with him in that… and I knew Craig Theta very well. Sadly, Craig left after my first year—I was pretty bummed about that. Um, so I knew, I knew there were people here who, you know, were supportive of students and, and all that kind of thing.

Although Logan came in with established social ties at MAU and had a small community by the end of his program (he graduated during this study after five years in the program), he implied that it was not necessarily easy to form connections with others in the department—particularly between graduate students and faculty. He shared:

> Even [after] five years at MAU, I'm still nervous talking to a professor who I don't know, you know. Or like, uh, if I need to ask someone for something or, you know, whatever, I,

> I still feel a little bit like, “oh, eh… I don't know what kind of email I should write,” or, you know, silly things like that.

Logan’s statement illustrates that even for graduate students who come into MAU with social ties, forming new ones could still be intimidating, and being connected to everyone by the end of the program was highly unlikely due to the department’s size, separation, and individualistic culture.

While forming social ties with faculty may have felt more formal and intimidating to participants, there were also more casual ways that participants were able to make connections in the department. As Declan stated:

> What helps me feel like I belong at the math department is like… I go to the lounge, and I always eat the coffee and cookies, and, you know, I play board games with the other students, uh, sporadically… I don’t know, that’s, that’s kind of how I feel included, is just like, you know, getting lunch with the other students.

Spending downtime in the graduate lounge—which was often populated by both faculty and students—was something that allowed students to form social ties in less formal (and perhaps less high-stakes) ways. Several participants spoke about their experiences in the graduate lounges or in other social spaces, and how that helped them feel a sense of connection and community in a department as large and decentralized at MAU. It was clear that a reliance on social ties—whether for teaching support, academic success, or sense of belonging—was a part of the culture at MAU. However, what became clear from both the interviews and the focus groups was that forming social ties was easier for some people than others, depending on their social identities.

The Impact of Social Identity on Social Ties. Although the graduate student lounge was an important space for participants to build social ties and find connection in the mathematics department at MAU, the space tended to skew more towards the dominant social identities in the department. As Caleb, a white, male, early-stage student in the Applied Mathematics program, observed:

> Most of my courses are almost all male. Um, but we typically have a couple of females. Um, and then in the math lounge, it's mostly the same. Um. But I know some of—like, some of my friends just don't come to campus unless they have a class or they have some other reason to be here. So it could be something like that, where people just don't come in.

What is implied from Caleb's quote is that because the department is predominantly male, the graduate lounge—a social space for students in the department—also skews male. He questions whether the latter might also be because some of his friends, who he described as "kind of like a mix," don't spend social time on campus in such spaces because they don't tend to come to campus unless there is a specific academic reason to. However, what may be the case is that his friends who are not male do not spend as much social time on campus because they do not share the same identity as the majority of people who spend time in the mathematics departments' social spaces.

Quin, who was one of the three participants who did not identify as male, shared a sentiment that more directly connected their gender with their sense of belonging and ability to make social ties in the department. They shared:

> I think I was more plugged in when I was starting out. Like I would go to department tea like, every day and kind of stand there when people talked about things. I think as I got

> older, it… I don't know if—it felt like… like too much of an investment of energy. Yeah. Like I, you know, had other things to focus on. And… yeah, and just being, like… not a cis man in the math department, just… like—yeah, yeah. Like it, it makes connecting with people nontrivial.

It is clear from Quin's quote that having an identity that was a minority in the mathematics department at MAU made it more difficult for them to form social ties in the casual ways that others who did share a majority identity (in this case, being a cisgender male) could. They gave the example of how connecting at department tea hours—-which were scheduled times when the department would provide cookies and coffee in the department lounge so that faculty and students could mingle—took more energy for them than it might for cisgender men in the department. As such, they disclosed that they became more intentional in who they chose to connect with, which did ultimately leave them feeling less connected within the department. While the feeling of disconnect was not the main cause of their decision to leave the program without completing the dissertation, it was clear that the lack of connection they felt was difficult for them as they progressed through the program.

Gender identity was not the only social identity that influenced the types and ease of making social ties in the mathematics department at MAU. Several participants noted that racial identity also seemed to influence students' participation in social events in the mathematics department at MAU. For example, Aditya shared:

> So there's this thing which, I don't know why it's happened. So. Um, I'll maybe just like, describe this one experience, or one thing I've observed where I really don't know why this happens. So as I described earlier, we have seminars in the math department. One of the main ways students especially interact among each other. So we have this student

> seminar—a students in geometry seminar where we get together. So there are many geometry students in the department from various backgrounds. But I noticed that most people who show up in the seminar are mostly white males. I'm not sure why that happens. Even though everybody's invited to come and participate in the seminars and give talks, somehow the diversity doesn't show up in the seminar. I don't know why. Though like, I have made a point to go to the seminar as often as I can. I don't know why other people don't really go.

He then shared that he has noticed that he is often the only person of Color at these seminars, which he stated above are "one of the main ways students especially interact with each other." This begs the question: if strong social ties are a key component of the culture of the mathematics community at MAU, but students of Color are noticeably missing from the department-sponsored spaces where interaction and connection happen, how do students (and people) of Color within the mathematics department at MAU form social ties and find a sense of belonging within the mathematics community?

It is likely that some students of Color, like Aditya, feel comfortable engaging in department-sponsored social spaces in the mathematics department where they are the only person of Color. However, other students of Color may prefer to form social ties with people who share their specific racial (and in some cases, specifically, cultural and national) background. For example, Jun, a male, mid-stage international student from South Korea in the Pure Mathematics program, remarked:

> My opinion here is people just, *[laughs]* want to hang out with people from like, similar races. I think, well, for me, I have a like, very specific cultural background. So I usually hang out with other Korean students, because we share a lot of things in common, right?

> Well, I also hang out with other students with different racial backgrounds. For example, students from the states, students from China. Like that. But still, I felt more comfortable with students from Korea because I can talk in my mother tongue. That's for sure.

While Jun acknowledges that he has social ties with non-Korean students, he feels most comfortable with other Korean international students—that is, students who share both his racial and national identities. However, while Asian international students are students of Color, they make up a sizable proportion of the graduate student population in the mathematics department at MAU as compared to underrepresented students of Color. Indeed, nearly all participants specifically discussed a lack of Black people in the mathematics department at MAU. Thus, it is likely that Asian international students may have an easier time forming social ties than underrepresented students of Color. In fact, all of the East Asian international participants stated that they did not necessarily identify as people of Color because they felt demographically represented in the mathematics department at MAU. As such, they—along with the white participants—felt that they could not fully understand what the experience of underrepresented students of Color (specifically, Black students) in the department, and could only guess what the lack of other people who shared their racial identity meant for trying to form the necessary social ties that were a hidden staple of the culture in the department.

Isolation and Lack of Ownership for Underrepresented Students of Color. While all participants acknowledged that they could not truly understand the experiences of underrepresented students of Color in the mathematics department at MAU, most of them felt that because of the importance of social ties in such a large, individualistic, and decentralized department, and because they felt it was easier to make social ties with people who they shared social identities with, it was likely difficult for underrepresented students of Color to feel a sense of belonging in the mathematics department. Declan, for example, shared the following in talking about how race might affect someone's experience in the mathematics department:

> Yeah, I just—I think the biggest barrier probably would just be like, feeling, feeling cohesive with the math department. You know, just feeling like, you know, it's your math department, feeling like, you know, instead of "I am, I am visiting," or "I am an outsider" or "I am a transitory student here." Cuz we all are, on one hand, but it's also all of our math department. So.

He felt that as a white male, it was easier for him to spend time in department-sponsored social spaces and thus, form strong social ties. As such, he felt a sense of ownership and connection with the math department, and as though he was as full a member of the mathematics community as a graduate student could be. He posited that this was likely a bigger challenge for underrepresented students of Color.

Other students echoed the sentiment that it was less likely for underrepresented students of Color to feel connected to the math community due to the lack of racial diversity in the department. Lin, a female, mid-stage, international student from China in the Statistics program, shared that:

> There are some cases like isolation, because I do have one friend—he is a Black guy—but we, we will share some—you know, if we are classmates, we will share some ideas about some problems. So it's, it's just—I feel there's no, no, some specific discrimination for them. But I feel they may feel isolated, because there are lack of Black or colored students, yeah.

While she did not think there was any overt discrimination in the department, she did feel that because there were very few Black students in the department, it was likely harder for them to form social ties, and as such, it was likely a very isolating experience.

However, there were some cases of overt discrimination and racism in department-sponsored social spaces, which likely contributed to the lack of underrepresented students of Color—and in particular, Black students—in those spaces. Quin, for example, shared the following in terms of how race might influence someone's experience in them mathematics department:

> Well… As far as I can tell it seems like an isolating force for any student of Color who tries to like, be a math major. And so—or who is a grad student... um… yeah, like I know like… what was like, the, a couple, couple Black students—one of my yearmates and someone else—like, I remember one time, them mentioning like at the department like, holiday party, like, one of the admins like making some racist remarks. And so that was really troubling.

Similarly, in a focus group, Logan pointed out that he had heard faculty sharing overtly racist sentiments with each other in the third-floor lounge, which made him extremely uncomfortable. He wondered not only why they had those beliefs, but why they would express them in such a public space. Both of the instances that Quin and Logan mention indicate that aside from being isolating, department-sponsored social spaces may be unsafe environments for students of Color, and specifically, Black students, in the mathematics department at MAU. As such, students of Color may be discouraged from engaging in spaces where they could form necessary social ties in the mathematics department, and as a result of not having strong social ties, may feel disconnected and excluded from the mathematics community due to the size, separation, and decentralization of the department.

Theme 1 Summary

It was clear in participants' descriptions of the necessity of social ties in the department that students of Color—and particularly, Black students—likely faced isolation and difficulty forming social ties in the mathematics department at MAU. Furthermore, the ways in which students' of Colors experiences in the mathematics department were negatively impacted by the barriers that they faced in forming social ties was obscured by the fact that the forming social ties was a hidden necessity within the department. In turn, the necessity of social ties in successfully navigating the mathematics department at MAU was hidden by the culture of individualism in the mathematics department, which also shielded the way that power operated within the department. The culture of individualism that participants described was a result of the size and decentralization of the department, which reflected the field of mathematics more broadly. Participants felt that people in the department tended to be siloed based on their research areas, and thus, they had difficulty describing or naming shared values within the department. Although participants felt that the size and decentralization of the department led to a lack of shared values, it was clear that aside from the culture of individuality and the hidden necessity of social ties, that there were other unifying aspects of the culture of the mathematics department, which will be discussed in the next theme.

Theme 2: The Valuation of Teaching as a Means of Doing Research

"You know, teaching is not our main topic for our graduate students, especially for our PhD students…to be honest, firstly, I feel it's a burden for us. It's not—you know, our time is limited, so we want to focus on research."

-Lin

Although participants felt that there were not many unifying aspects of the culture of the mathematics community at MAU, something that became very clear from all three phases of the study was the deep love of math that members of the mathematics community had. Participants described the way they viewed math—and thus, their interest in and love for the subject—as being different from the type of math they learned as K-12 students. In many cases, they even felt that the mathematics they learned as undergraduates was different than what they were doing—and what they were excited by—as doctoral students. This love of math led them to specifically choose to pursue a PhD—a research role —at an institution of higher education that specifically valued research. However, the focus on research often meant that teaching math was not as important, except in the ways that it allowed for research. As a result, the culture of a "deep love of math" led to a deprioritization of teaching in the department. This subsequent deprioritization also led to differential measurements and support for research and teaching in the department and the belief that teaching was not a serious profession that required training and sustained developmental opportunities.

A Love of "Real" Math versus Classroom Math

In sharing their views on mathematics and what drew them to the subject, participants largely emphasized the "beauty" of mathematics, especially at the research level. Lin, for example, explained that "why I feel I'm keen on mathematics, mostly because I found there are some beauty of mathematics. It's about logic's beauty." In a similar vein, Quin shared that as they progressed in their undergraduate mathematics education, they began to see mathematics in a new light:

> Once it got more to stuff with like, proofs and like, geometric figures and stuff, like yeah it started to be like something that—I started to see aspects of it were more beautiful and like, like, you know, started to feel more like an opportunity for creating something. Like solving a puzzle, and like, like this, this like, putting together the things I know and then suddenly there's this that result I didn't have before

Caleb echoed similar sentiments to both Quin and Lin, highlighting the beauty, creativity, and piecing together of mathematics that he enjoyed at the higher levels of his mathematics education. He expressed:

> The best comparison I can think of is like, creative writing. Cuz you're trying to think of, 'Okay, I have this concept. What—how do I think about this and connect it to ideas I already know work? And, you know, join them together'... and you can even then—like when someone does it very um, succinctly or very creatively, you also have this kind of beauty that's built into it.

The admiration and deep love for math that participants had is evident in these three quotes; it was clear for all participants that they were passionate about mathematics and felt that it was a beautiful subject.

While participants' current views of math were that it was a "beautiful" subject, most of them acknowledged that they did not always see mathematics in this light, and that there was a clear difference in how they viewed mathematics now, versus how they viewed it growing up. Aditya, for example, shared how his views of math changed between K-12 and his undergraduate studies, as well as how his views on mathematics changed between his undergraduate studies and his doctoral studies:

> In school, I would say I was happy with being able to solve the questions in the textbooks and like, exercises and like, getting good scores in exams and tests. And everybody appreciating me for doing well in math, like, it kind of motivated me to do way more and do better in math. In undergrad, I would say I was interested in learning all the new fields in math that out there were, which I was very unaware of when I was in school. And in school I was mostly aware of the school syllabus and all that. I did not really know much about math outside what was taught to me in school. But after coming to undergrad I learned that there is so much more in math which I did not know about earlier, so I wanted to, like—I was really excited by all the new ways of thinking that there were in so many different subjects in math. So I was just like, interested in learning things in math. But now things have kind of changed, I guess. It seems like, now that I'm in this program being a PhD, I can't really focus on all the, all the different things out there. I try to work on the particular field I'm working on and just see what people in my field are working on and like, trying to find questions and trying to solve them. It's kind of, it's kind of a very different mode of thinking in math… I guess the main point of doing math is not like, finding the results but like, getting—having understanding of the subject. If we are understanding it and studying it, maybe we can find some results by crunching the numbers, but that won't give us understanding of what we are trying to understand.

Aditya discusses how as a K-12 student, being good at math meant getting good grades and being able to complete the exercises given to him in school; since these exercises largely revolved around answering questions in his textbooks, he perceived math to be about solving those types of written problems. As an undergraduate, he began to better understand the depth, breadth, and separation of mathematics as a field that was discussed in the prior theme, and realized he wanted to learn and better understand the different areas of math. However, as he began his PhD journey and realized he can only focus on one specific area of mathematics, his beliefs around what it means to study math has changed. Whereas he used to feel that studying math and being successful at math was about results and problem solving, he now sees the goal of studying math as developing a deeper understanding, which he referred to as “real math”.

Aditya’s belief that the goal of studying math is to develop a deeper understanding is consistent with the admiration and deep love of math that participants expressed. Because they loved the subject and saw the beauty in it, the value of mathematics, for them, was now about developing an understanding of the depth and beauty of the subject. Logan, for example, had double-majored in mathematics and physics as an undergraduate, but was drawn to mathematics as an area of graduate study because his mathematics classes provided a sense of depth and understanding beyond what he was learning in his physics classes. He shared:

> An experience I had over and over again in math and physics, is I would see something for the first time in physics, see that it was useful and cool but not really understand it, and then it would show up in a math class and you would actually dig into the details… Well, and, and it's just... you know… [real analysis] teaches you what a—for example—what an integral actually is, even though you've been using them forever, and then you finally understand what they are. Like, how they're really defined, you know?

In this quote, Logan shares that while as an undergraduate, he was able to see and appreciate the utility of mathematics in his physics classes. However, appreciating the utility of math—and even utilizing math—did not necessarily equate to having a deep understanding of math. This deep understanding was ultimately what he decided to pursue in continuing his graduate journey in mathematics. Logan’s quote is also a clear example of how the purpose of math—where the value of math used to lie in solving predetermined problems, whereas now the value for participants lay in developing a deep understanding of concepts and the utility of mathematics — changed for participants over the course of their educational journeys.

As a result of how their views of math as a subject—and what it meant to study math and be successful at math—changed throughout their mathematical journeys, it also became clear that participants saw a divide between mathematics at the research level, and mathematics in the K-12 or even the undergraduate space, and assigned a valuation to that divide. Yuanjun, for example, discussed:

> So during—so when I grew up, I just thought math is all about solving questions. Solving problems. I guess that's also true for you, right? But after doing three years in the PhD program, I guess math is become—it's becoming more and more challenging for me, because before, I can solve math questions quickly. So even though—even if I do solve some hard questions, I solve them in one day or just a few hours. But now, when you are really on your research project it's a long process. It takes you like, months or years, and you don't know—you don't know what's the progress of this project. So, I guess that's how I, how I changed my view during the years. And I think research-level math is—it's really hard. So, *[laughs]* Yeah. It's definitely harder than those undergraduate things. Even harder than [graduate level] abstract algebra *[laughs]* or something. Yeah… You don't even know whether the statement you're trying to prove is true or not. So yeah. It's much unknown to you. Much uncertainty, yeah.

Yuanjun's valuation of research-level math being "harder" than the math he had learned in the classroom—even at the graduate level—denotes the perception of a clear difference between "classroom" math and "research-level" math, which seemed to be a common sentiment amongst participants. Declan, for example, shared that “I have my coursework, and then I have… uh, and then my like, actual work. My like, ‘what I wanna do” math kind of work’,” implying that classroom mathematics—even at the graduate level—was different from the “actual” mathematics work of research. Based on the ways that participants described how their views of mathematics had changed over time, it seems fair to assume that “research-level” math, and developing a deep understanding of mathematics, was seen by participants as what Aditya referred to as “real math”—or what math “actually is”—while classroom math was not the same thing as “real math”.

Separation of Teaching and Research

The clear distinction between “classroom math” and “real math” was evident in the ways that participants discussed the relationship between teaching and research in the mathematics department at MAU. As a research-1 institution, most of the doctoral students and tenure-track faculty at MAU were there because they had a deep love of “real math” and, as such, wanted to pursue their research. While those in research-based roles (e.g. doctoral students and tenure-track faculty) still taught, the nature of MAU as a research institution meant that most of the academics who came to the department did not value teaching as much. As Cody explained:

> I mean also there's just the perspective of like, from the academic per—side—most of the staff is there for research more than they are for teaching. So there's also that, as well. So like, “Hey, they do teach, but it's more of like, ‘Ah, I gotta teach,’ than like, ‘Oh, I gotta teach!’” And the ones that are more happy to teach, that's what they do, they don't really do too much research outside of it.

Cody points out that most people who work at MAU are there to do research, and that while the majority of roles are research-based, there are roles for those who want to focus specifically on teaching. However, he also notes that while people who are at MAU to do research still have to teach, the teaching staff do not have to do research, and while the teaching staff are at MAU specifically to teach and are happy to do so, because the research staff are not there primarily to teach, they see teaching as more of an obligation than as something enjoyable.

All of the participants came to MAU to pursue their love and deepen their understanding of math, and as such, specifically chose to be in a research role: that of a doctoral student. Similarly to the phenomenon that Cody described amongst the research faculty, participants shared that while teaching was part of their responsibilities, their priority was to do research, as that was the purpose of doing a mathematics PhD. As Lin explained, "you know, teaching is not our main topic *[laughs]* for our graduate students, especially for our PhD students." While she shared that she really enjoyed teaching, as a PhD student, "to be honest, firstly, I feel it's a burden for us. It's not—you know, our time is limited, so we want to focus on research." Lin's quote reflects other participants' sentiments that research was the purpose of being a PhD student, and as such, was a priority over teaching.

Similar sentiments were shared by other participants; though they enjoyed teaching and accepted it as part of their responsibilities as a graduate student, if they wanted to prioritize and focus on their teaching, they would have gotten a degree in math education rather than in mathematics. As Quin shared, while they cared about teaching, "I'm not here to get a math education, um, degree. At least they're not, they're not gonna give me a math education degree. They're gon—you know, we're, we're supposed to be doing math research." Jun made a similar distinction when discussing the responsibilities he had to juggle as a doctoral student and GTA:

> I have to meet all the requirements to be a math graduate student. So I have to pass some qualifying exams. And I have to pass some classes as a requirement. And I have to pass

preliminary exams and write the dissertation. Yeah. Kind of like that. These days I prioritize my research over teaching, definitely. Because I'm not a graduate student in the math education department.

The distinction that both Jun and Quin make between a doctoral degree in mathematics, versus a doctoral degree in mathematics education, clearly show the ways in which teaching and research—and thus, classroom math and "real math"—are seen as separate at MAU, and how at a research-focused institution, many roles are specifically designed to focus on research rather than teaching.

The separation between teaching and research and teaching was evident not only in how participants conceptualized the parameters of their roles as doctoral students in the mathematics department, but in how they then compartmentalized their academic and professional lives. Logan, for example, noted:

> Um… I think… interestingly enough, like from the perspective of the people I do research with, like nobody—we don't talk about our teaching at all. That's like a totally separate um… thing that you talk about with the people you're teaching with. It's, it's not like your advisor or your people you're doing research with are, you know, I don't know, we just don't discuss teaching at all. So they're, they're sort of completely separated. That's maybe one part of the culture.

Declan shared similar sentiments around who he talked to about research, versus who he talked to about teaching, commenting:

> I don't know, I guess I don't really talk about teaching with my advisor. We definitely have a relationship, like research-wise. We, we talk a lot about math research. But like,

> teaching is just like, eh. It's like, I don't know. It's, it’s important to me. It still, it still is very important to me, but uh, it's just not uh, yeah. Not the goal.

As discussed in the prior section, participants saw advisors as their connection to their specific area of mathematics, and thus, the work that they were interested in doing as a career. Not talking to their advisors at all about teaching indicates a clear separation between research and teaching in the mathematics department at MAU.

The compartmentalization between research and teaching in participants’ lives was also evidenced in how they described the role of teaching. Eunji, for example, shared:

> Honestly, it's like… it's like, I don't think [teaching is] really much connected to my student life. Like, the life as a graduate student. I feel that they're kind of really separated. And it's more like, the TA job is more like… it's like work that I have responsibilities. And, yeah. So I have to do it, and like, I have to meet certain expectations, I have to help a lot of people, but um, it isn’t really something like my research or like, my homework, or student job. So yeah, I feel like it's pretty much separated from my student life. But still, I can't really—I can’t really be not doing it. Or like be a bad TA *[laughs]*.

Eunji’s quote highlights how the separation of research and teaching in the department, and the compartmentalization of each of those roles in her academic and professional life, meant that while she saw research as part of her role as a graduate student—which she wanted to do and actively pursued by applying to MAU—she saw teaching as a job, and thus as something she *had* to do.

Teaching as a Necessary Means of Doing Research. The view of teaching as a necessity was expressed by other participants as well, who saw teaching as something that was necessary to allow them to do research. As Lin explained, “you know actually teaching assistant is our, you know, our necessary mandatory, because, because if we are not teaching assistants then there's no payment for us.” Similarly, Yuanjun said that while “in long term, I guess research is more important to me… in daily life—so everyday life—I guess teaching is something else I must do. I must do, because you know, I get paid for teaching *[laughs]*.” In this vein, teaching is seen as somewhat of a means to an end for GTAs in the mathematics department at MAU, though Eunji shared that she saw it as “kind of like, one opportunity, we’re given so that we can do research. And yeah. I view it as some kind of like, an opportunity as a graduate student.”

All of the participants shared that when applying to doctoral programs in mathematics, they expected to be teaching. As Logan shared, “everyone I’d talked to had said, you know, unless you’re, yo—you’re in a very specific situation, you pretty much are going to be teaching for some portion of the PhD.” It seemed from other interviews that the “specific situation” Logan referred to was being on a research grant and obtaining funding for the degree through research rather than teaching. Cody, for example, said “most people in the PhD program are… um, trying, you know, to get their dissertations. They’re more research-focused, so a lot of people—once they get funding for their research, they stop teaching.” Quin also shared that “when I did my oral prelim, I—that was the semester I got a research support,” and so they were able to focus on their preliminary exams since the research support replaced their teaching responsibilities. Logan also shared that he worked as a GTA up until he found a research assistantship and could fund his degree program via research rather than teaching. Clearly, teaching was a means of financing the research work that GTAs came to MAU to do. As such, for most doctoral students at MAU, the goal was to obtain research support in order to not have to teach, especially since most of them did not intend to pursue teaching-focused jobs after graduation.

Interestingly, the necessity of teaching as a means to do research was reflected in the departmental structure as well, due to how the mathematics department was situated within the broader university community at MAU. As discussed earlier in this chapter, MAU has a mathematics requirement that all undergraduate students must meet in order to graduate; many majors also require mathematics courses beyond the level of the university's graduation requirements, because such higher-level mathematics course (e.g. calculus) are required prerequisites for other major courses. As such, nearly all undergraduate students at MAU enroll in at least one class in the mathematics department, which is not the case for nearly every other department on campus. Logan explained in a focus group "the number of students that go through the MAU math department is just enormous compared to any other school." Declan added that "at orientation, Levi Tau [the chair of the mathematics department] told us that the math department is the biggest department. Just like, by class number, by—significantly," to which Logan responded, "we're a service department. We help all the other departments."

The conversation then turned to wondering why other departments can't teach lower-level prerequisite mathematics courses, with Declan remarking, "well, maybe the engineering departments need to start teaching calc… where are the engineer grad students? They can teach calc too," and Logan joking in response, "if we do a bad enough job, they might do that." Quin added that "that's definitely a possibility. But then that means they have less TA-ships for math students." It was clear from this focus group conversation that much of MAU's funding for graduate students—and thus, their ability to bring in new researchers—came from the department's role as a service department for the broader MAU campus.

The connection between teaching and research—in that teaching was a necessity for research—meant that the two were inextricably linked in being part of the essential functions of the mathematics department at MAU. As Logan shared in his individual interview, while research and teaching were clearly important to the mathematics department at MAU, other values that graduate students held—such as taking care of their mental health—were not necessarily valued by the mathematics community. While they weren't devalued (that is, while no one would say that taking care of mental health, for example, isn't important), he elaborated:

> But I do think that there's no incentive for them to value it other than the extent to which that it allows the person to contribute to teaching in a, in a really good way and, and to research in a really good way. So, I think it's, uh… you know, it's minimally valued to the extent that it, it permits the other, other functions which are the ones which are really important to the, to the department, particularly teaching at a big school, like MAU.

However, while teaching was important to the mathematics department, it was only important insofar as it allowed for research to also happen. Logan remarked that this relationship between teaching and research was "paradoxical," because "they really need lots of teachers. They teach lots of classes. Um, they probably need the teaching more so than the research, right? But they value the research—in a prestige sense—more." Thus, while teaching was an important function of the department—and seemed like it should be more important than research due to how much the rest of MAU relied on courses from the mathematics department, the main value of teaching seemed to be in that it allowed for research.

Tensions in the Prioritization of Teaching and Research

The ways in which teaching and research were differentially valued in the mathematics department at MAU often led to tensions in how to prioritize these two tasks. As teaching was primarily valued in the department due to the ways in which it allowed for research, teaching was also primarily seen as a task that simply needed to get done, rather than a task that extra work or effort needed to be put into—even if doing so would benefit undergraduate students. Participants noted that while in some cases, faculty were aware that they could be enacting more student-centered practices in their teaching, there was tension between enacting those practices, and minimizing instructor workload. According to participants, the priority in the department seemed to be to keep instructor workload as low as possible, given the deprioritization of teaching, and the fact that most instructors were tenure-track faculty who were at MAU in order to pursue research, rather than teaching. While the tension between best practices for undergraduate students and instructor workload existed prior to the COVID-19 pandemic, the pandemic exacerbated this tension in several ways. One such example came up in the first focus group.

At the beginning of each of the early focus groups, we discussed challenges that participants were facing that week in their role as a GTA. Eunji shared a challenge she was facing when it came to requiring students to turn in worksheets that they would receive during discussion sections that she facilitated:

> I'm teaching Elementary Calculus I, which is elementary calculus, and um, like, we have to deliver some instructions about um, when they can, cannot um, cannot participate in the session. Um, and it seems like it's never going to get delivered to them, like no matter what um, what I do. Like, I deliver it in class and um, do the Canvas instructions like, um like, um cited on the webpage, and um, I also send them like, Canvas messages and like, email replies um, for it. Like it's been several weeks with it, but seems like it's never gonna get better *[laughs]*. So um, I'm thinking of um, like a good way to not to exhaust them with overloading messages about the instructions, but um, still gonna get delivered. The instructions to them…. If it's not for COVID, we can just like, give drops and then

um, like not allow any extra virtual worksheets, but um, it seems like if people feel like they are not feeling well, then they might not want to come to the discussion because it's a group work, um, and we want to respect it, but it seems like *[laughs]* it's a complicated procedure to do it.

Cody added onto Eunji's comment, as he was teaching the same class. He shared:

> Yeah. I, I just wanted to—yeah, I'm also doing Elementary Calculus I, so I find that interesting. So I guess that's the different—differences in lecturers, cuz my—no my lecturers are essentially saying, "If you don't show up in person, it doesn't—there are no virtual worksheets, essentially."

Eunji responded "yeah, that's like a really normal thing," to which Cody then elaborated:

> Like I send out the worksheet after, but the idea is like, "Hey, if you didn't show up like, you have the worksheet at your disposal, but like, you're not gonna get credit for it essentially, if you didn't show up."

The policy that Cody described seemed to be fairly common among the department; Eunji commented that it was because "I think it's really more convenient for us," to require students to show up in order to get credit, but she recognized that it was unfair to students to require attendance in a post-COVID era where it is important to allow people to stay home when they are not feeling well or may have been exposed to COVID. Cody then added requiring attendance was a course policy for his lectures, and found it "interesting" that Eunji was allowed to deviate from that policy, as he also wanted to be more student-centered in his approach to teaching, but found himself restricted by policies designed to make the workload easier for instructors at the expense of undergraduate students.

Another way in which the COVID-19 pandemic exacerbated the tension between best practices for undergraduate students and instructor workload was in regard to the relationship between assignments and exams, ensuring student learning and understanding, and preventing cheating. This line of conversation was brought up during the second focus group, where we discussed common concerns people in the mathematics department at MAU have around teaching undergraduate students. Participants discussed how some faculty were particularly concerned with preventing undergraduates from cheating on exams; this concern was exacerbated when courses went online during the COVID-19 pandemic, as it became difficult to administer traditional exams in a way that limited students' opportunities to cheat. However, not all faculty were particularly concerned with whether students cheated on exams or not, and felt that ultimately, undergraduate students were responsible for their own learning. If they chose to cheat rather than work to learn and understand the material, that was up to students, rather than instructors, to ensure that the exams properly measured student understanding. As Aditya shared:

> Yeah, I, I feel like, taking—when the courses were all online—like, like, all the terms to like, prevent cheating were kind of like, not good enough, it sounds. It's just like kind of inevitable to uh, prevent all the cheating I guess. But so, keeping that in mind I think some profs were like, "Okay if they wanna cheat, they cheat." I can't tell you too much about that *[laughs]* because however much we can do I think is increasing work for us and like it's more difficult to prevent all cheating. Yeah.

Aditya noted that some professors were less inclined to try and prevent cheating, as the amount of work that would be required to prevent cheating on exams would likely not completely eliminate all opportunities for undergraduate students to cheat—rather than learn and understand the material—and thus, would not be a worthwhile tradeoff.

Lin then built on Adtiya's comment, describing a parallel between some professors' attitudes on both exams and homework. She added:

> Yeah, actually, I found out—for example some courses, you know, our faculty, you know, do not have enough time to prepare for the homework. So every semester they will use the same homework questions *[laughs]*. So for, for example, lots of students will find the previous homeworks and the answer-sheet —or the answers for those questions—so it's very easy for a TA to figure out Oh why are those mistakes are the similar *[laughs]*—are similar, so similar.

Lin's comment is slightly more charitable to faculty, as she points out that sometimes it is less about faculty simply not wanting to take on more work to improve undergraduates' learning, and more about time limitations. Nevertheless, faculty with limited time are making choices about what to prioritize, and creating new homework questions or restructuring exams to prevent cheating was not something that they found to be a worthwhile use of their time and effort. During this conversation, I had found it interesting that traditional exams continued to be administered during the pandemic. While I understood Aditya's point that trying to completely prevent cheating on online exams wasn't possible, I questioned "why exams then continued to be the standard like, marker of learning? Like why did we continue with like, exams like that when it was so hard to prevent cheating on—when we moved online?" Quin then quipped that it was "because it's easy to distribute them to a large number of people and then offload the labor to the cheap grad students." This sparked a short conversation around faculty's resistance to creating new modes of evaluation that were more student-centered, to which Quin then added:

> Yeah, I think there's also a lot of inertia, espe—like, like with um, tests being what, what profs are used to doing for, for evaluation, or what they're used to, like, from their own

> experience in the education system. It’s, you know, it's what they know how to do. And like, you know, it’s, it's not—especially the research professors, there is no reason for them to put all that thought into doing something new.

Quin’s comments neatly synthesize how the departments’ differential valuation of research and teaching resulted in two distinct, but interrelated consequences: the deprioritization of teaching, and the offload of labor onto GTAs.

The Offload of Faculty Labor onto GTAs. The offloading of faculty labor onto GTAs often meant that GTAs faced a parallel tension to tenure-track faculty in determining how much to prioritize their teaching, as opposed to their other responsibilities (namely, their research). The participants in this study largely wanted to be good teachers and support their undergraduate students, but this was made difficult due to the departmental deprioritization of teaching, and the desire of most tenure-track faculty to minimize their own labor. Since course supervisors could be either tenure-track faculty or lecturers, there was often variation in the quality of GTAs’ course supervisors, as well as variation in the level of support that course supervisors wanted to provide to their undergraduate students. When course supervisors did not prioritize their teaching, they tended to not provide as much support for the undergraduate students they taught. As such, GTAs who wanted to be good teachers had to take on a higher workload if they wanted to provide better support for their undergraduate students than the bare minimum that their course supervisors were providing. For example, in one of the focus groups, Yuanjun shared that his teaching workload was much easier than it had been the prior semester. When asked to why that was, he said:

> Oh yeah. That's a good question. So, well, first of all, I have four sections last semester, so I have three sections this semester *[laughter from multiple people]*. And, well, last

> semester, the professor of that course is—well, was not caring enough about our students, so we, we had a lot of workload to do like... like what… You had to provide homework solution all the time, you had to like, do other things.

As Yuanjun explained, part of what had made his teaching workload so difficult last semester was the amount of extra work added onto his regular GTA duties (such as running the discussion section, administering the exams, holding office hours, and grading) because of the lack of support his course supervisor provided for the undergraduate students in the course. Implicit in Yuanjun's description is that supervisors who cared about their students would provide homework solutions for students to refer to in order to check their work and understand the process of solving problems correctly as a form of studying. Without correct solutions provided by the supervisor—who was also typically the person who chose and assigned the homework problems—students would only know whether they got the problem correct or incorrect once the homework was graded. But, if the homework was only graded for completion, students might not even know whether they got the problem correct or not. In not providing homework solutions to students, course supervisors may have been able to reduce their own workload for the course, but made it more difficult for undergraduate students to check their own understanding of the course material. This may be why Yuanjun described this professor as "not caring enough about our students," and why Yuanjun—as a GTA who cared a lot about being a good teacher and supporting his students as much as possible—added providing homework solutions for his undergraduate students to his workload.

In some cases, it was possible that course supervisors who did not provide answers to assignments chose not to provide answers to GTAs in order to ensure that GTAs reviewed the material assigned to undergraduate students, and had an understanding of the material they were helping students to learn. However, course supervisors' intentions in assigning workloads were often unclear to GTAs. For example, when describing the work that he did to prepare for teaching during his first year, Caleb shared:

> For the calc courses, um, we get a worksheet that the chair—the, whoever's the head of the course—wants us to do. So the only prep work I typically did was solve the worksheet myself, cuz we don't typically get the answers… I think [we don't get answers because] answers are supposed to be obvious. Um, but it might also be that we're expected to do it ourselves.

Interestingly, Caleb did not mention being told by his course supervisor that he had to work out the answers to the worksheet on his own; he just was not given the answers to the worksheet by his course supervisor, despite being given the worksheet to assign. Caleb still completed the worksheet as preparation for his course, because he wanted to have the answers for his students, but he was not sure why his course supervisor did not give GTAs the answers to the worksheet when they were given the worksheets. Although some course supervisors may not provide answers to assignments to ensure GTAs are engaged in the course content, by not being explicit in their reasoning, GTAs may assume a variety of explanations—from the more generous reasoning Caleb gave, to believing it might be because course supervisors simply are not caring enough." Furthermore, in not providing explicit reasoning or instructions to GTAs, GTAs who may not want to take on the extra work of solving homework assignments and worksheets leave their undergraduate students at a disadvantage, as the bulk of the responsibility for their learning was on them, due to GTAs' and faculty's minimization of this responsibility for themselves.

While most of the participants in this study were GTAs who did want to take on extra work where they could in order to better support undergraduate students, they could understand why some GTAs did not want to take on this extra work, and described facing their own challenges in determining how much extra work to take on for their undergraduate students. As Logan explained:

> Until I became an RA, which was about a year ago, [one difficulty] was juggling teaching and research, um, and that was easier when I'd already taught the class before. Although even that, I found that I could either teach really well in a way that I was happy with, or I could use the fact that I had already taught the class to kind of fall back on my notes and have more time for research. I couldn't really do both. Like, even though I'd already taught the class before—sometimes more than once—if I wanted to do a really good job and have like, a really compelling lecture or whatever, then it didn't help that I had already done it before. Maybe not yet anyway, maybe if you teach a class a bunch of times, you'd have, you know, enough experience to, to go into it and wing it and still have it be a really compelling lecture.

Although Logan cared about his teaching, and wanted to be a good instructor for undergraduate students, it was difficult to figure out whether to use his time to prioritize teaching in a way that was more student-centered, or to use that time to focus on his research. While he really wanted to be a good teacher, at the end of the day, he was at MAU to get his PhD, and thus, was there to focus on research, and there were only so many hours in the day. When he knew he did not have to prepare as much for a class, and that he could provide a decent lecture for a class he had already taught before, it was difficult to want to prioritize becoming an even better teacher at the expense of focusing on his research.

Structural Limitations in Prioritizing Teaching

As Logan described, participants' individual choice in how much extra work to take on to help their undergraduate students was limited in large part by their purpose in being there, as they had come to MAU in order to focus on their research. This tension was one that most participants agreed with, noting that at the end of the day, the extra labor that they often already took on for undergraduate students—due to faculty offloading of that labor—made it difficult to determine exactly how much extra effort they wanted to put into being a good instructor. While they did not necessarily want to completely minimize their work at the expense of undergraduate students—or their peers—they also felt as their perspectives on teaching went against the departmental norm, which was to minimize instructor workload as much as possible. GTAs who did want to minimize their own workload—often at the expense of their fellow GTAs and undergraduate students —were structurally enabled by the department in doing so. One such departmental system that allowed for this was the mechanism for assigning teaching assistantships to GTAs each semester. Each semester, GTAs ranked their preferences for teaching assignments. While they were not guaranteed to get their top choices, there was a way to rank their preferences to try and ensure that they got a teaching assignment with a lower workload. It was informally known amongst the graduate student social networks that being a grader would require the least amount of work for GTAs, while serving as the sole contact instructor for a course—instead of teaching a discussion section for a larger lecture—was the most work-intensive. As such, older graduate students who wanted to minimize their workloads would rank sole contact courses at the very bottom. This meant that first year GTAs, who had less institutional knowledge and teaching experience, were often given the teaching assignments with the heaviest workloads—namely, the sole contact courses.

Participants' frustration with the system for distributing teaching assignments—and the inequities for both GTAs and undergraduate students that resulted from this system—was a topic that came up during our third focus group. The discussion in this focus group was initially centered around things that participants wished they could change in the mathematics department at MAU—and what they thought the consequences might be for undergraduate students of Color. Declan was the first to broach the topic of departmentally-sponsored uneven teaching workloads, stating that he would change "the consistency and distribution of teaching and like, between and among courses… the variety and like, workloads is like, crazy." He then elaborated, explaining that "in my current teaching assignment, I do not do very much… and like, some of my other students—my other first year students—are just like, sole contact college algebra students…. This is just not an equitable system in any kind of—in any way." This sparked a discussion about other things the department could do in regards to GTA assignments to ensure that GTAs, according to Quin, "are like, more prepared and like, yeah, able—like doing a job that fits with what they are able to do" so that "students would have less stressed TAs. The TAs would like, have more of an idea of what they're talking about, more of a plan."

Aditya expressed disbelief that the department allowed first year students to serve as sole contact instructors, sharing the following:

> Honestly, I'm surprised that like, they gave sole contact teaching jobs to first year students. Like I would imagine that such a job would be like, given to like, more experienced TAs. Like at least third or fourth year, not really first year.

Logan shared that he was also surprised at first that sole contact assignments were given to first year students, and responded to Aditya's comments:

> No. Well, so I've been digging to try and figure out how this arcane system works. And I think it's, it's just priority. I think it's just, oldest TA gets preference. And so, nobody wants to teach college algebra because it's a very difficult—like an unrewarding class to teach, with a lot of work. And so I think the first years just get like, the last pick.

Quin added, "oh, yeah. And y'all, y'all don't know better, which—how to, how to rank the courses. Cud you don't—you're not familiar with them," to which Logan laughed and said, "Yeah no, yeah that—no, no one told you that's an awful class." Quin then went on to say that "No, a bunch of people in my year—and this is like, eight years ago—got college algebra first semester. It's always been like this."

What became clear from this conversation was that the disparity of workloads for GTA assignments was an inequitable system, wherein older GTAs who wanted to minimize their own workloads could do so at the expense of first-year GTAs—as well as the undergraduate students in those sole contact courses, who would benefit more from having an instructor with more time and teaching experience. While some participants, such as Quin, mentioned being willing to—or actively trying to—rank sole contact courses as their top choice in order to combat these inequities, participants overall felt that this problem could not be solved by individual GTAs, as it would lead to burnout. Moreover, participants felt that the disparity in workloads of GTA assignments was so vast that it discouraged them from wanting volunteer to teach a sole contact course when they would be getting the same compensation as a grader or a GTA teaching a discussion section—even though they knew it would be more beneficial for undergraduate students in sole contact courses to have them as an instructor, rather than a first-year GTA with little teaching experience, who would most likely be overwhelmed and underprepared teaching these courses. Most participants felt that it would benefit both GTAs and students if the department made changes to teaching workloads so that they would be more equitable—such as providing more support to sole contact instructors, scaffolding teaching assignments so that older GTAs would take on more responsibilities than younger GTAs, and building in semester breaks from teaching when GTAs had qualitative exams—as the current system was, in Quin's words, "designed to make everyone hate teaching… and make students hate math."

Differential Measurement and Support for Research and Teaching. Aside from the inequitable workloads in GTA assignments, another way in which GTAs who wanted to be good teachers were structurally limited in doing so was through the differential measurement and support for teaching in the department, as opposed to research. While there were clear ways to be successful as researchers, participants expressed that there were not the same kinds of measures for success in teaching. Successful mathematics research would be "interesting to a lot of people, especially in their fields" (Aditya), "important", which could be measured through being "cited" or receiving "awards" (Caleb), or measured through receiving a "fellowship through an outside source" or by winning "some sort of prize" (Cody), and would allow someone to get "into really good postdoc job" (Yuanjun). Grad student success was also measured by research. Both Caleb and Quin described successful graduate students at MAU as ones who began working early on their research with an advisor, and both Lin and Jun described successful graduate students as ones who were "passionate" about their area of work.

In contrast, participants expressed that teaching did not have the same concrete measures of success in the mathematics department at MAU. For example, Quin shared:

> I mean like—like to some degree, like someone who like, is able to like, do teaching well and efficiently and stuff would come off as successful, but it's definitely not like… like… Like it doesn't—it's not something that's really being paid attention to by anyone.

> Whether you're doing it well or not… if you're teaching well, people don't really know the difference. Like, like, like there are awards for people who have like, good reviews and stuff. But like, that… like, it's not really clear like, what, what you need to do to get those awards, and like, whether… like, to—the extent to which those awards actually correspond with like, effective teaching. However you want to measure that.

According to Quin, it was not very clear how successful teaching was measured by the department, and a sentiment echoed by other participants was that no one from the department really cared whether they put the bare minimum effort into teaching, or went above and beyond in their teaching. Cody, for example, shared that when it came to teaching, "if you wanna put in maximal effort, that's, you know, great. [The department is] happy about it, but if you wanted to put minimal effort, there's also no *[laughs]*, you know, barrier for that as well." Thus, it would seem that there were no clear external benefits to trying to teach well in the same way that there were clear criteria and benefits for being a good researcher.

The lack of clear criteria for successful teaching, as compared to successful research, was also reflected in the lack of departmental support for teaching. While all graduate students had to take the Math Teaching Seminar 101 during their first semester, participants had varying thoughts about how helpful the course was. Eunji, for example, shared "I think it was a good seminar. It taught me a lot and yeah, it was a good seminar," and Lin also shared that "I feel it's very helpful… [the teacher] will show us how to organize a math course… and how to provide some—how to construct some quizzes. And I feel is very helpful for me, yeah." Aditya felt that the course was helpful in that "there was some basic information given to us about what to expect. Because for example, me, coming here, I had no idea how it was supposed to be like here." Yuanjun appreciated that the course went over student assignments and "how you should grade it. So I guess that's very helpful, how you grade those homeworks." Quin described the course as having helped prepare them for "the mechanics of teaching… and you know, kind of get—-like, you know, starting to acclimate to like, being up in front of the room. Um, that felt like the main thing." It seemed in some ways that the course was helpful for people who had not taught (and specifically, who had not taught in the United States), before.

However, because the course only provided basic information about the mechanics of teaching at MAU, other participants—particularly those with prior teaching experience, did not find it as helpful. Both Cody and Caleb stated that they did not remember much from the course, and it seemed that the divide between who felt the course was helpful, versus who didn't, seemed to be based on who had taught (and again, specifically taught in the United States before), and who hadn't. Declan, for example, stated "I don't really think it prepared me at all… and I just wish that I didn't have to go, because it conflicted with my office hours. He conceded that he probably did not enjoy the course because he was not the target audience, which he described as "grad students who had never taught anything before, um, of which there are a couple." Indeed, Logan, who had no teaching experience prior to coming to MAU, shared:

> "Well, I definitely thought that course was helpful, but it might not have been as helpful if I'd had any experience teaching at all. Um, I sort of took everything that was said in that course as gospel, because I… you know, I was like, "I have no framework to cling to, so I will cling to, you know, whatever [the instructor] says." Um… and it was , it was helpful. Um, I definitely, you know, improvised and came up with my—what worked for me—as I went on and got more experience teaching and that kind of thing.

As Logan explained, he found the course helpful since he did not have any prior teaching experience. If he had taught before coming to MAU, what he learned in the course may not have felt useful, as it did for other participants who had prior teaching experience.

It is noteworthy that Logan referred to experience as being more helpful later on in learning how to teach beyond the basics. Most participants named experience as being influential in helping them learn how to teach, and that they learned more from their own experiences than from any formal type of departmental support. Aditya, for example, shared that while he found the teaching seminar helpful, "I feel like mostly, we learned about teaching from experience." Declan also felt like he mostly relied on "just past experience," and Eunji shared that although she found the seminar helpful, that "I think really experience tells people what to do." What is not clear from participants' reliance on experience is whether they felt experience was influential because there was a lack of formal support from the department, whether it was because they did not see teaching undergraduate math as a serious profession, or some combination of the two.

Teaching as a Serious Profession. In some ways, the lack of support for professional teaching development seemed to imply a perception within the mathematics department at MAU that teaching was not a serious profession that required training and development, and that anyone could teach without much formal training or support, as long as they had a basic understanding of classroom mechanics and content knowledge. This perception was consistent with the departmental deprioritization of teaching (and indeed, perhaps this perception was required in order to justify the departmental deprioritization of teaching). For many of the lower-level courses, it was assumed that GTAs would have the requisite content knowledge and could teach the course without much preparation. As Declan explained:

> We get teaching assignments like, sometimes less than a week before [the start of the semester]—like again mine [Elementary Statistics] was easy but I did have to learn R because I'm teaching a stats class and I don't know any R. So I had to learn all of R in like—it was, it wasn't terribly complicated but it was like, 'I could have spent a couple of weeks on this instead of three days.'

Participants described several other ways in which teaching—and learning how to teach—seemed devalued by the department. Caleb, for example, shared that part of the reason he did not remember much about the teaching seminar was because "it was online. Also I had a course at the same time. So I don't remember going to it very often. If ever." Although the course was required for all first-year students, the fact that Caleb was able to take another course at the same time implies that there may have been little accountability in attending the seminar.

As discussed earlier in this chapter, first year students were also observed twice by lecturers in the department, and given feedback on their teaching. However, Cody shared that when he asked during his second year when he would be observed again, as he hoped to grow as an instructor, that:

> I was told that it's really just a first-year thing, or if your reviews are bad enough, essentially. So I'm like, "That's interesting for the perspective of like, in terms of priorities, there's nothing." Like when you get like a one- or two-week thing, your first year of like, "Hey, here's how to teach." And that's it. I go—in terms of observation—someone comes in once and it didn't even matter pretty much—just from the sound of it, at least—that your observation mattered or did not matter. Like, if you did well, that's great. If you did poorly, well, we needed people there anyway [laughs], is kind of the sound of it. And then, "well, we stopped doing observations for reflection, cuz, well,

> you're not a first-year." and I'm like, well it's a year thing? Not a... Why is it a year thing?"

Cody was perplexed about the purpose of the observations, as it seemed to him that since observations stopped after the first year except in cases where someone got bad reviews, that the observations were necessarily not to help GTAs grow and develop as instructors.

Cody also mentioned in his quote that if reviews were bad enough, a GTA might be observed again. Participants shared that GTAs who received "low enough" reviews might be spoken to by the chair, or would be made a grader the next semester to get a "break" from teaching. However, it did not seem that GTAs who received low student evaluations would receive any extra support in helping them become better teachers, and in some cases, GTAs who had decent evaluations could also be assigned as a grader during a given semester rather than a TA. As Quin explained, the teaching support in the department was "just—it's not… there's a lot of vagueness and a lack of supervision," and did not seem to be prioritized.

The lack of departmental support to grow and develop as a teacher meant that GTAs who did care more about learning to teach had to look elsewhere to improve their teaching practice. Yuanjun, for example, admitted that "yeah, I guess the department, they don't offer too much in this area, I guess." He then shared:

> So… Mm… One of the, I guess, one of the major feedback I get is from my students. So I will have those midterm surveys so I could really know what they're thinking about of my teaching, of my teaching style, of my teaching pace, anything else I don't know.

Yuanjun created midterm surveys on his own in order to solicit feedback from students, as he felt it was an important way that he could gauge his teaching practice and ensure he was developing as an instructor. Other participants also spoke to the importance of getting feedback from their students when they could, as they did care about being a good teacher and wanting to support their students as best as they could.

One participant, Cody, was particularly interested in learning how to be a better teacher. He eventually formed a connection with the Math Education department at MAU, after talking to one of the math department faculty who did his teaching observations. He shared:

> I went to talk to her cuz I was like, “Hey, I'm starting to consider like possibilities, years down the line of like, hey, I might be interested in going like an academic teaching route more than a research route to begin with. Um. Like, do you have recommendations?” ...so I talked to her and she's like, “oh, you should talk to some of the people over in the math education department” I didn't even know it existed to be honest with you until *[laughs]*. So then I'm like, “Oh, a lot of those people sound interesting,” you know, and I reached out. She was, you know, she was also talking, she's like, “I don't really have time to support, but like I want, hopefully, maybe want—some people could start building more relationships.” Like she knows some exist between there, but like it's still pretty small in terms of the impact.

It is notable that despite having a math education department on campus, that the mathematics department and the mathematics education department had few formal connections, and that the mathematics education department was not a commonly known resource for GTAs—Cody, for example, had to rely on his established social ties in order to find out about the math education department on campus. Thus, the lack of teaching resources for GTAs was not due to the scarcity of these resources, as there were resources readily available on MAU’s campus. Rather, the lack of teaching resources and support for GTAs was largely due to the departmental deprioritization of teaching, and the view of teaching as a job or a task, rather than as a serious profession that required the building and development of skills through training, support, and evaluation.

Theme 2 Summary

Overall, the lack of departmental support for teaching in the mathematics department at MAU seemed to derive from the separation between teaching and research, which in turn mirrored the difference between classroom math and "real" math. Although participants believed both teaching and research were considered departmental priorities, it was clear that teaching was a necessity because it allowed for research; this relationship was established due to how the mathematics department was situated within the larger campus community at MAU and MAU's classification as a Research 1 institution. Participants saw research as being clearly valued more in the department, but that was because most people came to work and study in the mathematics department at MAU to pursue their love of research and deepen their understanding of "real" math. However, while participants described the ways in which research was concretely valued more than teaching in the mathematics community at MAU, they all did care about being a good teacher, and wanted to help their students. Unfortunately, due to the departmental deprioritization of teaching, participants felt that they faced several structural barriers in doing so. Other barriers that participants faced in trying to be good teachers—as well as opportunities that they had to help their students—will be discussed in the next theme.

Theme 3: Attempts to Shift Narratives of Mathematical Success

I have heard it many times from many different people that I was either teaching with or teaching for, of just like, "oh, well, you know, a certain number of people just are gonna get Cs and that's how this works" ... It is something I've heard many times, that there are just, quote-unquote "bad students, C students, D students."

-Logan

Thus far in this chapter, I have provided a written portrait of the mathematics department at MAU, and have described participants' perceptions of the culture of the mathematics department at MAU throughout the first two themes. As such, the first research subquestion (how do GTAs describe the culture [e.g. values and practices] of the mathematics department/community?) has been discussed thus far in this findings chapter. The ways in which participants both align with some parts of this culture, but want to break from other parts—particularly in terms of their teaching—was highlighted in Theme 2. I also discussed some of the barriers that participants faced in trying to break from departmental norms around teaching and prioritize their own teaching practices in Theme 2. Over the next two themes, I will continue to describe participants' desires to break from traditional teaching practices and norms in the department, and delve further into some of the opportunities and constraints they face in doing so. Thus, the second and third research subquestions (what opportunities/constraints do GTAs face in breaking from the normative values and practices of the mathematics department/community?) will be discussed in these next two themes.

Although participants struggled with how much to prioritize teaching at the expense of their other responsibilities (including their research, which was their top priority as doctoral students at a research-1 institution), all of them wanted to be good teachers and help their students be successful. Moreover, participants believed that all of their undergraduate students *could* be mathematically successful. They did not believe in the dichotomous concept of "math people," and wanted to change stereotypical narratives about what it meant to be "good at math" in order to help all of their students recognize that they could be mathematically successful. While participants felt that they had several opportunities to be able to shift these narratives around “math people” and what it meant to be “good at math,” they also faced several barriers in doing so, including navigating their undergraduate students’ expectations of them, and departmental narratives about “types” of students at MAU. However, while participants wanted to break from normative ways of valuing students that they recognized as exclusionary, there was still a racialized element to their valuation of students that they might not have recognized, and as such, they may have inadvertently perpetuated exclusionary forms of valuation of their undergraduate students.

Issues with the concept of “math people”

Almost all of the participants shared that there seemed to be a common narrative about what it takes to be a “math person”—and that they often heard undergraduate students share sentiments such as “I’m not a math person.” However, participants also shared that they didn’t think the concept of being a “math person” or “not a math person” really existed —or as Quin explained “I mean—I think the concept is not—it’s a bogus one”—and many of them shared that they felt the concept of a “math person” was associated with harmful stereotypes that served to marginalize people with certain social identities. As Lin shared:

> In our country, there are some stereotypes, actually. Especially for, for people feel—you know people's stereotype, is that girls are not good at mathematics. Boys are good at mathematics. You know, sometimes we are struggle with this stereotype. And we, when we—especially when I’m not good at mathematics, we will feel, “oh it's not my—it's because my gender.” Sometimes I will, I will have this stereotype and pressure for, for myself. But uh, you know, actually when I’m—when I became, when I became keen on mathematics, then I don't care this stereotype. I just do my best, try my best, and then we get some good results *[laughs]*. And after that, my major is mathematics and I feel there's

> so many excellent women or girls. They can do excellent job in mathematics. So, I just, just threw out the stereotype.

Growing up in China, Lin was surrounded by stereotypes that women were not good at math, and that men were better at math than women. This stereotype connoted that while men could be "math people," women could not be, which Lin shared put extra pressure on women when they made any mathematical errors. While she was able to move beyond the stereotype and now saw herself as someone who was capable of doing mathematics, she saw the ways in which the gendered stereotypes about mathematical ability were harmful to women's interest and persistence in math, and later questioned what types of stereotypes there were in the United States that might affect students' self-confidence and persistence in mathematics.

From the U.S. perspective, Declan also named gendered stereotypes as being associated with the concept of being a "math person" or not a math person, and named the intersection of racial identity as well. He expressed:

> I think like, the, the concept of, "I'm a math person" is also really tied up to the concept of like, "I'm a person who is encouraged to study a lot of math, via like, my privileged position in life, being, you know, a young like, white man who was successful and like, pushed into math."

Declan shared that he felt that he fell into this category, and that a saw young, white man who had early success in math, that he continued to be encouraged to continue in math, and was treated as a "math person". He did not think this would have happened if he were not a white man, as he felt that white men were more readily assumed to be "math people" if they showed interest and aptitude in math.

Participants also shared that there seemed to be a stereotype that math people were smarter than others. Lin shared that she noticed a societal narrative that "yeah, we still feel if a person [is] good at math or science, then we will feel he or she is smarter than others". Similarly, Quin shared:

> Like people think you have to be like, extra smart to be like, a math person. And like, yeah it gets conflated with like, being like, good with arithmetic or good with logic. Good with science, engineering-type things. Even though it's… or like, if you're good at one kind of math like, then you must be good at all the kinds of math.

Participants felt that the idea that math people were inherently smarter than others was a mistaken stereotype, and that being good at math was not about levels of intelligence. To them, the concept of a "math person" was associated with harmful stereotypes and mistaken beliefs about the nature of mathematics and what it took to be good at mathematics, and as such, they took issue with the concept.

Despite not believing in the concept of "math people," participants all largely acknowledged that their undergraduate students believed in the concept, and moreover, that their students saw them as "math people." Cody shared that some of his students explicitly "refer to me as a math person," while other participants shared more indirect ways in which they realized their students saw them as "math people" Caleb, for example, shared the following:

> On the, um, reviews that you get at the end of the year, some of them said um, things like, uh... um, what was it? Um, like, uh, one—I think one of them was like "very smart" and stuff like that. And it's like that—since it's a maths course that I'm teaching, that probably means they see me as a maths person.

Based on his teaching evaluations, Caleb knew that his students saw him as smart; given that the evaluations were in the context of a mathematics course, he then connected his students' views of him to the subject and concluded that they saw him as "very smart" in mathematics specifically, and thus, as a math person. Similarly, Jun shared that he believes his students see him as a math person, citing a time where he was trying to explain a proof to a student and "I think I just said in the class that, well, for this, it's not that difficult. I probably said that. And one student reacted like they probably do think like that." Jun acknowledged that what seemed easy to him may have seemed difficult for his student, and because of that, his student likely saw him as "smarter" than them in math, and thus, a "math person."

Participants also shared that their role as a GTA and thus, as an instructor, likely led students to see them not only as "math people," but as mathematical authorities. Eunji, for example, shared that she thinks her students see her as someone who is very good at math, and that "one reason—like one biggest reason would be that I'm a TA." Similarly, Declan shared that his students "definitely" see him as a math person and a mathematical authority, because "there is no other authority that they have, so it is, it is now me." Clearly, participants were aware of how—despite seeing it as a problematic concept—their students saw them as a "math person," and that there was authority and power in the way their students saw them. The awareness of this authority led participants to want to try and change students' perceptions on what it took to be "good" at mathematics.

Changing the narrative around being "good at math"

While participants acknowledged that there were people who grasped mathematical concepts with ease and quickness, that was not an indicator of how good someone was—or could be —at math. As Yuanjun shared, he believed that undergraduates saw "math people" as people who got good grades and “can solve question very quickly and have a clear mind.” However, he did not think quickness was an indicator of whether or not someone was good at math, “I guess it's just that some people, they are so-called ‘quick thinker,’ and the other people are not. So, it's not necessarily a reflection of how you, how your mathematical ability at… but yeah you know, just, if you are solving questions quickly, it looks like—you look like you are good at math.” Several other participants noticed that there seemed to be this association between quickness at solving problems, and mathematical ability, for undergraduate students, whether that was in the societal narratives of what it meant to be good at math, or how classes were constructed. Aditya, for example, shared that he felt that the exam process in the United States was very different than it was back home, because in that the exam process and expectations process “discourages that it’s okay to not be able to solve the problem in the given time,” and that the way exams are structured doesn’t help students learn that “it’s okay that all math problems aren’t—are not supposed to solve a math problem in like, five minutes.”

Aditya felt very strongly that an important skill for being good at math was having patience, and being comfortable sitting and struggling without giving up, especially because he felt that “real” math was not about quick problem solving, but was more about persistence and thought process. He shared:

> Like, one lesson that we learn when we are getting into math is—and more like, problem-solving phase of math—is like, you won’t know how to solve a problem when you first see the problem. Like, if you look at the problem and you know how to solve it, then you’re not solving the hard problem. You’re not solving the right problems. You’re solving the problems you already know how to solve. So that’s not like, doing “real math”. One thing is like, when you—to, to accept the fact that, okay, when you look at

> the problem and you don't know how to solve it and like, being able to not be disheartened by that, is kind of like, first like, math lesson, I would say, outside the particular path…I mean, of course you will find people who are quick as well. Like, when you are looking at a problem, you don't know how to solve it, but the other person will just like look at it and will be able to do it. But like, not being discouraged by that, and like, being able to still sit down and think through it—that's what's important in being able to do well in math.

Like Yuanjun, Aditya acknowledged that there were some people were quick at thinking through mathematical problems, but quickness and mathematical ability—while associated—were not the same thing. Building skill in mathematics had more to do with persistence and patience than speed.

In a similar vein to Aditya, Eunji shared that when it came to building mathematical skill, "like, one good quality, maybe you have to have some persistence. So it doesn't seem like it's going to work, but then, like, if you don't have persistence, then people give it up easy." Aditya's and Eunji's emphasis on patience and persistence was also consistent with participants' views on "real math" being more about the process of understanding concepts, and struggling with questions that had unknown answers, rather than the "classroom math" of solving rote problems. As Cody shared, part of being "good" at math was the following:

> Um, I think it just—it takes time for one thing, and it takes just the thought process. How, how do you think, is an, I'd say the, the big thing. So like, um, can you think through a problem if you're not sure of how it works? Can you maybe even come up with like, an estimate or something like that? Like, "Oh, it should be close to this," or like, something, based on some logical reasoning behind it, rather than, "oh, I knew the formula." Cuz I

> remember in class, sometimes it boiled down to, "did you know the formula? Or did you not know the formula?" But there's that gray area in between them. Like, maybe you didn't know it, but you can almost get there or get there.

As Cody explained, memorization of formulas and routinely applying techniques to rote problems was less of a mathematical skill than developing a deeper understanding of math through a focus on the thought process. Similarly to what Cody expressed, participants largely agreed that based on how they now viewed math—rather than what they thought math was in the past —that the thought process was most important for building mathematical skill. Patience, and reframing views on mathematics to focus on the thought process and understanding, was something that they wanted to emphasize to students over just rote memorization and solving problems on worksheets.

Other skills that participants emphasized in developing mathematical skills included curiosity and work ethic. Declan shared that he felt being good at math was "like 90% curiosity. I think you have to just be willing to be curious in a sort of abstract way," which was aligned with participants' views that a deep understanding of math—rather than using it to solve problems—was the purpose of studying math, and thus, building mathematical skill. Participants also emphasized that this kind of deep understanding took a lot of time and work, and recognized that social narratives around mathematics meant that the work and time required to develop this understanding was often not intrinsic. As Lin shared:

> Yeah, practice makes perfect. I do believe, I do believe this motto, actually. Because I'm a—I'm not, you know, I was a not good, I was not a math person, and then I became a math person, I feel. So, I know why I'm not good at math when I was a—when I was in the elementary school. But after that, when I feel the beauty of math and the origin of the

> math, I can, I can be good at math. So, I know, you know, sometimes it's not because our gene *[laughs]*. It’s, it's because the environment, actually sometimes.

Lin emphasized the importance of time and practice when it came to building mathematical skills, but noted that when she was growing up, she thought math was more about speed and knowing the right answers, rather than taking time to build a deep understanding of math. Because of the mathematical norms she grew up with, and stereotypes about who could be good at math, she did not grow up thinking she was—or could be —good at math, but that her perspective had changed. This change of perspective was something she cared deeply about communicating to students, as she—like the rest of the participants—truly believed that anyone could be good at math and build mathematical skill.

Communicating Different Perspectives Via Classroom Norms and Office Hours. Some participants felt that they had a lot of potential power and opportunities in trying to communicate new norms. As Declan described:

> I feel like, when you're a grad student—or a TA, or any sort of generic, low-level teaching position—like you're both a cog in the machine, but also the closest to the students, so you're sort of like the, the field troops. Or you know, you’re, you're out there actually doing a lot of the person-to-person work.

Because GTAs largely worked with smaller class sizes of students, some participants felt like they had a lot of power in being able to try and change the way students thought about mathematics. Jun, Eunji, and Cody, for example, all talked about the ways in which they tried not to just give students formulas, but provide some theoretical background as well to help students gain a deeper understanding of mathematical tools they were using. Declan, Lin, and Aditya all shared that they tried to talk about mathematical history in order to show some the amount of time and struggle it took to develop new mathematical ideas, but also to humanize mathematical content by teaching students about history, and Lin and Caleb shared the ways that they try to discuss math in connection to students' lives and interests, to show that math is everywhere, and is not for specific "types" of people.

Some participants also shared the ways in which they tried to be explicit about the norms they were trying to encourage in their classes, in order to try and help students break from traditional norms around mathematics. Cody, for example, shared that:

> I always try to like, encourage, you know, the students. I'm like, "Hey, you know, I—" they might view me as a math person — "but I make silly—you know, these mistakes—all the time." And these students will say, they're like, "Hey, shouldn't that be a five?" And I'm like, "Oh, yeah, that should be a five" *[laughs]*. And I say that, you know, "Just because, you know, you're in front of the room, doesn't mean you're not prone to making mistakes, or how you identify doesn't mean you can or cannot do it in that perspective."

Cody utilizes the knowledge that his students see him as a "math person" to show that "math people" do make mistakes, and that making mistakes in mathematics doesn't negate someone from being able to be successful in a math course and be "good" at math. Participants also described other ways in which they tried to directly reshape the way students thought about "math people" and being "good" at math by communicating classroom norms. Quin, for example, said:

> I try to say that like, "mathematics is a skill, and is something that you can improve your skills with as you practice. It's like a muscle. The more you work with it, the more you get used to it. The more comfortable you get with it."

They expressed trying to emphasize directly to their students that being “good” at mathematics is about having time, patience, persistence, and practicing. However, Quin also then shared that they find it hard sometimes to feel that communicating these norms in the larger class is as effective as getting to talk with students one-on-one, such as in office hours. They shared that while they do feel like there have been times in class where they can build rapport with students, it is a different feeling when “the student does come to office hours and you go through things and then like, they do engage more.”

Other participants shared similar sentiments to Quin—that while they had smaller class sizes than some of the large lectures on campus, they felt like they had more power in office hours, because they could work more closely and one-on-one with students, and get to know them better. Through smaller settings such as office hours, they felt that they could build more rapport with students, and that their communication around mathematical norms was more effective. As Declan shared:

> Like, the good, productive conversations that I have had like, um, were at my office hours. I was very fortunate in that uh, the classes I've taught, I had a lot of office hour participation. I think it was just because I like, I kinda had a blanket policy of like, my general office hours, then also if students had to uh, come, I would al—I would have uh, individual office hours as well if students asked. And I just sort of, kind of built up momentum along this semester, so I had a, a pretty good group coming to office hours regularly. And in office hours, I had uh, I had some good conversations with my students about, usually like, their background.

He then shared that knowing more about his students’ background allowed him to not only have productive conversations in office hours, but also in class. He felt like knowing his students also allowed him to be more intentional in his messaging around supporting students and their mathematical success.

Blatant Forms of Subverting Traditional Classroom Norms. Aside from trying to communicate norms to students, some participants named ways in which they either blatantly subverted classroom norms, or saw opportunities to transform the structure of the undergraduate mathematics classrooms at a broader level than in their interpersonal communication with students. Declan, for example, shared that there were some policies that faculty he TA-ed for had, that he did not agree with, as he felt that they did not help anyone and were harmful to students. He believed that these policies were because "a lot of instructors have a lot of bad faith with their students, but I just—I don't know, I just didn't… Like I, you know, like I had faith in my students." He shared that as a result of this faith in his students, if there were policies he didn't agree with, or if students had tried communicating with the course faculty but did not get a response, he would tell them not to go to the faculty member or listen to them, and that the rules in his section could be different. Some examples of this were letting students turn in homework at any time—despite the course faculty's policy of no late work—and letting students make up exams without approval from the course faculty when faculty did not respond to emails about students needing to reschedule due to illness.

While Declan was the only GTA who spoke about blatantly subverting classroom norms on an individual level, both Logan and Cody spoke about some of the possibilities of transforming classroom norms on a larger scale that they saw others doing. Cody, for example, was particularly interested in how he could institute active learning into math classrooms, and was working with a faculty member on doing so. Logan had been a GTA for another course where discussion sections were entirely restructured. In one of the focus groups, he shared:

> One semester taught linear algebra and it was a very different TA-ship than my previous ones where essentially the professor had the TA kind of mediate student problem-solving um, completely. Like no lecture really at all for me. Um, and just kind of helping little groups of students solve problems the entire time. And I actually thought that worked really well. That might just be for linear algebra, but I thought that the extra 30 minutes of lecture was kind of much less valuable than the, the extra 30 minutes of problem solving for them. So that's one thing.

GTAs for the course would meet "with the professor twice a week to talk about what problems we would give." Later in the focus group, he followed up:

> I just felt as if, you know, it was really giving them something different from the actual lecture, and, and I noticed in that class that the discussion attendance was much higher, and I kind of correlated the two in my head. Uh, but, you know, they actually felt like they were getting something in, in addition, rather than just an extra 20-30 minutes of lecture and then a little bit of problem solving at the end. So I, I thought that was really good. That class was actually taught by another grad student um, who had very strong opinions about teaching *[laughs]*.

It was unique for a larger course to be taught by a doctoral student, and for that doctoral student to then supervise GTAs teaching discussion sections for the course, as typically, a professor would be teaching the larger course. While it seemed that the change in the course structure was because of the graduate student—and perhaps might not have happened with a professor—it was unclear how that doctoral student was able to take on a role usually reserved for professors, and create substantive change in a larger course. For most participants, while they wanted to create change in the department that would be beneficial for undergraduate students like the doctoral student Logan was a GTA for, it was clear that they still faced several structural constraints in doing so, which will be discussed in the following section.

Navigating Undergraduate Expectations

Although some participants were able to find opportunities to blatantly subvert classroom norms, and could see ways that undergraduate courses could be substantially restructured to better support undergraduate students, participants largely still felt that the GTA role was one with limited power in making any transformative changes to undergraduate instruction. When teaching a discussion section for a larger lecture course, participants described some of the ways in which their course supervisor's decisions around their own teaching practices—and the subsequent expectations from undergraduate students in the course—restricted some of the freedom they had in deciding how to teach their discussion sections. As Yuanjun explained in one of our focus groups:

> Yeah. So, for this semester, I, I guess things are going well, but last semester, the thing I worry about most is the time management issue, is that you had to—like, we only had, we only had like, 15 minutes to—each week—to talk about the stuff we learn and the worksheet, but you have to say a lot in the 15 minutes. So I can literally pack like a 100—sorry, one hour and 30 minutes lecture into a 15-minute lecture. And because, as I said, the lec—the professor was not very helpful, it's like, we had like, 250 people. So for his class, there were only like, 25 people going to his class. So, so the students are relying on us TAs, so I can feel a little bit of stress for about like, you have to deliver enough knowledge to them in order to—for them to be success like, in, in exam or something. Yeah.

Yuanjun’s statement highlights the impact of faculty’s teaching decisions and practices on GTAs’ agency and ownership within their own courses, and how faculty norms around teaching could often lead to more work—and thus, more constraints—for GTAs. Due to the “not very helpful” teaching style of Yuanjun’s course supervisor, including his lecture style and the assignment of required worksheets for students to complete during their discussion section, Yuanjun felt that his primary focus in teaching his discussion section was compensating for what his students did not learn during lecture. He felt that his students relied on the GTAs to teach all of the lecture content so that they could do well on the exams; as such, Yuanjun felt an obligation to help support his students in achieving mathematical success through traditional modes (i.e. providing lectures and trying to ensure they did well on their exams). The intersection of time constraints, student expectations, and faculty deprioritization of teaching limited Yuanjun’s power to alter or subvert traditional classroom norms or narratives about mathematical success.

Participants did share that when they were teaching a sole contact course—where they were the only instructor students interfaced with, as opposed to teaching a discussion section for a larger, faculty-taught lecture—was where they had the most power. In our third focus group, during a discussion around where people felt like they had power and ownership as a GTA, Logan mentioned having more power as a sole contact than as a GTA under a lecturer. Cody responded:

> Just put a plus one on like, the sole contact. You kinda have a lot more power besides, you know, what the curriculum is. Except, preparing them for exam one, this is gonna be what's on exam one. But besides that kinda, how you wanna teach it, how you wanna resolve disputes, a lot of those things are up to you.

Cody had also shared in an earlier focus group that serving as a sole contact instructor gave GTAs "a lot of control over [setting due dates for students]," which allowed GTAs to be more lenient to undergraduate students than faculty might be. However, he added that "the only thing that wasn't under your control was, 'this is the exam. This is what's gonna be on the exam.'" Thus, although GTAs serving as sole contact instructors had a lot of control over how they taught their courses, and had some ability in trying to shift traditional classroom norms and narratives about doing well in mathematics, they were still constrained by exams in the same way that GTAs who taught discussion sections were, as the content and timing of exams were usually coordinated by their course supervisors.

Although sole contact courses came with more agency and ownership for GTAs than discussion courses, the lack of control over determining course exam content and timing remained a rather significant barrier that GTAs teaching sole contact courses faced in trying to change norms and narratives around mathematics success in their classrooms. Despite having control over many other aspects of the course, they found that undergraduate student expectations—as well as undergraduate students' beliefs about what was important in mathematics courses—were difficult for one instructor to be able to change, especially when they were just one of so many mathematics instructors their students had had in their lives. Cody, for example, enjoyed teaching sole contact courses, and was passionate about trying to implement more student-centered pedagogies such as active learning in his classes. He also did not believe that exams should be markers of student understanding and success, and wanted to adjust his teaching according to this belief and help students care about and enjoy mathematical content beyond what would be on the exam. However, as he shared:

> Yeah. I mean, I don't wanna teach the test at all, but I always know that *[laughs]* that's almost the first thing on a student's mind, right? Like "Is this question gonna be on the test? And if it's not, why?"

Thus, while Cody wanted to be able to create transformative change in his sole contact courses, he found this goal in tension with his students' expectations about undergraduate math education; as such, his students' expectations were constraints that he faced in trying to transform norms and narratives about mathematics education in his courses, despite the ownership and agency he felt he had in teaching sole contact courses.

Other participants felt similar to Cody in that they wanted students to enjoy mathematics, and be able to engage with content beyond the exams; they felt that "classroom math" perpetuated false narratives about what it meant to be "good at math," and wanted to be able to help their students develop a deeper understanding of math and shift some of the exclusionary narratives about what it meant to be traditionally "good at math." However, similarly to Cody, other participants also expressed feeling constrained by student expectations in trying to shift some of these narratives. Eunji, for example, shared her own challenges with student expectations during our first focus group:

> So like, I really want to deliver some real concepts and like, really what's going on and how to connect the concepts, but um… it, also, it's like, it's helping some of them really, but some of them are not really interested. And like, it's actually many of them are not really interested. And um, in terms of the grades, um, for some people who don't really um… who are not really interested in the concepts, um, just um, get bored if I try to explain them. So I kind of always wonder the balance of um, just delivering the problem, problem solutions and like, going in theoretically.

While Eunji felt that it would benefit undergraduate students to teach more “real math” than “classroom math,” she was not sure how to balance students’ expectations with what she felt would benefit them more. In response to Eunji, Jun then shared his own experiences with trying to teach deeper theoretical content that clashed with students’ expectations:

> Personally, when I teach, I start from scratch. I, I start from scratch. But I go over all of the theories, but most of the students don't care, don’t care about the theory part. They just want to see how to solve the questions, but when I solve whole questions, I also start from scratch, I don't want to um, use the formula itself. So I—when I start, like the first question, I start it from scratch to solve all the—solve the question, to go through all the steps, but from probably the next question—like second, third—I can use the formula, but they don't just care about the, how the formulas are derived or something like that. So yeah. So, because of that, well, whenever I'm the sole contact in, instructor, a lot of students—probably like 20%—dropped out my classes [laughs], because um, they are not interested in um, the math—how math works—and um, they don't understand.

Thus, while participants wanted to be able to change narratives around what mathematics was, and what it meant to be good at mathematics, they found that it was difficult to try and communicate that goal to students, as their goals—while student-centered and well intentioned—were in conflict with students’ expectations, and what undergraduate students felt that they needed from their mathematics courses.

Finding the balance between shifting norms and engaging undergraduate students was complicated, due to how heavily ingrained some of these norms were in the mathematics department at MAU. As Quin explained, a large challenge with trying to break from traditional models of teaching mathematics to undergraduates was getting buy-in from students themselves. They stated:

> The thing about like, active learning is—and, and things along those lines—is like, it's like yeah, you like—students will learn more if you can get students to buy it and trust you that they can actually take the time to do this harder stuff, like higher-level thinking.

Thus, aside from structural constraints around the power in their role as GTAs, students' ingrained beliefs about traditional mathematical norms, and their subsequent expectations of their mathematics instructors, was a major constraint that GTAs faced in creating transformative change that they felt would better serve their undergraduate students.

Narratives about types of students at MAU

Another constraint that participants felt that they faced in trying to enact student-centered teaching practices that shifted narratives around mathematical success were the preexisting narratives around types of students at MAU. Negative narratives tended to persist around students taking certain entry-level courses, such as Algebra and Trigonometry. Logan, for example, explained that Algebra and Trigonometry (colloquially referred to as college algebra) was a course that "nobody wants to teach…because it's a very difficult—like an unrewarding class to teach, with a lot of work." Algebra and Trigonometry was well-regarded in the department as the sole contact course with the highest workload, and it was also the most common sole contact course to be assigned to first year students. However, it was not only the workload of the course—as a sole contact course—that made it one of the most disliked courses in the department to teach. The course was also regarded as "unrewarding" due to narratives about the students who took the course, since many students came into the course with much more diverse prior mathematical experience than students who took higher-level courses such as

Calculus. Participants felt that narratives about Algebra and Trigonometry in particular were exacerbated by the uneven distribution of GTA workloads (which were discussed in Theme 2), but even if the department were to step in to try and create a more equitable distribution of work among GTA teaching assignments, narratives about certain classes—and the students in these classes—might still persist and be detrimental to undergraduate students of Color in particular.

One of the reasons that participants felt that negative narratives about teaching Algebra and Trigonometry were particularly harmful to undergraduate students of Color was because of how racial diversity within the department was skewed. Participants explained that racial diversity within the mathematics department at MAU became scarcer along a hierarchy, with faculty being the least racially diverse, graduate students being somewhat racially diverse, and undergraduate students being the most racially diverse. For example, in talking about racial diversity in the mathematics department, Logan explained:

> Yeah. I mean, I think it depends on where you are in the math department. Obviously there aren't very many um, Black or Latino professors. Um. And I don't know exactly what the breakdown is of different groups, but um, I think as you go further along that hierarchy, right, it gets more and more egregious. Um. Um, in terms of students that I have taught, it's, you know, classes have been very diverse.

Similarly, in his individual interview, Yuanjun noted that he did not think that faculty were very racially diverse. However, in describing racial diversity among the students, he shared:

> I guess you have many Asian Americans or Asians in the department. In the graduate students. But yeah, but I don't know many African Americans in the department—in the graduate students, so yeah. For—with my students, I guess… Mm… I guess for those

> low-level, lower-level classes, I'd say it's diverse, yeah. It's like, yeah, like 100-class, one like calculus one, calculus two, yeah.

While both Logan and Yuanjun described undergraduate students as being racially diverse, it is interesting to note that they did so in a comparative context—that undergraduate students were racially diverse in comparison to other groups within the department. It is also worth noting that Yuanjun specifically named 100-level courses such as Calculus I and Calculus II as being diverse. As other participants explained, the skewing of racial diversity along a hierarchy was present not just between groups in the mathematics department, but within them as well.

While undergraduate students were the most racially diverse group in the mathematics department, racial diversity within the undergraduate student population was different between classes. Eunji shared her suspicions that some of the upper-level undergraduate courses may be less diverse than the lower-level ones when talking about racial diversity in her individual interview. She stated:

> The undergraduate students seem like they're from different backgrounds, I think. But then I'm only teaching —Like, I've never taught a course in like, the 300- or 400-levels. So yeah, I don't really know whether in really the math department they're—they have diversity. At least in Elementary Calculus or like, 200-level courses I've seen many people with different races.

While Eunji did not have as much experience teaching higher level courses, participants who were farther along in the program—and thus had taught a wider variety of classes simply due to being at MAU for a longer time—shared perspectives that confirmed Eunji's intuition. Logan, for example, shared that "some of the first classes I taught at MAU were the remedial classes… and um, you know, those classes were, um, had a lot more Black and Latino and Indigenous students than some of the higher up classes." Quin, who was the participant who had been at MAU for the longest time, stated in their individual interview:

> Yeah, no I mean like, literally like, I like—the first, like—you know a lot, a lot of the courses I taught at first were like, calc, calc one or above—like engineering calc or above—and like, so like, those pre-engineering courses are mostly white students. You know, like, just a few students of Color. And then, you know, later I taught precalculus and that was kind of like, half-and-half, and then I taught college algebra and that—those courses were mostly students of Color.

Thus, negative narratives about lower-level sole contact courses in the department, and their oppositional positioning to higher-level courses that were seen as more desirable to teach, disproportionately affected undergraduate students of Color, given how much more racially diverse the lower-level courses were as compared to the higher-level courses.

Some participants recognized that negative narratives about courses that had more racial diversity—such as those courses requiring more work to teach and being "unrewarding"—could lead to racialized stereotypes about undergraduate students of Color. Quin, for example, shared the following:

> Yeah. I don't think I've heard um, very many comments specifically referring to race, but there's—like with different, um, like when it comes to entry-level math courses—like for example, Calc I uh, for engineers, tends to be like mostly white students. Whereas like, College Algebra would tend to have a lot more students of Color. And so, like in a way that like, like people might talk about the "kind" of students that take one course or another. And so that—there's a certain racialized component to that, which can be a problem.

Others did not quite see the same connection, however, all participants believed that all students had the ability to be successful in mathematics, and that race did not affect students' mathematical abilities. They wanted to reject negative stereotypes and narratives about undergraduate students of Color, but rejecting negative narratives that were more subtly racialized—such as the ones about the "kinds" of students in Algebra and Trigonometry—were more difficult for some participants because they felt as though there was some truth to the negative narratives about students in Algebra and Trigonometry that constrained their ability to support these students and help them be successful.

The part of the negative narratives about students in Algebra and Trigonometry that participants struggled with had to do with student preparedness, which participants did not view as being connected to students' race. In fact, both Declan and Logan explicitly stated that they don't think about students' race in their teaching, but that they do think about students' math backgrounds and their high school mathematical experiences. While other participants' views on the importance of acknowledging their students' racial identities varied, in general, students' levels of mathematical preparedness seemed to be something that participants felt was the most important aspect of students' backgrounds to attend to in their teaching. Algebra and Trigonometry was a course wherein undergraduate students tended to have more diverse mathematical backgrounds, which contributed to the negative narratives about the "kinds" of students in that class. Declan, for example, shared what he had heard from friends of his who had taught Algebra and Trigonometry in our third focus group, when participants were discussing the uneven distribution of teaching workloads:

> The students are either way too—like fully prepared or completely underprepared. Like, their mathematics level is not at all even ready for college—and so like, you have kids

> don't, that don't know how to multiply fractions consistently, like in this college algebra class, which is supposed to get them up to speed to satisfy a minimum mathematics requirement, which like, they have no hope of doing. had one friend who told me, he was like, "I have to fail—" I don't know, and this is, yeah…He's teaching a sole contact class and he's like, "I have to fail a kid who worked really hard but, you know, had almost no chance of succeeding because of their—just their background was so poor and like I, you know, I tried to work with them to make it work, but I'm gonna have to fail them, and they're gonna have to be expelled from MAU because of it, because they're on academic probation." And it's just like, that's just, that's an awful TA experience. And awful for the kids.

Jun then added to what Declan shared, as he had taught Algebra and Trigonometry firsthand:

> So I was assigned to Algebra and Trigonometry um, in my first year and it was terrible. Yeah, exactly what you said, Declan, yeah. I, I had students who were quite like, fully prepared for the class. I was enjoying teaching them, but like, some of them like wasn't, weren't prepared at all. So like, for example, I had a student who kept arguing that square root of A squared plus B squared is A plus B because you square them, then you add them and you take the square root of it, so that's how we get A plus B, but I showed her by a counterexample—3, 4, 5, that's like a typical counterexample to it, right? But she just kept saying that "Well, my argument is perfect." Like *[laughs]*, "I can't fix my argument," something like that. So that was so frustrating. That was so frustrating.

Other participants then shared similar sentiments around how part of what made Algebra and Trigonometry particularly difficult to teach compared to other sole contact courses was students' varying levels of preparedness, through Cody added that it the varying levels of preparedness were likely also true for other lower-level courses, but that what made Algebra and Trigonometry particularly difficult was "just the amount of curriculum that goes into it as well. So Algebra and Trigonometry seems to cover more than some of the other sole contacts." Logan then added that Algebra and Trigonometry was a particularly high-stakes course for students as well, adding to the difficulty of teaching the course, noting "that for many kids it's kind of do or die in terms of their degree. That they need it for their uh, math requirement or to, you know, pass into the math classes that they need for their major."

What is reflected in both Declan and Jun's comments about the differing mathematical backgrounds of students in Algebra and Trigonometry is the general sentiment from participants that all students can be successful in mathematics, which was discussed in the prior section. However, the negative narratives about certain students and courses were difficult for participants to navigate, because while they theoretically believed that all students had the ability to be mathematically successful, and wanted to be able to support students in doing so, they did face challenges with students in their classes—such as students' mathematical backgrounds—that did feel like frustrating and insurmountable barriers. While they did not want to perpetuate negative stereotypes about students, they struggled with the amount of control they had in helping students be successful, versus how much was out of their control.

Navigating how much of student success was within their control as instructors was something that participants grappled with in another common negative narrative in the department about "types" of undergraduate students. Logan summed up this narrative well in his individual interview:

> Something I noticed on the teaching side—that there's a bit of a… not—I don't want to say culture, but like an attitude that, you know, some students are C students…And I

> think it comes from the statistics, you know? That like, a certain percentage of students get Cs in the course every year. But that's not determinism. That doesn't mean it's always gonna be those same set of students or that there wasn't a reason for it that semester… [but] I do think it's prevalent, and I have heard it many times from many different people that I was either teaching with or teaching for, of just like, "oh, well, you know, a certain number of people just are gonna get Cs and that's how this works." Um, and I—yeah, I don't know where it comes from originally, other than that, it's true statistically that usually a certain number of people get Cs, but um. I don't know. It is something I've heard many times, that there are just, quote-unquote "bad students, C students, D students."

Similarly to the negative narratives around the Algebra and Trigonometry students, participants did not believe that some students were just "C" students. However, they also struggled with outright rejecting this negative narrative, because while they did not believe there were "C" students who were incapable of learning the material, they did think that not every student was either able or willing to put in the work to be more traditionally academically successful in their courses. In this sense, they did recognize that some students would be "C" students every semester, but they did not necessarily see this as something negative—nor did they feel that a "C" grade reflected a student's mathematical ability or potential.

However, participants did feel as though part of the negative narrative in the mathematics community at MAU around certain students being "C" students was the implication that "C" students were either intrinsically bad at math, or were lazy and did not work hard. They felt differently. Eunji, for example, shared that she thought that undergraduate students did not have to do well in the course she taught—Elementary Calculus I—in order to be successful. She shared:

> I don't really think—my think is kind of, I guess a little bit different from usual thinkings. So even though I'm teaching Elementary Calculus now, I don't think that they really have to be good at Elementary Calculus in order to success. Like, I kind of understand that if they want to miss it and if they have more important things to do, then they can do it. And like, even if they get—like, they fail in this course, or something like other things happen, I don't really think who are good at Elementary Calculus, is going to be more successful. It's more like, if they find something more valuable than my course, then I think they can do it. But I still have to, like—yeah it doesn't mean that I'm gonna like, let them do whatever they want. I try to encourage them. Because that doesn't happen for everyone, and I have to encourage people to learn, but I also kind of think their success doesn't relate like, very strong to my course… [but] I kind of hear that some people think they think they should be doing their courses and be engaged in all, and like, have good grades. And like I think that's like mostly expected from students to be successful.

As Eunji explains, while she doesn't necessarily see a correlation between undergraduate students' performance in her mathematics class, and their abilities, success, or attitude, she felt that her thinking was against the norm within the mathematics department, and that while some students might be "C" students, that labeling didn't really say anything negative about them, except that they might have had other priorities in their lives.

Participants largely agreed with Eunji, in that while there might be "C" students, this didn't mean anything negative about their work ethic or their mathematical ability. More often than not, they felt it just meant that students had other priorities in their lives, and that it was important to recognize their students as holistic people who had a life outside their classroom that sometimes would prevent them from being traditionally successful in their course. While participants rejected the idea that some faculty had (that students of Color were intrinsically worse at math), there was a racialized connection to the way participants might have viewed who the students with more pressing external priorities—and thus, the "C" students—were. Logan, for example, shared:

> That's probably when I think about [race] most, just because the distribution of which students have had real impositions on their careers, students from parts of their life that have nothing to do with that, that has not been even on a, a racial demographic breakdown. Um, yeah, in terms of people who've had to go home because they, you know, were needed to help out with something or whatnot. Um, or people who've had early parent deaths or, you know, tons of other random bullshit that happens to everybody throughout life—or, you know, happens throughout life —uh, that has... I've felt it in my teaching has been uneven or it turns, it's—yeah, happened more often to students of Color.

Thus, while participants felt that it was important to be understanding of students who might not perform academically well in their classes, and recognized that sometimes students' performance and success in their class was outside of both their control and the students' control, it is interesting that the students they more readily accepted as the "C" students might have been students of Color.

The Racialized Valuation of Students. Interestingly, while participants did not necessarily think poorly of students who may have had other priorities and thus, did not perform as well in the course, they did particularly value students who showed a desire to work hard and a deep interest in mathematics. While this did not necessarily mean they valued students who got As in the course, they did value students who exhibited a genuine interest in mathematics, and a desire to do well. Aditya, for example, discussed the types of students he valued and appreciated most during our fourth focus group:

> I feel in terms of value, uh, that the students who are like, genuinely interested in learning about the subject, I, I feel like I can really uh, appreciate them. Like, uh, they often like, pay really well—pay good attention to the class and, and like, have questions like, coming out of curiosity, or sometimes confusion, which they, which they uh, encounter when they're really trying to understand the question. So such students, I think I really appreciate and value. Uh. Uh, yeah. And in terms of success, like it—again, in terms of grade, like it is not necessary that such students might earn the best grade. Like uh, partly because like, maybe when they're coming from the—like maybe when the course started, they were not as ahead as the rest of the class, but likely that these other students like, who make the most progress during the course. Um, but if the student is like, lacking in some kind of background when they're starting a course, uh, it is easy for them, I feel, uh to like uh, fall behind sometimes. Like because it can get overwhelming when they're learning too many things. And like, even though they want to learn and they're curious, but like, it just becomes too overwhelming and like, uh, uh, so that may not translate into success, but like their, their curiosity and uh, attitude towards learning like, makes me appreciate them.

Aditya's sentiments—that he particularly valued students who worked hard or who were genuinely interested in the course material—were echoed by others in the fourth focus group. Participants largely rejected the notion that traditionally academic students were the ones that they valued. Rather, they appreciated the students who were willing to come to office hours, attend classes regularly, help their peers, and ask interesting questions—even if those students did not get the best grades. Valuing these students seemed somewhat racialized, given both their acceptance of students (and typically, students of Color) who may not be able to be as engaged in class due to external priorities, and participants' recognition that students of Color may be feel less comfortable being more "visible" in class or coming to office hours.

While participants did necessarily see the racialized component of valuing students who were more visible in office hours and classes, they did discuss how valuing these students more was something to be aware and cautious of, as they wanted to ensure that they were being fair to their students. Lin, for example, shared that she intentionally tried not to bond as much with students, even if they did participate more in class or in office hours. She shared:

> But for me sometimes if, if we, we are friends, then I will be very, very kindly and very friendly. So I might—I cannot make myself very fair to all of students. Yeah. Because I'm lack of a—I do lack this skill to keep the uh, fair grading for all students. Yeah. If I, I'm, I'm, I—if I, I, I—if all the students and I have the similar relationship, then I will, yeah, I can keep fair. For, for example, if when, when we're grading, if we don't know the student's name, then I can grade fairly. But, if I know *[laughs],* yeah, it's very hard. Yeah, you know, it's too difficult for me. Yeah.

Caleb, Declan, and Quin all chimed in that while they did appreciate being able to get to know students better, they tried their best to be aware of their biases towards students who did come to office hours. As Declan noted:

> I definitely am biased. Like I, you know I, basically I'd be lying if I said that I wasn't, but it's more of a "Stay aware of it and minimize it to the best I can," you know, because… I

don't know, just, just this semester, I was grading a student's work and like, my office hours attendance this semester is much less. Um, prob—mo—80% by like, course design. The students just have less need, uh, compared to like, Calculus I. And, you know, I had a s—I had a student come, uh, to my office hour, ask me how to do something, uh, and like, work on a particular type of—just a probability problem. And we did it, and, you know, I only had maybe five students total for my whole class come to office hours, and she came multiple times. So, uh, you know, way—I knew her comparatively way better than all my other students. And uh, and I was grading her exam, and I was like, reading the problem where we were—that we worked on—and she didn't get it fully right. And—but for a second, I just gave her full credit instinctively, cuz I was like, "Oh we did this." And I was like, "Oh no, there's still a slight mistake." So I, I like, I even caught myself doing it. Uh, it was—I think it was easier to catch because again, it was like, a more noticeable difference because most of my students, I don't know as well at all, cuz they just don't come to my office hours, etcetera. So no, I think it's, it is real, and you just gotta, you just gotta try your best. I don't know, I don't, I don't really have any other solutions. I don't have big, big picture solutions besides just stay aware, stay viligent [sic]

Participants' desire to be fair to all of their students, as well as their limitations in making connections between racialized values and the racial patterns they noticed, were also evidenced in how they described the way that they felt their ability to support undergraduate students of Color was limited by their own racial identities and racial consciousnesses, which will be discussed in the next section.

Theme 3 Summary

Despite teaching not being as much of a priority for participants as their research, all of them cared about being good teachers and helping to shift narratives of mathematical success, either through their teaching practices or through conversations with their undergraduate students. However, they recognized that they were fighting against specific norms and constraints —both in the mathematics department at MAU and in society more broadly—that contributed to exclusionary narratives about who could be "good" at math, and what skills were required to be a "math person". GTAs saw opportunities in being able to try and shift some of those norms and narratives and help their students be successful, but still felt that they were facing many constraints that limited their ability to do so, such as the lack of institutional power they had as GTAs, trying to meet their undergraduate students' expectations, and navigating negative narratives about certain "types" of undergraduate students at MAU. However, in trying to shift narratives about mathematical success in the department, participants may have been inadvertently perpetuating racialized norms, despite—or perhaps because of—their desire to be fair to all students. Participants' difficulties in navigating issues of race will be discussed further in the next theme.

Theme 4: Navigating Racial Privilege in Supporting Undergraduate Students of Color

Uh, and, what—and in a sort of like, do I have a very open, straightforward like, immediate conversation? Or like, you know, set the norm of, you know, not talking about [race and racism]? And like, you know, sort of taking the uh, "Just like, be a good teacher first," approach?

-Declan

Thus far in this chapter, undergraduate students of Color have not been specifically centered. As explained at the beginning of the thematic findings, this is largely because participants were reluctant to talk more directly about race, racism, and supporting undergraduate students of Color until later in the focus groups, and because they struggled to make connections between race and the normative culture of the mathematics department. While some connections between race and the normative culture of the department were discussed in the first and third themes, these discussions largely occurred due to direct prompting either by myself or specific participants with more developed critical consciousnesses. Most participants largely focused on serving undergraduate students more broadly, rather than undergraduate students of Color more specifically. Furthermore, when it came to specifically serving undergraduate students of Color, and helping them see themselves as capable of doing mathematics—and thus, as members of the mathematics community—all participants felt as though they faced several additional barriers in doing so, as compared to serving undergraduate students more broadly. As discussed in the previous section, participants already struggled with serving undergraduate students more broadly due to constraints they faced as GTAs. They felt that their own racial identities, as well as racism within the mathematics department, provided additional barriers in serving undergraduate students of Color more specifically. While they recognized their own racial privilege[12] in the mathematics community at MAU, they struggled with what their

[12] While I use the term "racial privilege" as an umbrella term in this section (and because it reflects the way both white and Asian international participants used the term "privileged" to describe their experiences and positioning in the mathematics department at MAU related to their racial identities), it is important to note that there is a difference between white racial

responsibilities and capabilities were in addressing the structural racism in the mathematics department, and in serving undergraduate students of Color. As a result, they felt the best course of action would be for them to try and focus on *all* undergraduate students, with the mentality that by doing so, they would also be helping their undergraduate students of Color.

Defining Racism and Its Influence at MAU

As discussed in the prior section, participants noted that racial diversity in the mathematics department at MAU became scarcer along a hierarchy, with faculty being the least racially diverse, undergraduate students being the most racially diverse, and the racial diversity of graduate students falling between the two other groups. Additionally, although undergraduate students were the most racially diverse group in the mathematics department, there was still a racial hierarchy within this group; lower-level courses such as Algebra and Trigonometry, Precalculus, and remedial courses were more racially diverse than higher-level courses such as Calculus and beyond. Participants also named that in particular, there was a lack of Black people in the mathematics department, even in more racially diverse undergraduate courses. Some participants also shared instances of overt racism that they either saw or had heard about in the mathematics department, and largely acknowledged that both the lack of racial diversity, as well as instances of overt racism, might affect people of Colors' experiences in the department. More specifically, they also suggested ways that the lack of racial diversity in the department, as well as instances of overt racism, may affect the experiences and retention of undergraduate students in the mathematics department at MAU.

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privilege and proxy privilege, as proxy privilege is contingent and not protected and permanent in the same way that white racial privilege and power are (as discussed in Chapter 1).

All participants agreed that overt racism was an issue that underrepresented students of Color faced at some point in their lives. However, not all participants felt at first that this was something that many students of Color in the mathematics department at MAU experienced or were affected by. This topic came up in our final focus group, which we opened with discussing how racism shows up in mathematics classrooms and spaces at MAU. While participants largely focused on systemic racism at first—rather than interpersonal overt racism—and subsequently, the importance of understanding how intent and impact may differ, and how systemic racism shows up in the department regardless of intent, Logan remarked:

> Yeah, I mean, I would just add that I do think overt racism still exists in math departments. I've seen it at MAU. Um, it's still a thing, but it's hopefully not showing up in the classroom in any kind of obvious way ever. But I don't know, I don't know to what extent the, the fact that it exists in departments, uh, impacts the classroom environment for specific classes.

While Logan had heard and seen instances of overtly racist comments between faculty members in the mathematics department at MAU (he later shared this specific context), he hoped that these beliefs were never shared directly with students, and that at the very least "I would imagine [those faculty members] are not so stupid as to think they might not lose their job if they did something like that. But uh, *[laughs]*, but you know, like it's possible."

Other participants pushed back a bit on Logan's implication that overtly racist beliefs of specific faculty might only show up in specific classes, and that even if those views weren't shared directly with every student of Color, that the knowledge that some faculty members in the department held overtly racist views was likely detrimental to undergraduate students of Color in all mathematics spaces at MAU. Cody, for example, responded:

> I mean, that, that's kind of where I was going as well, of like, the intent versus impact because, sa—said students have experienced that in the past, and they are aware of it that as well so they might not be comfortable in your classroom without you being aware of it, because they've experienced that. And they're like, "Oh, they—if I ask a question, they might think I'm dumb." Or like that, you know, like, you might be confirming some of these [beliefs], even though none of it is, is true.

Quin agreed, adding:

> And then that follows the, that, that—I think you're talking about like, stereotype threat, um, which can like, impact students who might like, see themselves as being like, higher-achieving or something. Like, then they can have—that can make it even harder for them to succeed in situations where they feel like they're like, having to like, represent their identity group.

While Logan saw a bit of a separation between systemic racism in the mathematics department, and the overt and interpersonal instances of racism that he saw, Cody and Quin saw a connection between the two, and how undergraduate students of Color in the mathematics department might thus be affected, even in courses with faculty who did not hold overtly racist beliefs or intentions. Jun found this conversation to be particularly interesting, because while he had noticed some instances of racial grouping in his courses, he had not realized that there were instances of overt racism in the mathematics department at MAU, and how that might affect undergraduate students of Color.

With the exception of Caleb, all of the white participants in this study either named explicit instances of racism that they had seen or heard about in the department, or named and described the likely role of systemic racism in undergraduate students' of Colors mathematical experiences at MAU. The remainder of the participants, who were all international Asian students, had a more difficult time identifying and discussing the role of racism in undergraduate students' of Colors' experiences in the mathematics department at MAU. The Asian international participants noticed racialized patterns in their classrooms—such as Jun observing that his Black undergraduate students tended to work together in isolation from their non-Black peers—but did not explicitly connect these patterns to racism. They did, however, posit that the lack of racial diversity in the mathematics department likely led to undergraduate students of Color—and particularly, Black students —feeling isolated in the department. For example, when asked during his individual interview to name a time where a student of Color felt uncomfortable or marginalized in a math course, Yuanjun shared:

> I think, okay, so I came into the situation that some students in Color that… they are still struggling to find groupmates—group project mates, so. And they might be the only student in Color in my discussion class, so I guess that could have made it a little bit uncomfortable, yeah…Mm... [and] I guess, if you don't have many fellow students of Color, so, you might not encouraged to like get a further study, right? So you might think of yourself like, yeah, yeah, "I'm the only Black student in class so yeah I guess that's the last one—last math class I have to take."

Yuanjun connected the lack of students of Color—and specifically, Black students—to the possibility that the isolation that these students faced could lead them to feel less comfortable within the mathematics community, and thus, not continue pursuing related fields of study where they would continue to be isolated. Jun shared similar sentiments, positing that "I think that kind of like, atmosphere affects definitely peoples' opinion about math. I mean, if you have a lot of friends who study math, of course then you want to study math." Although he believed that students of Color who feel may feel isolated in their classes would not want to continue being in those classes, he also did not make any explicit connections to systemic racism, concluding “but I guess the reason why we don't have enough Black graduate students is because I think there are like, not a lot of Black students who are interested in STEM majors, I guess. Especially in math.”

International Participants’ Perspectives on Race and Racism

It is important to note that Asian international participants’ inability to explicitly name and discuss the influence of racism on undergraduate students’ of Colors experiences in the mathematics department at MAU was not because they did not believe that racism existed in the mathematics community. Rather, it was because their home countries' contexts shaped their understandings of race and racism, and they were not taught about racism in the United States when they came to MAU. Jun even shared that prior to this study, no one had talked to him about race or engaged with him in conversations about racial patterns he was noticing in his classrooms, and thus, he came to the conclusion that it was “taboo” to talk about race in America. Jun also stated several times that he was not sure that he fully understood what racism was, and that although he was not white, because he was from a racially homogeneous country, he did not feel that he had ever experienced racial discrimination. While he struggled with identifying more covert and systemic forms of racism, he did know that overt racism existed. However, he had never directly experienced or seen instances of overt racism, and thus, had asked a few clarifying questions during the final focus group when Logan, Cody, and Quin were discussing faculty members who they knew held overtly racist views. Jun then commented:

> It sounds very interesting. I mean, well, I don't think I've ever experienced some racism against me. Probably some, some, some, one or two. Not in math, um, um, math uh, setting. Well, so actually, I don't know what racism is exactly, so I’ve—because I've

> never experienced, like most of my lifetime *[laughs]*. So I'm sorry, I can't like, 100% sympathize with you.

It was clear during the focus groups that Jun was trying to understand the conversations that other (mainly, white) participants were having about race and racism, but he struggled to really be able to make the same connections that they were having, and thus, also felt like he could not necessarily weigh in on how to address racism in the mathematics department at MAU.

Jun emphasized several times throughout his individual interview and the focus groups that he had very limited experience thinking about race and racism. At one point, he also explained that prior to coming to MAU, he had not really ever thought about race, because he had never needed to. He shared that he began to think more about his students' races when he noticed patterns of racial groupings in his classrooms, but still was not sure how to think of himself as a racialized person. In our final focus group, he added that "I started to think about [racism] because here, I'm one of the minorities, right?" But he also felt like because of the large number of Asian international graduate students in the mathematics department, he did not necessarily think of himself as a minority who experienced racism in the same way that Black students did. Lin shared a similar perspective during her individual interview when we discussed racial diversity and the experiences of people of Color in the mathematics department at MAU. Lin shared—as many other participants did—that there was a noticeable lack of Black students in the mathematics department, which may lead to them feeling isolated. She then asked a clarifying question about whether Asians were considered people of Color. I responded affirmatively, and she said:

> Oh, for Asians, then it's okay *[laughs]*. There are lots of Asian students in our department. Oh, okay. So, so there's no, no no no. I feel there's no, no, no no hate, because lots of Asian students are very good at *[laughs]* very good at math, I feel.

Like Jun, Lin felt that although she might be considered a person of Color, she did not share the same experiences as underrepresented students of Color in the mathematics department., due to both the demographic representation of Asian students in the department, and how Asians were viewed in relation to mathematics, as opposed to other racial groups. Additionally, Lin also seemed to correlate racial discrimination and racism with hate, rather than viewing it as a structural phenomenon.

Because Asian international students did not necessarily see themselves as people of Color, and recognized there were differences between their racialized experiences—as well as their mathematical experiences—and the experiences of underrepresented students of Color in the mathematics department, they were unsure what they should do to help undergraduate students of Color. They felt that they did not understand underrepresented students' of Colors experiences, and could only guess at the ways they could better support these students. Yuanjun, for example, shared:

> I don't really think about my race [when I teach], because I don't think that's really a problem. But I guess sometimes I could care more for those people in Color because I know that it's a little bit difficult to—for them. To take those classes. So I guess they need to be encouraged more, I guess.

Yuanjun shared that race was not an identity that was particularly salient for him, and as such, it was not an identity that he thought about when interacting with his students. He felt as though he was not necessarily racialized or discriminated against, but recognized that his underrepresented students of Color may feel that race is a more salient identity to them, and wondered whether he should attend more to their racial identities. Similarly to Yuanjun, all of the other Asian international participants shared that they did not often think about their own racial identities when they taught, because race was not a particularly salient identity for them. What was salient to them was their international status and their nationality, and rather than thinking about their race when they taught, they often instead thought about their accents and their English proficiency.

Since race was not a salient identity for the Asian international participants in this study, and they did not feel as though they understood the racialized experiences of underrepresented students of Color, participants also struggled with how to appropriately support these students. Since they felt as though they had to guess at how to best support their undergraduate students of Color, they also worried that they might do so in a way that was offensive. Eunji, for example, explained:

> I came from South Korea, which, um, we don't really have many different um, nationalities mixed in. Like almost no Black or Brown students, or like, even whites. And like, no—not many other races in—um, mixed up in my country. So, um, one, one thing is, I don't really—I'm not—I cannot consider myself less. Like I—that I know what they're going through, like what racial discriminations they go through. So, I feel like I cannot really presume anything they, like they specifically need, because I don't really know much about the differences between us. Um, so like, for now, my best is I think, just not to um, not to *[laughs]* treat them differently. Yeah. Um, I, I'm not sure, like I—if I know better, like—I, I’m not, I'm not sure whether—um, because I have a different race

> than them, I… I think it could, it could be even like, offensive if I were to treat them differently. That's, that’s what I think.

Eunji felt that because she did not have experiences of racial discrimination, she could not necessarily empathize or understand what undergraduate students of Color were going through. She worried that it would thus be presumptuous of her to assume what they had experienced, and did not want to offend students by assuming they experienced any forms of racism unless they told her that they did. As such, she felt the best thing that she could do to support students of Color was to treat all of her students equally.

The Discomfort of White Privilege and Fears of “Messing Up”

Overall, the Asian international GTAs in this study felt that they were privileged to be Asian in the mathematics department, and felt that they could not understand the racialized experiences of underrepresented students of Color. As such, they felt that their own racial identities were a barrier that they faced in supporting undergraduate students of Color. Although the white participants in this study felt similarly—in that their racial identities were a barrier they faced in supporting undergraduate students of Color—they had more developed racial literacies than the Asian international participants, and were better able to articulate and name the ways in which their whiteness privileged them, and how racism might operate in the mathematics department and affect undergraduate students of Color. Quin, for example, shared that they try to be aware of “the privilege that my skin gives me” and shared the following about what it meant to be a white GTA in the mathematics department at MAU:

> I think that [being white in the mathematics department at MAU] … it—what’s the word… like, it’s, it’s a—means I have the privilege of not having to engage with the challenges that people of Color face in mathematics. It means that I may have more

access to spaces that people of Color may not have much access to. And like, access to like conversations that might not happen. And um… yeah. It's, it's a responsibility… [and] being a white graduate teaching assistant is… to be a… I mean, you're, you're the face of like, the department, the face of enforcement of department policies. And… that's… yeah, like you have somehow so much power and yet, like… it's hard to… and yet you don't have that much leverage within the department. And yet, like yeah, you know, it's like, saying that you have no power isn't true either, and so it's like, yeah. You, you—it's like, again, you have a responsibility to like, be equitable and fair to your students… but that—the department doesn't make that easier.

However, while they recognized many of the responsibilities that they had in being a white GTA in the mathematics department at MAU, they also felt like they were limited in a lot of ways by departmental policies, and weren't sure how much they could do as an individual, and did feel like because their racial identity as a white person meant that they couldn't fully understand what students of Color were going through, and how to best support them.

With the exception of Caleb, who did not think race affected undergraduate students of Colors' experiences in the mathematics department, the other white participants shared Quin's sentiments, though they expressed more discomfort than Quin when talking about race and racism because they were white. When asked to describe a time when he had noticed a student of Color might have felt uncomfortable or marginalized in a math course at MAU, for example, Logan shared:

That's a really good question, and to be honest… I'm not sure I can, just because it, it never really felt like that was something that you could talk to your students about. Um, I mean if they came to me about it, that would be one thing, but I never wanted to broach

> subjects like that, on the grounds that it just seemed kind of personal… Yeah, um, I don't know. [Racism] is, it’s a, it’s a really, [laughs] uh really difficult thing to talk about, particularly since obviously as a white guy, I haven't really faced it at all. So um, I don't—I can't—I don't know really what people's subjective experiences are.

Because they felt limited by their whiteness, the white male participants also worried—like Eunji—that they might make wrong assumptions when trying to support undergraduate students of Color and notice the influence of racism in the mathematics department. Declan, for example, shared that he wanted to be able to figure out how to address racial disparities in math, noting that doing so was up to the people in the field, because “the math doesn’t care”. He thus shared that while he tried to be aware of when students of Color might feel marginalized or uncomfortable in his class, that “it’s a hard thing to like… you don’t wanna, you don’t wanna *mis*-notice. You don’t *[laughs]* wanna—you don’t wanna notice incorrectly, cuz that’s, that’s just as bad.” He worried that if he incorrectly assumed that an undergraduate student of Color was feeling isolated or marginalized in his class, and tried to do something about it, that he might ultimately then be the one discriminating against or marginalizing that student. As such, Declan felt more comfortable supporting students based on other identities they had, such as their high school backgrounds and mathematical preparedness.

Several white participants ultimately worried that if students did not come to them about experiences of racial discrimination or marginalization, that it might not be their place to try and do anything, because they did not want to offend students or end up being discriminatory themselves. However, they also felt that relying solely too much on students to come to them could be an issue, as they did not want to put extra labor on students of Color when they also knew they had a responsibility as white people to educate themselves. Cody elaborated on this tension, sharing:

> And then like, how do you bridge the gap, such that like, you can relate with students without crossing any sort of lines as well. Like, trying to make that—or every once in a while talking with people—like, “I'm tired of people trying to do something here, or trying to say this, but it actually comes off really poorly.” ... Yeah, you don't want to say the wrong thing as well, cuz like, um, say, certain situations, you're like, “I don't wanna be the person where you always ask me, like, ‘Hey, is that okay. Hey, is that okay? Hey, is that okay?’ Like I’m not your—I'm not here to educate you on everything.”

Cody was afraid of “crossing any lines” with his students of Color, and recognized that despite good intentions, he could end up having a negative impact on his students of Color in trying to better support them. He also did not want to put unnecessary labor on his students of Color to educate him, and recognized that this was often something that well-meaning white people did. He also worried that specifically attending to the needs of undergraduate students of Color might be unfair to other students. Due to all of these concerns, Cody felt a bit stuck, and lamented, “I wish I had more *[laughs]* resources for this.”

The lack of resources participants felt that they had in teaching undergraduate students of Color and trying to combat racism in mathematics spaces was something that they named as a barrier to supporting undergraduate students of Color. Logan, for example, shared:

> Yeah, I totally agree. I was gonna add, on the side of barriers—I don't know if it's a real barrier—but I think, you know, when people think about this topic, they mostly think, “Well, I'm gonna keep my head down and not ever bring it up basically.” And I think that is a, a kind of impediment to, yeah, any changes…. [and] I would just add that it's, it’s

> inter—I mean, cuz everybody, you know, feels like they want to be in a position of uh, combating these things, but nobody quite knows how.

Participants did not feel as though the mathematics department provided any resources around racism in mathematics spaces, and how to support undergraduate students of Color, because addressing diversity and racism was not a priority of the department. Quin noted that there were not many departmental initiatives to diversify the department, and that prior diversity initiatives they had seen in the past were due to the efforts of individual professors of Color.

Structural Barriers and a Focus on All Students

Overall, while participants recognized that race likely negatively affected undergraduate students of Colors' experiences and sense of belonging in the mathematics community at MAU, their ability to support undergraduate students of Color as white and Asian GTAs was limited in a lot of ways due to systemic racism and the limitations of their individual power in the department. As Quin shared in the final focus group:

> Yeah, I think, um, yeah, like we've been saying, like so many of the major issues are systemic, and so that's not something that just one individual can really fix. Especially since graduate students don't have um, institutional power in the department for the most part.

Participants felt strongly that because there was only so much they could do as individual GTAs who did not identify as underrepresented students of Color, the department had a responsibility in trying to increase diversity and inclusion in the mathematics community, and support undergraduate students of Color from a more structural perspective.

One way in which participants felt like the mathematics department could address diversity and inclusion from a structural perspective, and reduce racial discrimination and racism in the mathematics community, was to increase the racial diversity of GTAs. Jun noted for example, that while we spoke about how to support undergraduate students of Color in our focus groups, that the focus group was not very racially diverse—though this was representative of GTAs in the mathematics department. He stated:

> Here, in our discussion, probably we have only like, two or three like, ethnic groups, here. Like white, Asian. Oh, I know Aditya is Indian, so probably three. Not, not any other races. So, basically, students of Color don't have um, role models. For example, we don't have—probably, we have some, like, very few Black TAs. I guess—well, like, students feel more comfortable with Black TAs, because they share some cultures. Right? So that's why I was curious, I mean, about like, students' attitudes like, toward faculties and TAs, because they barely find, um, TAs of Color, except for Asians probably. And Indians.

Implicit in Jun's comments are that while we could theorize how to best support undergraduate students of Color in our focus groups, participants still faced barriers due to their own racial identities, and that undergraduate students of Color would likely benefit more from having GTAs who shared their racial identities and understood their racialized experiences. He felt that the best thing that could be done to improve diversity in the mathematics department, and to improve the experiences of undergraduate students of Color in the mathematics community, was to diversify the instructor workforce.

Logan felt similarly to Jun in that structural change in diversifying the instructor workforce was needed in the mathematics department. Although he was not able to attend the fifth focus group, where we talked about what undergraduate students of Color—and particularly, Black and Brown students—need from their math instructors, he shared his thoughts via email, writing:

> Mostly I think they need more of their instructors to look like them. I think that would be the single biggest improvement we could make to their education, and certainly to their likelihood of becoming more interested in mathematics. Obviously a single instructor can't do that, so restricting our view to a single instructor I think some things that particularly help minority students (but are pro-student in general) are flexibility (postponing tests when needed, accepting late work without too much or even any penalty), availability (both in schedule and demeanor), and emphasis on improvement in the classroom (I gave earlier the example that the final could replace a bad first midterm, for example).

While Logan did believe that structural change is needed within the mathematics department at MAU, he also believed that there are still things that individual instructors might be able to do to support their undergraduate students of Color. However, because of the racial limitations of most GTAs in the department—who are predominantly either white or Asian international students—he described ways in which GTAs can be more intentional in supporting all students, rather than focusing specifically on students of Color.

Other participants echoed similar sentiments to Logan, in that the best way to support undergraduate students of Color, given their own racial identities, was to focus on building relationships with all of their students, and be more student-centered in general and focus on their teaching as a whole. Declan, for example, shared that he wasn't sure how much to talk explicitly about race and racism with this students, questioning:

> Uh, and, what—and in a sort of like, do I have a very open, straightforward like, immediate conversation? Or like, you know, set the norm of, you know, not talking about these things? And like, you know, sort of taking the uh, "Just like, be a good teacher first," approach?

He ultimately concluded that the best thing he could do was to focus on being a good teacher who saw his students as people first and foremost, and that the rest would follow. While Quin acknowledged the difficulty that Declan expressed in figuring out how to navigate confronting racial inequities and racism as a white GTA, they also pushed back a bit on the idea of seeing students as people first without acknowledging their racial identities, sharing:

> It's hard to figure out how to do more, but I—like…I, I, you know, I don't—like, if you're seeing someone for who they are, like, who they are is gonna be impacted by their like, racial and other social identities that they have to deal with in their lives. Um, yeah, I mean, just like, it would be—like it'd be weird for someone to say like, "Oh, I don't see gender," like and, and also claim that they're seeing all of who I am.

Because of the salience of their marginalized gender identity, Quin felt that it was important to acknowledge students' social identities as part of their humanity, but like other participants, struggled with figuring out how to do so as someone with a white racial privilege.

As a whole, participants felt that the best—and safest—course of action in supporting undergraduate students of Color was to improve their teaching and be more student-focused in general. Aditya, for example, felt similarly to Declan and Logan, in that focusing on his relationship with all students, and trying to be a good and approachable teacher, would hopefully lead to students of Color feeling more welcome in his classroom, without singling them out. He shared his goals for future teaching assignments as a result of participating in this study:

> I would like, make more effort to connect with the students… So maybe like, going further, I would like, try to uh, create more opportunities in—even in such setting to be able to interact with the students more, so that if students like, feel more comfortable, uh, asking questions—like, not just like a coup—few students who usually ask—but even other students who usually shy away from asking questions, like, are able to uh, do that and hopefully reduce the, the uh, the chance of inequalities that already exist.

Aditya then shared that another big takeaway for him from participating in this study was to recognize some of the structural racial inequities that existed within the mathematics department at MAU, which was something that was echoed by many of the other Asian international participants in this study. They felt as though having a space to talk about these issues was illuminating for them and important in developing their racial literacies and critical consciousnesses, as they did not have many opportunities to do so outside of this study.

For all of the participants, being part of a larger community of GTAs was something that had drawn them to this study, and something that they left this study feeling hopeful about. Because teaching was a fairly isolating and deprioritized responsibility in the mathematics department at MAU, and because the department was so large and decentralized, participants appreciated having opportunities to discuss these topics with other GTAs in the department, and felt as though forming these connections was one of the first steps in being able to create a positive change for undergraduate students of Color. As Yuanjun shared in our final focus group, something that he was taking away from this study was that:

> Um, for me I guess, um, one of the important point, I think, is that being aware, being aware of those problems in the department is important I guess. Like, um, you have to like, talk with your fellow graduate students because, well, some of them might not even

be aware of those questions—those problems—present, presenting in the department. So you have to like, say it out loud. So. That's it.

Theme 4 Summary

Participants ultimately did not feel as though they arrived at any concrete answers as to how to best support undergraduate students of Color, but they did find that having a space to talk about issues of race in the mathematics department—as well as issues with teaching more generally—was a helpful place to start. While participants largely recognized their racial privilege and how they felt better integrated into the mathematics department as a result of their racial privilege, they struggled with how they could best support undergraduate students of Color specifically, given their own racial identities. As a result, participants felt that focusing on building relationships with students and being more student-centered in general—-and thus, supporting their undergraduate students of Color by way of supporting *all* of their undergraduate students—was the best course of action they could take given their own racial identities.

Summary of Findings Chapter

Over the course of this findings chapter, I have provided a written portrait of the mathematics department at MAU, which helped to contextualize the four thematic findings that resulted from this study. These four themes are listed below:

- Theme 1: A Culture of Individualism and the Hidden Necessity of Social Ties
- Theme 2: The Valuation of Teaching as a Means of Doing Research
- Theme 3: Attempts to Shift Narratives of Mathematical Success
- Theme 4: Identity Tensions in Supporting Undergraduate Students of Color

As these themes detailed, participants struggled in explicitly naming aspects of the departmental culture, due to the ways in which its size and decentralization—which reflected mathematics as a field—-promoted a culture of individualism. This culture of individualism shielded the necessity of social ties, and the barriers that students of Color faced in forming the social ties necessary to successfully navigate the department. Additionally, although participants struggled in naming shared values in the department, it was clear that research and a deep love of "real math" was a shared value in the department due to its position in a research-1 institution. Most faculty and doctoral students were at MAU to pursue research, which resulted in a departmental deprioritization of teaching, as teaching was only valued to the extent that it allowed for research to be pursued. Despite teaching not being particularly valued—and thus, not prioritized—by most instructors, the participants in this study wanted to be good teachers and shift narratives of mathematical success to help support their undergraduate students. However, while participants had several opportunities to support their undergraduate students and shift narratives of mathematical success, they also faced several barriers in doing so. They faced further barriers in specifically supporting their undergraduate students of Color due to their own racial identities. As such, they concluded that the best way they could support their undergraduate students of Color was to focus on the ways they could be good teachers for *all* of their undergraduate students.

CHAPTER 5: DISCUSSION

In starting off this chapter, it is helpful to restate the overarching research question that drives this study, as well as the four sub-questions that comprise this study. The overarching research question this study seeks to explore is: how do GTAs serve as agents of mathematics socialization for undergraduate students of Color at an HWCU? The four subquestions are as follows:

1. How do GTAs describe the culture (e.g. values and practices) of the mathematics department/community?
    a. Do they align with this culture or want to break from it?
2. What opportunities do they face in breaking from those values and practices?
3. What constraints do they face in breaking from those values and practices?
4. Does the way they discuss their own values, practices, and goals reinforce whiteness & the consolidation of power along a racialized hierarchy in the department, or does it have the potential to make positive changes for undergraduate students of Color?

The main findings in the previous chapter address questions 1, 2, and 3. As a reminder, the four main findings discussed in Chapter 4 were:

1. The decentralization in the department leading to a culture of individualism, which obscured how power operated and hid the necessity of social ties.
2. A deep love of math creating a divide between teaching and research, and an ultimate lack of support for—and deprioritization of—teaching.
3. Opportunities to try and change narratives about mathematical success and messaging to undergraduate students, but constraints from a lack of institutional power and expectations around undergraduate mathematics education.

4. Good intentions in trying to help undergraduate students of Color, but a pivot to helping all students and focusing on general good teaching due to GTAs' own racial identities and limitations.

Findings 1 and 2 help to address the first research question, while findings 3 and 4 help to address the second and third research question, as well as question 1A.

As discussed at the beginning of Theme 4 in the findings chapter, undergraduate students of Color were not specifically centered in the first three themes, as participants were reluctant to talk about race until the later focus groups. Additionally, participants struggled to make connections between race, racism, and the mathematics department's norms, values, and practices that they described. Thus, the purpose of this discussion chapter is to bring together the findings as well as the theoretical perspectives and conceptual framework from Chapter 1 of this study to answer the fourth research question, and discuss all four research questions to try and explore the overarching research question. As such, this chapter is divided into three sections. The first section will use the findings as well as theoretical perspectives on racism, whiteness, and the literature from Chapter 2 in order to answer the fourth research question. The second section of this chapter will return to the conceptual framework from Chapter 1 of this study, and incorporate the findings and the Part 1 of this chapter to define the mathematics community at MAU and explore the opportunities and constraints GTAs have as agents of mathematics socialization for undergraduate students of Color—and thus, the overarching research question. Limitations of the conceptual framework, as well as implications for its future use, will also be discussed. The third and final section of this chapter will summarize the response to the research questions of this study (both the subquestions and the overarching questions), as well as limitations of the study.

Part 1: Intentions Versus Impact in Supporting Undergraduate Students of Color

The first part of this chapter bridges the theoretical framings from this study on race, racism, whiteness, and white supremacy with the findings of this study to address the fourth research question. As a reminder, the fourth research question is: Does the way they discuss their own values, practices, and goals reinforce whiteness and the consolidation of power along a racialized hierarchy in the department, or does it have the potential to make positive changes for undergraduate students of Color? Because participants had difficulty in describing how they specifically supported—or could support—undergraduate students of Color, it is necessary to first begin this chapter articulating the ways in which participants diverged from elements of the culture of the mathematics department to try and better support undergraduate students of Color more broadly. Thus, the first part of this section discusses the ways in which participants felt that the culture of the mathematics department was harmful to all undergraduate students. The second part of this section then utilizes theoretical perspectives and literature from Chapters 1 and 2 to describe how the culture of the mathematics department is particularly detrimental to undergraduate students of Color, and thus, why centering race and racism is important. The third part of this section then discusses participants' reluctance to center race, racism, and the needs of undergraduate students of Color particularly in their teaching practices. I then discuss why participants' desire to avoid centering race and racism in their teaching is particularly problematic for undergraduate students of Color, even though participants had good intentions and wanted to be able to support their undergraduate students of Color by way of supporting all students and being good teachers in a race-neutral way.

A Color-Blind and Race-Neutral Focus on All Undergraduate Students

It was clear that participants saw a myriad of ways in which the culture of the mathematics department was exclusionary and detrimental to undergraduate students, and that they wanted to be able to change some of these elements of the culture of the mathematics community. Some of the issues participants named, for example, were the ways in which social ties were a hidden necessity, how teaching was deprioritized in the department, and narratives about mathematical success—and thus, what it meant for undergraduate students to be able to be successful in a mathematics course. These elements were largely ones that also either currently affected graduate students, or had affected them as undergraduate students themselves; as such, they could empathize with undergraduate students around these issues, and this empathy was something that encouraged them to try and create change in the departmental culture for undergraduate students—albeit in a race-neutral way.

Social Ties and the Hidden Curriculum

One of the aspects of the culture of the mathematics department that affected graduate students and undergraduate students—and thus, that participants could empathize with—was the hidden necessity of social ties. Participants recognized and named how having social ties—whether with classmates, faculty, fellow GTAs, or administrators—was essential to their academic success, their ability to navigate the department and their roles as GTAs, as well as their sense of belonging in the department. They also discussed how not having social ties in the department would be detrimental to their doctoral trajectories. However, while some participants—like Quin and Eunji—were able to name the hidden importance of social ties in their individual interviews, others—like Declan—were not able to recognize the importance of social ties in their experience at MAU until the focus group conversations with other participants. As such, all participants agreed that the necessity of having social ties in the mathematics department was not something that was intuitive—and thus, how their importance was hidden—due to the individualistic and decentralized nature of both the mathematics department, and mathematics as a field. Moreover, recognizing the importance of social ties was not something that was explicitly told to them by the department, and was instead an understanding they arrived at through word of mouth, trial and error, or reflection of their own experiences and the experiences of those around them.

Thus, although they did not explicitly use this term, participants described the necessity of social ties in the department as a type of hidden curriculum (Apple, 1982; Jackson, 1968; Margolis et al., 2001). As Alsubaie (2015) explains:

> A hidden curriculum refers to the unspoken or implicit values, behaviors, procedures, and norms that exist in the educational setting. While such expectations are not explicitly written, hidden curriculum is the unstated promotion and enforcement of certain behavioral patterns, professional standards, and social beliefs while navigating a learning environment [Miller & Seller, 1990].

One of the primary issues with hidden curriculum is reflected in its name; because hidden curriculum is hidden—and thus, not explicit to all students—those who are not aware of, or do not understand, the hidden curriculum, are at a disadvantage in navigating the learning environment. Declan noted the way in which not having knowledge of the hidden curriculum could have disadvantaged him in the focus group where he recognized the importance of social ties in his experiences as a GTA, when he had remarked that "it could be so easily that I was not as well-connected through word of mouth, and if I wasn't connected through word of mouth, I don't know where I would get this information."

While Declan did not explicitly recognize social ties as being part of the hidden curriculum at first, other participants, such as Quin, did. Quin also recognized the importance of making the hidden curriculum around social ties explicit, and believed that other graduate students felt similarly; as such, they had shared how older graduate students try to tell incoming graduate students how important it is to make and rely on social ties in the department. Interestingly, other participants did not share similar sentiments; while they recognized the importance of social ties, and acknowledged how this importance was part of the hidden curriculum, they did not name making the hidden curriculum explicit as something that they necessarily prioritized-either for graduate or undergraduate students. Cody, for example, named the ways in which having social ties was clearly important for undergraduate students, and mentioned how not having social ties could be detrimental for them, but did not mention whether as an instructor, he tried to make the importance of social ties explicit to his students.

Perhaps part of the reason that most participants did not name making the hidden curriculum of social ties explicit to undergraduate students was because they were "insiders" to the hidden curriculum, and benefited from it. Because the hidden curriculum is implicit, participants may not have entirely been consciously aware of how the hidden curriculum operated, especially because of how normalized and accepted it was to them as insiders who were knowledgeable of the hidden curriculum. Moreover, some participants were able to name when they realized that social ties were important, and that working alone was not conducive to success or sense of belonging in the mathematics department at MAU or at their undergraduate institutions. As such, they may have seen recognizing the importance of social ties as somewhat of a rite of passage for mathematics students, and that undergraduate students ultimately had to realize on their own the way participants did themselves. Regardless of the reason, it was clear that while participants saw the hidden importance of social ties as a potential barrier to success in the department for both undergraduate and graduate students, they did not see it as one of the primary issues in the culture of the mathematics department that affected undergraduate students; as such, they saw it as something that was a part of the departmental culture, but not something that necessarily needed to be changed from a structural perspective.

Good Teaching and Graduate Socialization

While the hidden necessity of social ties was an element of the culture of the mathematics department that participants saw as potentially problematic, but not urgent to address, there were other aspects of the culture of the department that participants felt more strongly needed to be changed in order to better support undergraduate students. The two main aspects of the departmental culture that participants felt most strongly affected undergraduate students—and felt most strongly about trying to change —were the departmental deprioritization of teaching, and the narratives about mathematical success. Both of these issues were aspects of the departmental culture that participants did not align with, and that they felt presented direct barriers to undergraduate student success. The departmental deprioritization of teaching, for example, meant that faculty often opted to try and minimize their own teaching workloads through continuing to use traditional, transmissionist, instructor-centered methods of teaching. These policies and practices were criticized by participants as being unhelpful for undergraduate students' learning, and in some cases, inconsiderate and disrespectful to students' experiences and lives outside of the mathematics classroom. Declan, Eunji, and Cody, for example, all described instructor policies and modes of communication that were inconsiderate of students' health concerns in the aftermath of the COVID-19 pandemic. Quin and Eunji also both noted how faculty did not seem to have an accurate gauge on the amount of work students were expected to do for a course, versus their other capacities and priorities. At one point, Yuanjun directly described faculty who minimized their own labor as “not caring enough about our students.”

Participants’ perceptions of traditional, instructor-centered, and minimal-effort approaches to teaching courses as being unhelpful to students are aligned with the body of research on STEM students’ perceptions of poor instructional practices in the disciplines, most notably, Seymour and Hewitt’s (1997) seminal study of undergraduate students who either stayed in the science, mathematics, and engineering fields, or switched out. Seymour and Hewitt (1997) found that one of the four most commonly cited reasons undergraduate students switched out of STEM fields was due to poor teaching by faculty. Participants in Seymour and Hewitt’s (1997) study described ways in which instructors seemed to put minimal effort into their teaching, and either did not have an awareness of, or did not care about, student’s understanding of the material, or proper pacing and workload for a class. In other words, they felt that instructors taught according to what made sense to themselves, and put minimal effort into trying to create and communicate class content in ways that were accessible, appropriate, and understanding of students—not unlike the ways that participants in this study described faculty’s approaches to teaching in the mathematics department at MAU. In recounting the originally 1997 study, Seymour et al. (2019) also noted that “both switchers and seniors recounted experiences from which they inferred that STEM instructors avoid contact with undergraduates, are indifferent to their academic problems, dislike teaching, and lack motivation to do well” (p. 11), which also paralleled the way participants in this study described the departmental deprioritization of teaching, and how faculty interacted with undergraduate students outside of class.

Participants' discussions of what they tried to do in their own teaching practices to better serve undergraduates—as well as what they wanted to be able to in an ideal setting—were also consistent with the literature on best teaching practices in undergraduate STEM courses. Students in Seymour and Hewitt's (1997) study, for example, felt that good teachers were more student-centered; they showed care and respect for their students and made time for them, and held classes that were more discussion and inquiry-based. Other studies on the correlation between pedagogical practices and student attitudes and persistence in undergraduate mathematics courses also highlighted the importance of discussion based, interactive courses, responsiveness to student questions and concerns, providing extra resources and support, appropriate pacing and workload, and assessments that required students to explain their mathematical thinking, rather than solve rote problems (Ellis et al., 2014; Gasiewski et al., 2012; Sonnert et al., 2015). All of these student-centered practices were ones that GTAs in this study either enacted, or wanted to enact in their classrooms—but felt that faculty did not. Indeed, the transformative class Logan served as a GTA for (which had restructured discussion sections to replace lectures with additional problem-solving) was led and redesigned by a fellow doctoral student who was passionate about teaching.

While participants did want to diverge from traditional modes of teaching to better serve their undergraduates, there was a general acknowledgement that student-centered instructional practices required a lot more work than relying on traditional modes of teaching. Most participants wanted to be open and accessible to their students, cared about soliciting feedback, and wanted to be sensitive to the things that were going on in their lives, even if it was less "convenient" for them—as Eunji explained. They also wanted to try and make interesting lectures, and disliked the outdated worksheets that their course supervisors provided them with, as they felt they were disconnected from what students were learning in class. Participants also did not want to "teach to the test"—which Cody felt particularly strongly about—and wanted to be able to engage their students in deep mathematical discovery and thinking. However, most participants had a limit to how much extra work they wanted to do in order to adopt more student-centered practices, especially since research was their main priority, and teaching was still a means to be able to do research—and thus, a job and a responsibility, rather than a passion—at the end of the day. Cody was the main exception, in that he was passionate about trying to implement active learning in his courses, and sought out resources and support in doing so. He also turned down opportunities to be funded through a research assistantship, and wanted to continue to serve as a GTA to try and restructure undergraduate courses. The amount of work that Cody put into trying to restructure such courses, however, was further exacerbated by student expectations of instructors; as participants explained, student expectations for how courses should be taught was another challenge that took effort to navigate.

It is unsurprising that GTAs were critical of traditional modes of teaching, and that this was an element of the departmental culture that they wanted to change. Having been undergraduate students more recently than faculty were, and having still been students in graduate classes, participants were able to empathize with the impacts of "poor teaching" from the student perspective. Although they themselves had been successful as mathematics students, they wanted to create environments where students did not have to navigate poor teaching as a barrier to mathematical engagement and success. Moreover, because they were often supervised in their GTA roles by faculty members, they were directly impacted when faculty offloaded labor onto them in order to minimize their own workload. Thus, it made sense that they wanted teaching to be more of a priority in the mathematics department, and why they wanted to enact more student-centered practices and pedagogies.

However, it is also unsurprising that the majority of participants only wanted to try and change their teaching practices to the extent that the amount of work required would not interfere too much with their primary goal of research—this is directly in line with socialization into graduate programs. As Weidman et al. (2001) explain, while novice graduate students may enter their programs with values, beliefs, and attitudes that are oppositional to their graduate programs' normative culture, they must negotiate their values and the normative values of their program in order to be successful in their programs. In context, this meant that participants could not be successful as doctoral students at MAU unless they prioritized their research over their teaching, and while they could strive to be good teachers as part of the values negotiation process, it could not be at the expense of research. Indeed, Quin—the only participant in this study who planned to leave the graduate program—planned to leave because they cared more about teaching than research, and did not want to continue to prioritize their mathematics research. Other participants admitted that while they felt strongly about being good teachers, they would deprioritize their teaching further if their advisors told them it was necessary to do so.

Normative Mathematics Identity and Mathematical Authority

Participants' critiques of the departmental deprioritization of teaching were also connected to the second cultural element of the department that they felt most strongly affected undergraduate students, and that they felt most strongly about trying to change: narratives about mathematical success. All of the participants recognized that there existed stereotypical notions of "math people," and the necessary qualities to be successful at math—namely, intrinsic mathematical ability, and agility in grasping concepts and solving problems. Participants also recognized that due to the innateness of these qualities, part of the stereotype about "math people" was that it was a dichotomous identity—you either were a "math person," or you were not a "math person". According to participants, there were certain aspects of the culture of the mathematics department at MAU that reinforced the stereotypical concept of a "math person," such as narratives from faculty that there were certain "types" of students (such as the narrative that Logan heard from faculty that "some students are C students," or negative views of Algebra and Trigonometry students' mathematical abilities), or how the way that high-stakes exams were constructed and graded promoted the idea that if you were not quick and intuitive, you were not good at math (which Aditya strongly felt should be changed).

All of the participants rejected the notion of the stereotypical "math person," and critiqued the elements of the departmental culture that supported this stereotype. They believed that the stereotypical narratives about "math people" were both exclusionary and false; while they did believe that there were people who did have innate mathematical ability and agility, they felt that being good at math had more to do with persistence, patience, and hard work. However, because they recognized the pervasiveness of stereotypical narratives about "math people," they also realized that undergraduate students likely assessed their own mathematical abilities and mathematical potential through the lens of the stereotypical "math person." In other words, participants recognized that undergraduate students who did not grasp mathematical concepts intuitively, and who could not solve problems quickly, likely felt that they could not be "math people," and as such, faced a mental barrier in being successful in mathematics courses.

In describing stereotypes about "math people" and how undergraduates saw themselves—and thus, their mathematical abilities—in relation to the stereotypical "math person," participants were essentially describing undergraduate students' mathematics identity development. Moreover, through the concept of the "stereotypical math person," participants describe Cobb et al.'s (2009) notion of normative identity in the mathematics department at MAU. Building off of Martin's (2000) original framework, which was discussed in Chapter 1, Cobb et al. (2009) define a normative mathematics identity as "a collective or communal notion" (p. 43) that is established in an environment and "comprises both the general and specifically mathematical obligations that delineate the role of an effective student in a particular classroom" (p. 43). While they focus specifically on classrooms in their original paper, Cobb et al. (2009), also make it clear that their interpretive scheme is meant to extend the school level of Martin's (2000) framework; since the school-level in the modified framework in this study corresponds to the department-level forces of socialization, it makes sense here to discuss normative identities in the context of the mathematics department. Participants seemed to describe the normative math identity at MAU as a stereotypical one, wherein effective students are ones who enter the university taking higher-level math classes (as opposed to lower-level courses like Algebra and Trigonometry), grasp concepts quickly and intuitively, and perform well on exams. Thus, undergraduate students who do not identify with the normative math identity may develop personal math identities that either cooperate or resist the normative math identity (Cobb et al., 2009), though there may be consequences in doing so, such as "becoming disenchanted with or alienated from mathematical activity" (p. 48), or in this case, mathematics at MAU. Given how much of an undergraduate student's academic trajectory is contingent on traditional success in the mathematics department at MAU, it is likely that undergraduate students at MAU whose personal identities do not align with the normative identities have a more difficult time achieving their academic goals.

Participants' beliefs that they could try to communicate new norms to their undergraduate students through classroom practices, policies, and interactions during office hours reflect a larger belief that they had some power in changing the normative mathematics identity in the department. In turn, the belief that they had some power in changing the normative mathematics identity in the department indicates that they recognized the mathematical authority they had in establishing normative identities, due to the distribution of authority in the mathematics department. As Cobb et al. (2009) explain, the distribution of authority is one of the primary ways in which normative identity in a learning environment is established, and define authority in the following way:

> Authority concerns the degree to which students are given opportunities to be involved in decision making about the interpretation of tasks, the reasonableness of solution methods, and the legitimacy of solutions. Authority is therefore about 'who's in charge' in terms of making mathematical contributions. For example, authority in some classrooms is distributed only to the teacher, who is solely responsible for determining the legitimacy of student responses. In other classrooms, authority is distributed more broadly, with students and the teacher jointly determining the legitimacy of contributions by relying on mathematical argumentation (p. 44).

Given the traditional styles of teaching that were dominant in the department, authority was clearly distributed to instructors; indeed, several participants explicitly stated that they knew their undergraduate students saw them as a "math person" who held mathematical authority.

Participants' recognition of this power, and their attempts to try and change narratives about what it meant to be good at mathematics, is also consistent with the teachers in Martin's (2000) study, who served as agents of mathematics socialization. However, like the teachers in

Martin's (2000) study, and as Cobb et al. (2009) warn of, participants found themselves battling other contextual forces of mathematics socialization in trying to change the normative narratives around mathematics. Additionally, since participants felt as though they went against departmental norms when it came to caring about teaching, they likely had less mathematical authority within the department on a numerical level, which made it more difficult to change the normative mathematics identity. As GTAs, they also had very little control within the department when it came to setting policies and practices—such as the curriculum, pacing, or the exam-based, format of courses—that contributed to the normative mathematics identity in the department, and were usually supervised by professors who led courses, which limited the mathematical authority participants had, even further. Interestingly, it is possible that some participants, such as Cody, may have recognized this difficulty on some level, and felt that a better use of energy in changing the normative mathematics identity was not to try and use their own authority to shift the normative mathematics identity, but to try and redistribute authority by trying to shift towards active learning environments. Perhaps those participants also felt that they did share mathematical authority with their students, and that was also why they felt that student expectations of instructors were particularly difficult to navigate.

Adding Race to the Equation

While participants were able to name these three ways in which the culture of the mathematics department negatively impacted undergraduate students, they discussed many of these issues in a race-neutral way. Participants largely described how each of these issues that they saw in the mathematics department had negative impacts on *all* undergraduate students, and did not organically focus on undergraduate students of Color in particular. However, through the interview and focus groups conversations, they were able to connect these issues that they named to the lack of racial diversity and inclusion in the department, and were thus able to postulate how these issues might differentially impact undergraduate students of Color. For example, they described how the lack of racial diversity may make it more difficult for undergraduate students of Color to form social ties, how the departmental deprioritization of teaching disproportionately impacted undergraduate courses that enrolled larger numbers of undergraduate students of Color (such as Algebra and Trigonometry), and how narratives about mathematical success in the department might be connected to racialized stereotypes about undergraduate students of Color (e.g. that they are not as good at mathematics).

However, although participants could name the ways in which the lack of racial diversity—as well as the distribution of people of Color along a hierarchy—in the mathematics department at MAU exacerbated the impacts of the hidden necessity of social ties, the departmental deprioritization of teaching, and narratives about mathematical success, they did not recognize the ways in which systemic racism and whiteness influenced each of these issues. Interestingly, there were participants who recognized that both systemic and interpersonal racism was present in the mathematics department. They were able to discuss how systemic racism in the field of mathematics, in mathematics education, and in the mathematics department contributed to the scarcity of racial diversity along a hierarchy in the department, and many participants could also speak to how the lack of racial diversity, systemic racism, and interpersonal racism might affect the mathematical experiences and trajectories of undergraduate students of Color. Where participants struggled was in explicitly connecting systemic racism, a lack of diversity, and how the issues they named disproportionately affected undergraduate students of Color. In other words, while participants understood how racism might operate in the mathematics department from a more abstract and conceptual level, they were not able to make explicit and concrete connections to name how aspects of the culture of the mathematics department at MAU—such as the hidden necessity of social ties, the departmental deprioritization of teaching, and narratives about mathematical success—were both products and perpetuators of systemic racism and whiteness.

The Hidden Curriculum and the Normalization of Whiteness

While the hidden curriculum surrounding social ties was detrimental to any undergraduate student who was not well-connected in the department, or who believed mathematics to be an individualistic discipline, the hidden curriculum in the department surrounding social ties was particularly detrimental for undergraduate students of Color. As discussed in the prior section, participants were able to make connections between the lack of racial diversity in the department, and the difficulty for people of Color in the department to make social ties and be well-connected within the department. Many participants largely recognized that it was easier for them to make connections and feel comfortable in social spaces within the department, due to being surrounded by people who shared their racial and cultural identities, and because they did not experience microaggressions or instances of overt racism from others in the department. Participants' perceptions of the mathematics department being more socially isolating for people of Color due to a lack of racial diversity, as well as racialized microaggressions, is consistent with the literature on the "othering" experience that many students of Color face in the STEM fields due to their numerical scarcity and racialized stereotypes in STEM (Beasley & Fischer, 2012; Blosser, 2019; Dortch & Patel, 2017; Lee et al., 2020, Malone & Barabino, 2008).

Participants also recognized how the racial dynamics they saw at the graduate student level extended to undergraduate students' experiences; for example, they posited that the lack of

Black people in the department at all levels may have left Black undergraduate students feeling isolated and marginalized in the department, which is consistent with the aforementioned literature. Participants also noted that their students of Color tended to either work together in isolation from their peers, or struggled to find groupmates if they were the only student of Color in their class. While participants were not entirely sure why their students of Color tended to work in isolation rather than in cross-racial groups, other studies have found that Black students tended to have difficulty forming cross-racial study groups in STEM due to the combination of their numerical scarcity and racialized departmental climates (Blosser, 2019, Burt et al., 2018; Justin-Johnson, 2004). Park et al. (2021), for example, posited that "for Black students at predominantly White institutions, same-race organized study and friendship groups may be a more attractive option [than cross-racial groups], as well as a reaction to the underrepresentation and marginalization that Black students face in STEM" (p. 1162). In other words, it is possible that Black students may self-segregate in their math and STEM courses as a form of self-preservation in the face of isolation, marginalization, and racism in their departments.

As Park (2020) points out, what may be missing in noticing or discussing Black students' tendencies to group with peers of the same race when possible—or work on their own when this is not possible—is how white students also self-segregate. While Black students and other students of Color may group together as a form of self-preservation in the face of racial discrimination or exclusion from the self-segregation of white students, Park discusses how because whiteness is so pervasive and normalized, we are more likely to notice the self-segregating actions of students of Color rather than white students. As Tatum (1997) explains, part of the normalization of whiteness is that whiteness is often not conceptualized by white people as a racial identity; rather, it is just seen as normal and standard. Thus, the normalization of whiteness may be another reason why participants did not discuss the importance of making the importance of social ties explicit to undergraduate students, and why they did not see it as something that necessarily needed to be changed from a structural perspective. While they could see challenges to undergraduate students of Color forming social ties in the department, they did not see it as something structurally embedded in systemic racism and whiteness, because of the normalization of both the hidden curriculum of forming social ties, and the ways in which forming social ties was racialized.

The normalization of both the hidden curriculum of forming social ties, and the racialized nature of forming social ties, also meant that participants were also unable to identify the role of the hidden curriculum in systematically reproducing racism. As Margolis et al. (2001) explain, the purpose of the hidden curriculum is to reproduce social stratification—whether it be race, gender, class, or some other social identity. Drawing on Apple (1982), Margolis et al. (2001) explain:

> "A fundamental problem facing us is the way in which systems of domination and exploitation persist and reproduce themselves without being consciously recognized by the people involved" (Apple 1982, 13). Students encounter norms, values, and beliefs through the rules and practices that form the daily routines and social relationships in the classroom and the extended school. The hidden curriculum…must also foster faith in the putative "neutrality" of schools and the supposed "natural" environment of education and tolerance (p. 12).

Indeed, the hidden curriculum of social ties in the mathematics department at MAU was something that was not consciously recognized by participants; several participants were not able to name or see the ways in which social ties were key to successfully navigating the mathematics department, due to the individualistic culture of the department. The fact that they did not see explicitly naming the importance of social ties to their undergraduate students, perhaps because they saw it as a natural rite of passage that all students in mathematics must realize, also points to the naturalization and neutrality that the hidden curriculum fosters (Margolis et al., 2001). However, in not being able to name and expose the hidden curriculum around social ties, and perhaps even accepting it, participants were complicit in the hidden curriculum's role in reproducing social stratification in the department.

More specifically, the hidden curriculum in the mathematics department reproduced racial stratification, given the racialized nature of forming social ties in the department. This stratification is evidenced in the ways in which students of Color—and particularly, Black students—were at a disadvantage in being able to form the social ties necessary to be successful in the department. Moreover, as Moore (2008) notes, the hidden curriculum is also often manifested through physical space, and indeed, the physical space of the department was set up in a way that restricted students of Colors' abilities to form social ties. The design of classrooms in the department, for example, made group work difficult due to the size, weight, and number of desks in each classroom. There was also a lack of places to sit and congregate socially, except for restrictive spaces such as departmental lounges, which participants had described as being spaces where overtly racist sentiments were sometimes shared, making them unsafe for students of Color. As such, all of these elements of the hidden curriculum of social ties served to reinforce the notion that undergraduate students of Color could not be successful in the department, and as such, systematically reproduced racial hierarchies in the department.

The Myth of Meritocracy in Teaching Practices and Narratives about Mathematical Success

While GTAs were more critical of other aspects of the departmental culture—such as the deprioritization of teaching and narratives about mathematical success—they also did not recognize how each of these aspects of the culture operated in racialized ways that systematically excluded undergraduate students of Color from the mathematics community. Similarly to how participants recognized that forming social ties might be more difficult for undergraduate students of Color, they also recognized that the deprioritization of teaching and narratives about mathematical success might disproportionately affect undergraduate students of Color. However, they did not recognize the ways in which undergraduate students of Color were particularly impacted by the ways in which racism and whiteness interacted with these aspects of the departmental culture. Instead, they adopted race-neutral views of the impacts of the deprioritization of teaching and narratives around mathematical success, rather than foregrounding the role of race and racism in these elements of the departmental culture, and the subsequent impact of these exclusionary practices on undergraduate students of Color, specifically.

While it was true that the departmental deprioritization led to teaching-centered practices that negatively affected all undergraduate students, research has highlighted specific ways in which traditional modes of STEM teaching are specifically detrimental to undergraduate students of Color due to the racial dynamics that guide interactions in STEM settings (e.g., Johnson, 2007; Leyva, McNeill, et al., 2021; McGee, 2015). As discussed in a prior section, the deprioritization of teaching and transmissionist, teaching-centered practices cultivate impressions of faculty being inaccessible, intimidating, and uncaring. While such impressions can lead to attrition for *all* undergraduate students—as Seymour and Hewitt (1997) found in their seminal study, these types of teaching practices and subsequent impressions of faculty also create impersonal classroom environments wherein there is limited opportunity for faculty engagement, which disproportionately affects undergraduate students of Color. Positive student-faculty interaction has been found to be a key factor in the retention of undergraduate students in the STEM fields of any race, however, undergraduate students of Color typically experience higher rates of negative interactions with faculty (Park et al., 2019; Park et al., 2020). As such, there is greater risk for undergraduate students of Color to try and engage with faculty in these impersonal, transmissionist classroom environments; for example, the literature has shown that undergraduate students of Color may be particularly unlikely to ask or answer questions in large STEM lecture courses because they are afraid of confirming negative stereotypes associated with their race, and do not want to be perceived as less intelligent or capable by their professors or peers (e.g. Johnson, 2007; Leyva, Quea, et al., 2021; McGee, 2015). As such, the teaching styles that participants named as being prevalent in the department—and the consequential limitation of opportunities for student engagement in class—either lead to undergraduate students not engaging with faculty at all, or trying to engage with faculty, but facing risk and race-related stress in doing so.

The teacher-centered instructional practices described by participants—as well as faculty's minimization of their own labor and how that led to students having to take on extra work in order to understand content and succeed in courses—also reflected a meritocratic ideology wherein it is up to individual students to compete and work hard in order to be successful in mathematics courses at MAU. Such a meritocratic view also suggests that only the most deserving students are successful—whether through talent, hard work, or a combination thereof. However, as Bonilla-Silva (2018) explains, meritocracy is a color-blind tenet of liberalism that negates the historical and present impacts of discrimination and racism in racial stratification. Or, in other words, to refer back to a quote from the literature in Chapter 2 of this dissertation, "the assumption that success in science is based on merit conflicts with the racial dynamics that govern how science students interact with one another" (Johnson, 2007, p. 817). Thus, in putting the onus of success onto individual students through trying to minimize their own labor, faculty in the mathematics department at MAU ultimately perpetuate the colorblind and racially exclusive myth of meritocracy in the department; such perpetuation also upholds the supposed objectivity and neutrality of mathematics (Lue & Turner, 2020), thus pathologizing undergraduate students of Color who are not successful, rather than acknowledging the role and influence of structural racism and whiteness. Such views are consistent with findings from Ferrarre and Miller's (2020) study, wherein the majority of STEM instructors believed in the myth of meritocracy, and moreover, that the STEM fields are a post-racial, race-neutral discipline.

Interestingly, the meritocratic views of mathematical success that faculty's practices espoused seemed contrary to participants' descriptions of faculty beliefs about stereotypical "math people." However, these views are consistent with findings from the available literature on the socializing power and views of mathematics faculty (Leyva, McNeill, et al., 2021; Leyva, Quea, et al., 2021). Mathematics faculty hold similar views to the broader STEM faculty about the objectivity of their discipline and believe in the myth of meritocracy. However, the literature also suggests that mathematics faculty tend to weigh innate mathematical ability as a more important factor in success than hard work (or at least, believe that hard work can only help students so much if they do not have stereotypical innate mathematical ability). Racialized stereotypes about innate mathematical ability, then, serve to systematically discriminate against undergraduate students of Color by affecting faculty's views of—and expectations for—undergraduate students of Color in their mathematics courses. Literature has shown how undergraduate students of Color face discrimination and microaggressions from mathematics faculty regarding their mathematical ability (e.g. Borum & Walker, 2012; McGee, 2015; Oppland-Cordell, 2014), which is consistent with the views that Logan had overheard in the faculty lounge, as well as the racialized views participants shared hearing about undergraduate students in Algebra and Trigonometry (such as that they were difficult and unrewarding to teach).

Unlike faculty, participants did not weigh innate mathematical ability as a stronger indicator of success than hard work, and did not believe that innate mathematical ability was a prerequisite to being successful in their classes—especially as they themselves did not identify with the normative math identity. As such, they sought to change the narrative surrounding the necessary qualities to be good at mathematics, promoting the view that hard work was what it took to be mathematically successful, and that anyone could be successful in mathematics by adopting this mentality and work ethic. And so, ironically, while participants believed that changing the normative narrative around mathematical success might help undergraduate students of Color (because they felt it would help *all* undergraduate students, including undergraduate students of Color as a subset), because they did not recognize the racialized nature of the normative narrative around mathematical success, the narrative they tried to shift to was also racialized and embedded in the myth of meritocracy. In other words, although participants hoped they might be able to better support undergraduate students of Color by way of supporting *all*, undergraduate students, not attending explicitly to race and understanding the influence of structural racism on the field of mathematics, as well as mathematics education, ultimately served to mutate the ways in which the racial hierarchy was reproduced in the mathematics department. Indeed, although participants had good intentions, and wanted to be good teachers and more inclusive of undergraduate students of Color, because they did not foreground racism and whiteness in the issues they named within the culture of the mathematics department, the ways in which they tried to diverge from this culture ultimately served to reproduce the racial exclusion of undergraduate students of Color from the mathematics community, which will be discussed further in the next section.

Divergence and Convergence with Departmental Norms & Faculty Values

In beginning this next section, it is important to be clear that participants had good intentions behind all of the ways in which they tried to diverge from the culture of the mathematics department through their teaching practices. They wanted to be able to better serve undergraduate students of Color, and believed that all undergraduate students—regardless of race—had the potential to be mathematically successful. They recognized the ways in which the culture of the mathematics department was exclusionary, and wanted to find ways to change the departmental culture to be more inclusive of all undergraduate students, including undergraduate students of Color. They also recognized the ways in which elements of the departmental culture and climate—such as the lack of diversity, overtly racist beliefs from some faculty members, and more indirect ways that inequities manifested—might disproportionately affect people of Color, and they wholeheartedly believed that racism was bad, and that diversity and racial equality in mathematics was an important goal. However, despite acknowledging the ways in which elements of the departmental culture and climate might disproportionately affect their undergraduate students of Color, participants were reluctant to focus specifically on the needs of these students, as opposed to focusing on the needs of undergraduate students more broadly.

One of the reasons that participants were reluctant to explicitly focus on undergraduate students of Color in the ways they tried to better support their students was the racial stress they faced around confronting racial dynamics; for white participants, this triggered a state of white fragility that led to disengagement with issues of race (DiAngelo, 2011). For example, Declan and Cody both explicitly named being worried that they might make false or intrusive assumptions about the needs of their undergraduate students of Color, thus making those students uncomfortable. While Declan worried that this discomfort might be "just as bad" as racist microaggressions or discrimination, Cody worried that he might put too much labor on undergraduate students of Color to educate him on what they needed. Both of these worries are founded in fears of how their students might perceive them; specifically, that their students might perceive them as racist. Other participants felt similarly, in that making assumptions about what undergraduate students of Color might need could be offensive to those students, and could be perceived as racist despite participants' contrary intentions. As such, participants felt safer focusing on the needs of all students, rather than centering the needs of undergraduate students of Color, and thus, directly engaging with race and racism. Some participants justified this disengagement through discourse around equality and fairness, articulating worries that focusing specifically on the needs of undergraduate students of Color might be unfair to the rest of their students. As such, they felt it would be best to try and focus on equality and fairness in how they treated all of their undergraduate students, rationalizing their disengagement with issues of race and racism.

While they did not outright use this term, participants' worry that focusing specifically on the needs of undergraduate students of Color might be unfair to the rest of their students alludes to a fear that they may be partaking in "reverse discrimination," a concept that most white people now believe in due to the changing racial demographics of U.S. society, as well as policies like affirmative action that try and redress the historical disenfranchisement of people of Color (Bonilla-Silva, 2018; Delgado & Stefancic, 2017; Feagin, 2020). As Delgado and Stefancic (2017) explain, there are implicit assumptions in arguments about "reverse discrimination," particularly as it relates to affirmative action:

> Part of the argument that [affirmative action is reverse discrimination] is that it rests on an implicit assumption of innocence on the part of the white person displaced by affirmative action. The narrative behind this assumption characterizes whites as innocent, a powerful metaphor, and blacks as—what? Presumably, the opposite of innocent, namely, guilty. They are like the thieves who enter where they do not belong and take things that others have worked hard for (p. 91).

The very concept of "reverse discrimination" preserves the fallacy that whites have advantage and power in society through innocent means, rather than through systemic racial domination (e.g., racism and white supremacy). Thus, the logic becomes that since whites in present-day society obtained their advantages through innocent means, it is unfair to intentionally give power to Black and Brown people of Color. This logic then relieves white and non-Black and Brown people of Color of any responsibility in addressing structural racism and white supremacy, thus reinforcing the maintenance of the status quo. And so, implicit in participants' worries about "reverse discrimination" is the characterization of white and non-Black and Brown students of Color as innocent, the belief that these students have been mathematically successful based on their own merits, and the abdication of responsibility on the part of GTAs and instructors to specifically support undergraduate students of Color—thus insulating participants from racial stress.

By not focusing specifically on the needs of undergraduate students of Color, the ways in which participants tried to diverge from departmental norms in service of *all* undergraduate students often risked re-marginalizing undergraduate students of Color. For example, as discussed in Chapter 4, participants largely recognized their roles as mathematical authorities, and wanted to try and de-emphasize learning mathematics procedurally in order to perform well on exams. As such, they tried to foster genuine mathematical interest in their students through integrating history and rigorous theoretical concepts into their lectures. However, participants also explained that some of their undergraduate students were resistant to these modes of teaching, and wanted to focus on content that would be on the test, which was frustrating for participants, who wanted their students to learn and appreciate "real math". The tension that participants describe here is reminiscent of findings from the literature, wherein STEM faculty want to focus on the "disciplinary integrity" of their fields (Haynes & Patton, 2019), and see those who study STEM fields because of passion or interest in the subject as more "elite" than those who might have other motivations for studying in STEM (Carlone & Johnson, 2007; Johnson, 2007).

Indeed, participants did describe valuing students who showed a deep interest in mathematics more than they valued students who simply performed well on the exams or were academically successful in their course but were not interested in the content in the same way that they were. As Carlone and Johnson (2007) explain, underrepresented students of Color often have more contextual, altruistic, application-based, and people-centered motivations for studying STEM. Moreover, underrepresented students of Color are more likely to be able to persist in the STEM fields when "redefining their understanding of what it means to be in science and whose recognition is important to them" (Carlone & Johnson, 2007, p. 1210), rather than studying

STEM for the “disciplinary integrity” of the fields, as they are often systematically racially included from the latter. Thus, in trying to focus on deep, rigorous mathematical theory in their courses in order to change mathematical norms around success, participants may inadvertently be signaling racialized values to their students, in that the “real math” that many undergraduate students of Color do not have equal access to, is more important than the applications or utility of math (either as a subject itself, or as a way to take other classes in the subject area they wanted to pursue) that many undergraduate students of Color may value more.

The racialized mathematical values that participants espoused may have also impacted another way in which participants tried to support their undergraduate students of Color by way of supporting all undergraduate students equally: through trying to connect with their students and build one-on-one relationships where they got to know their students better. One of the primary ways in which participants felt they had more opportunities to get to know their students was through office hours, and they encouraged their students to come see them during office hours. However, as Johnson (2007) explains, STEM faculty who are focused on the acontextual disciplinary integrity of their fields are likely to try and build relationships around the content of their field, rather than their students, which can lead to students of Color feeling as though they cannot develop meaningful and supportive relationships with faculty around their own reasons for pursuing the STEM fields. As such, undergraduate students of Color who are taking mathematics courses for utilitarian or altruistic reasons may feel uncomfortable attending office hours with instructors who center and encourage the study of “real math”—particularly as undergraduate students of Color already face racialized risks in attending office hours or approaching faculty after class and asking for help (Basile & Black, 2019; Lee et al., 2020; Park et al., 2019). In somewhat of a similar vein, while some participants sought to solicit feedback from their students, it is possible that undergraduate students of Color may not feel comfortable voicing feedback if they do not have meaningful relationships with their instructors. Moreover, they may not feel that their feedback will be attended to if their mathematical values are not aligned with participants' values around learning "real math".

Thus, in trying to focus on all undergraduate students, versus centering their undergraduate students of Color in particular, participants also did not attend to or center the influence of racial dynamics. Overlooking how racial dynamics operated in the mathematics department led to several other ways in which participants had good intentions in trying to break from the normative values of the department in their teaching practices, but still risked perpetuating racialized and exclusionary environments by not centering race and racism. Cody, for example, tried to emphasize the acceptance of making mistakes through his lectures. However, in not taking into account his own racial identity as a white man, he may not have understood that for undergraduate students of Color, making mistakes runs the risk of confirming negative stereotypes about their race, as they often are underrepresented, and thus, seen as representative of their entire race (Dancy et al., 2020; Malone & Barabino, 2008; McGee & Martin, 2011). As a white man in mathematics, Cody does not share this experience, and thus, making mathematical mistakes—especially in front of others—carries less repercussions for him than it might for an undergraduate student of Color. Cody was also a proponent of active learning, and other participants also wanted to provide more opportunities for their students to problem solve in small groups and learn with each other. However, as discussed earlier in this chapter, the ways in which racial dynamics play out in forming social ties in classrooms may lead to undergraduate students of Color continuing to be marginalized in more student-centered practices such as active learning and group work, if these racial dynamics are not intentionally attended to.

The ways in which participants focused on equality and fairness to the detriment of their undergraduate students of Color—despite their contrary intentions—exemplify what Bonilla-Silva (2018) calls "rationalizing racial unfairness in the name of equal opportunity," (p. 58), a tenet of the abstract liberalism frame of colorblind racism. As Bonilla-Silva (2018) writes, "by supporting equal opportunity for everyone without a concern for the savage inequalities between whites and blacks, [this] stance safeguards white privilege" (p. 59). Similarly, as Leonardo (2004) reminds us, "in general, whites recreate their own racial supremacy, despite good intentions" (p. 144). Here, it is important to note that only half of the participants in this study were white; the other half identified as international Asian students. However, as Lue et al. (2022) discuss, due to their home countries' contexts, their own racialization process, and the influences of neo-racism, international Asian GTAs may adopt colorblind views that uphold whiteness in mathematics and STEM departments; furthermore, as Liu and Liu (forthcoming) explain, they may receive proxy or contingent privilege in doing so based on their proximity to whiteness. Thus, by trying to insulate themselves against racial stress, and thus absolving themselves from confronting issues of racism and white supremacy, participants' focus on fairness and equality were antithetical to their intentions in trying not to be racist or discriminate against their undergraduate students of Color. Instead, through the abstract liberalism frame (Bonilla-Silva, 2018), emphasizing the importance of equal opportunity while acknowledging how race and racism might affect people of Color was a way that participants rationalized—and even justified—modern racism in the mathematics department. Thus, *despite good intentions*, by not centering race and racism in the ways in which they sought to enact change in the mathematics department, the participants in this study ultimately continued to reproduce racial stratification and thus, racialized hierarchies in the mathematics department through their divergent practices. As such, in trying to diverge from exclusionary practices and elements of the departmental culture, they ended up realigning with the culture of racialized exclusion.

Good Intentions and the Nature of Power

My purpose in continually emphasizing participant's good intentions surrounding race, racism, and supporting their undergraduate students of Color is two-fold. For one, it is critical to highlight the ways in which systemic racism and white supremacy mutate and exist regardless of intentionality; one does not need to have racist intentions to uphold racism. As Bonilla-Silva (2018) explains:

> The problem of racism [is] a problem of power… therefore, the intentions of individual actors are largely irrelevant to the explanation of social outcomes. Second… racial analysis [is] "beyond good and evil." The analysis of peoples' racial accounts is not akin to an analysis of people's character or morality. Lastly, ideologies, like grammar, are learned socially, and therefore, the rules of how to speak properly come "naturally" to people socialized in particular societies. Thus, whites construct their accounts with the frames, style, and stories available in color-blind America in a mostly unconscious fashion" (p. 78).

Bonilla-Silva's (2018) words highlight the second reason I have continued to emphasize participants' intentions: because the normalization of whiteness shields participants from fully understanding the ways that whiteness is upheld through the pervasiveness of racism and white supremacy. As discussed in Chapter 1, whiteness is normalized and hidden through color-blind racism, which includes claims of innocence, fairness, equality, objectivity, and neutrality (Bonilla-Silva, 2018; Leonardo, 2004; Martin, 2008).

The normalization of whiteness also means whiteness is the standard, and thus, is viewed as normal and invisible, wherein white people do not have to consider race or think about themselves as racialized; instead, they see themselves as "just normal" or as individuals, rather than as members of a racial group (McIntosh, 1989; Tatum, 1997). This was consistent with the findings from this study, as most participants—whether white or Asian international students—did not find their racial identities to be salient, and in some cases, did not think of themselves as racialized. For white participants, this was a manifestation of their racial privilege. For Asian international participants, this was likely due to a combination of their developing racial literacies, as well as the proxy privileges they received in the mathematics department and community. As a result, participants were able to see their humanity and personhood as separate from their racial identities, and largely expected to be able to do the same (e.g., focusing on personhood separately from race) for their students. This conceptualization of race ultimately contributed to their rationalization of not centering race and racism in how they sought to diverge from elements of the departmental culture. Again, while not all participants were white, as Lue et al. (2022) discuss, because Asian international students might not see themselves as racialized, they may be reluctant to confront racism, and believe that it is not their responsibility—or that it may be inappropriate—to do so. Furthermore, many of the Asian international participants in this study had limited understandings of how race and racism operated in the United States, due to their home countries' racially homogenous contexts, limited opportunities to talk about race and racism with their peers, and the influence of neo-racism (Lue et al., 2022). These limited understandings of race and racism, combined with their proximity to and benefits from whiteness

(Liu & Liu, forthcoming), likely shielded Asian international participants from considering race in similar ways to white participants.

Aside from allowing participants to unconsciously disengage with—yet support—race and racism, the normalization of whiteness also shields the role of white privilege (and subsequent proxy privileges). As McIntosh writes (1989), gaining awareness of white privilege is difficult, as it conflicts with the myth of meritocracy, which seemed to be pervasive in the mathematics department at MAU. However, participants' abilities to recognize that there might be racial barriers to undergraduate students' of Colors mathematical success in the department may indicate a willingness from participants to engage with their racial privilege and proxy privilege. Indeed, participants were able to name that they were privileged in the mathematics department at MAU due to their racial identities. While prior to our interviews and focus group conversations, they did not often think of themselves as racialized, they did begin to think more critically about their racial identities, as well as how race and racism operated in the mathematics department, through our focus group conversations. However, while both white and Asian international participants could name that they had privilege (whether white racial privilege or proxy privilege [Liu & Liu, forthcoming]), most of them were not able to explicitly articulate how that privilege manifested, or how their privilege influenced how they showed up in spaces. Additionally, while participants were all able to discuss their privilege, they were unable to differentiate between white racial privilege and proxy privilege, and how the differentiation between white racial privilege and proxy privilege both positioned participants—and allowed participants to position themselves—in specific ways in our space. A clear example of this was the distribution of speaking time in the focus groups. Aside from Caleb, all of the white participants (particularly the white men) in the focus groups tended to spend more time talking and building directly off of and responding to each other than the Asian international participants. Moreover, two of the Asian international students—Aditya and Yuanjun—rarely spoke in the focus groups. Although both were engaged in the conversation through nonverbal cues, each of them averaged speaking once or twice in each focus group, occasionally not speaking at all.

Participants' limited understandings of privilege were also evident in the fact that they did not connect privilege and power (which was also a limitation of McIntosh's [1989]) original essay on white privilege). As Battey and Leyva (2016) explain (drawing on Leonardo, 2004):

> For White privilege to take shape it must be accompanied with a process of racial domination. In other words, while White privilege refers to benefits from racism in favor of Whites, White supremacy is the systemic maintenance of the dominant position that produces White privilege (p. 50).

Participants' acknowledgement of their privilege without connecting it to power indicate a limited understanding of how racism and white supremacy are ultimately issues of power. It is also likely that participants do not recognize the nuanced ways in which power operates to maintain the racial order and preserve whiteness, which was also evident in the ways that participants recognized the scarcity of diversity along a hierarchy within the mathematics department, but did not connect that differentiated diversity to the racialized distribution of institutional power (Moore, 2008). Important here to note is that the connection between privilege and power is particularly critical for the white participants, as the power that comes with proxy privileges is contingent upon endorsing white institutional norms.

In general, participants had a difficult time naming the nuances of how power operated—even outside of race. This difficulty was evident, for example, in how participants had difficulty naming who in the mathematics department had power, due to the decentralization of the department; because of the obfuscation of this power, participants believed that there was not really a consolidation or concentration of power in the department, and believed individuals had agency and power. The way in which the culture of individualism occluded where power lay in the department is reminiscent of Margolis et al. (2001), citing Ferguson (1990, p. 9):

> The place from which power is exercised is often a hidden place. When we try to pin it down, the center always seems to be someplace else. Yet, we know that this phantom center, elusive as it is, exerts a real, undeniable power over the whole social framework of our culture and over the ways we think about it (p. 3).

Power operates in all spaces, even when it appears to be hidden. Moreover, as in the case of whiteness, power can often be hidden in order to be protected, and is often hidden through frames such as individualism (Bonilla-Silva, 2018). In staying hidden, power is less likely to be exposed and shifted. Thus, in not understanding—and thus, not being able to name—the ways in which power operated in the mathematics department, participants were not fully able to combat mechanisms of power, particularly in relation to race, racism, and the experiences of undergraduate students of Color.

In recalling the original research questions at the core of this dissertation study, the fourth question can now be answered: Does the way that GTAs discuss their own values, practices, and goals reinforce whiteness and the consolidation of power along a racialized hierarchy in the department, or does it have the potential to make positive changes for undergraduate students of Color? Participants' good intentions, color-blind views, and inability to identify power, indicate that while they may have surface-level understandings of racism and how racial discrimination affects undergraduate students of Color in the mathematics department at MAU—and people of

Color more broadly—they do not understand the nuanced, covert, and pervasive ways that racism and white supremacy function to uphold and center whiteness. Moreover the decentralized nature of the department—and the subsequent culture of individualism and neutrality—contributed to participants' difficulties in naming how power and racism functioned within the mathematics department at MAU. As such, they were either unable or unwilling to center race and racism in the ways that they sought to diverge from normative elements of the departmental culture at MAU, and thus, ultimately reinforced whiteness and the consolidation of power along a racialized hierarchy in the department.

A Cautious Optimism Regarding Institutional Reform

Given that participants wanted to be able to support undergraduate students of Color, as well as their eventual openness in discussing issues of diversity, race, racism, and racial privilege, it is possible that participants would be more willing and able to center race, racism, and the needs of undergraduate students of Color if they had deeper understandings of how whiteness, racism, and power operated. As participants discussed, part of what drew many of them to this study was a desire to learn more about supporting undergraduate students of Color, and to have a space to talk to fellow GTAs about their teaching and about issues in the mathematics department. International students of Color in particular felt that participating in this study was one of the few spaces where they could learn and talk about issues of race and racism in the department, as well as language for how to articulate and problematize things they had noticed. By having a space to talk about issues of race and racism in the mathematics department, and how undergraduate students of Color were affected, some participants felt that this was an important step in potentially building community and moving towards effective change. As Yuanjun had said:

> Being aware, being aware of those problems in the department is important I guess. Like, um, you have to like, talk with your fellow graduate students because, well, some of them might not even be aware of those questions—those problems—present, presenting in the department. So you have to like, say it out loud.

Yuanjun's words are reminiscent of a reminder from Delgado and Stefancic (2017) about the power of Critical Race Theory and narrative storytelling: "once named, it can be combated" (p. 51). Without naming the existence of racism and whiteness, and understanding and articulating how they operate, participants could not center the needs of undergraduate students of Color in the mathematics department—or understand why it was necessary to do so.

While there is hope that with more education, support, and collaboration, that GTAs might be able to make changes in the culture of the mathematics department at MAU to be more inclusive of undergraduate students of Color, it is also important to note that GTAs are still structurally limited by their roles in the mathematics department. As Quin had pointed out, it is already difficult to be an individual trying to combat systemic issues; as a GTA in the mathematics department at MAU, it is even more difficult because they are overworked and don't have permanence or status as graduate students, and thus, don't have much institutional power in the department. Indeed, Whittaker and Montgomery (2013) argue that institutional reform must come from those with longevity, status, and institutional power: namely, faculty members. Thus, even while looking at the possibilities for GTAs to create change in the mathematics department and support undergraduate students of Color, it is also important to be realistic about the structural limitations that they face—and how their capacity is also limited as a result of the offloading of labor and diffusion of power within the department. As such, the second part of this discussion section will return to this study's conceptual framework in order to understand how the findings from this study help to conceptualize the role of GTAs as gatekeepers of the mathematics community at MAU, and the opportunities and constraints they have as agents of mathematics of socialization.

Part 2: Returning to the Conceptual Framework of Membership Into the Mathematics Community

In the second part of this chapter, I re-center the conceptual framework that guided this dissertation study, and discuss the findings through the lens of this framework. In doing so, I also discuss the overarching research question for this study, which is: how do GTAs serve as agents of mathematics socialization for undergraduate students of Color at an HWCU? What follows in this section is a short review of the conceptual framework from Chapter 1, as well as contextualizing the framework in light of the findings from Chapter 4. In contextualizing this framework, I then define the mathematics community at MAU, and discuss how GTAs serve as agents of mathematics socialization into this community. This section then concludes with implications for the future use of this framework, including possibilities and cautions.

Review of the Conceptual Framework

In the conceptual framework of membership that guided this study (Figure 5), the mathematics community was depicted almost like a physical building, wherein the walls of the building—which restricted access into the community—were constructed from the norms and culture of the mathematics department at the department (school) level of mathematics socialization, and the university (community) level of mathematics socialization. The mathematics community was situated within a white institutional space (given that it was situated in an HWCU). I had also posited that mathematics departments—and thus, the department level of mathematics socialization—also operated as a white institutional space. The findings from this study illuminated several ways in which the department and university levels of mathematics socialization at MAU restricted access into the mathematics community, and how the mathematics department at MAU also operated as a white institutional space.

Department and Community Levels of Socialization

In Chapter 1, the elements of socialization I named at the department level of mathematics socialization were norms, graduation requirements, instructors (faculty and GTAs) as agents of mathematics socialization, and instructors' expectations and beliefs about student achievement, mathematical norms, and classroom culture. Many of these factors were evident in the findings from this study, particularly the norms within the department. For example, it was clear that decentralization and individualism were normative aspects of the departmental culture that defined a sense of belonging in the mathematics community; moreover, decentralization and individualism within the mathematics department led to an exclusionary norm of social ties. Thus, members of the mathematics community at MAU were those who felt a sense of autonomy and the ability to follow their personal values within the department, and were able to successfully navigate the decentralization of the department due to their social ties.

Other socializing elements found at the department level that were also originally named in the conceptual framework were instructors' expectations and beliefs about student achievement, mathematical norms, and classroom culture. It was clear that instructors at MAU had certain beliefs about students' potential for achievement based on their mathematical background and the class they were teaching (for example, instructors tended to have low expectations of students in Algebra and Trigonometry, which was a more racially diverse class due to its positioning in the mathematical hierarchy). Instructors also seemed to ascribe to stereotypical notions of mathematical success for their students, such as innate mathematical agility and ability, as well as exam scores. The transmissionist teaching practices that participants described, as well as procedural assignments and exam questions, indicated the reliance and perpetuation of traditional mathematical classroom norms and culture. And so, members of the mathematical community were also able to succeed and be seen by instructors as successful through these traditional views of mathematical skill and achievement.

While graduation requirements were originally listed at the department level of mathematics socialization, it may be the case that graduation requirements are part of both the department and university levels of socialization. The general education requirement at MAU for mathematics (a course at the level of Precalculus), for example, was determined at the university level. Prior learning credits to satisfy this mathematics graduation requirement were also determined at the university level. However, the mathematics department administered and scored the math placement test, and also determined the set of courses that were equivalent to Precalculus, and thus, satisfied the graduation requirement. The ranked system of entry-level courses that would satisfy the university's graduation requirement was one way in which an element of the university-level culture also became a socializing factor at the department level. The subsequent hierarchical tracks that each entry-level course would lead to (and determine students' eligibility to take other classes) also became a socializing factor at the department level, though it originated at the university level. In other words, the setting of mathematics graduation requirements at the university level created a socializing hierarchy based on placement procedures and policies set at the department level.

The difficulty in differentiating whether certain factors—such as graduation requirements—are part of the departmental level of socialization or the university level of socialization, is indicative of how the departmental culture is influenced by the university culture, and thus, how these levels are interconnected. Recall that in my conceptual framework, the university level of mathematics socialization is derived from Martin's (2000) community level of mathematics socialization. One of the purposes of the community level of analysis is to bridge individual and collective experiences and beliefs about the importance of mathematics; in other words, the community level of mathematics socialization forms beliefs about the importance of mathematics for at the school (or in my modified framework, department) and individual levels. Indeed, the influence of the university culture on departmental culture could be seen in a variety of ways in the findings, such as through the hierarchy of academic disciplines. The hierarchy of academic disciplines—and the subsequent correlation with the hierarchy of math courses—was another socializing factor originally listed at the university level of socialization; however, it is clear that the hierarchy of academic disciplines at the university level also influenced a hierarchy of mathematics courses at the department level, which was also connected to the hierarchy of placement procedures and policies.

Another element of the university culture that affected the departmental level of socialization was MAU's status as a research-1 (R1) institution. Since MAU was an R1 institution, many faculty members and doctoral students came to MAU in order to conduct research. Teaching, on the other hand, was a necessary means of being able to do research (e.g. through funding). Instructors saw a difference between "real math" and "classroom" math, and placed higher value on "real math", thus valuing "real math"—and people interested in "real math"—more than they valued "classroom math". Thus, the university's research culture also led to a departmental deprioritization of teaching. In turn, this deprioritization of teaching led to a lack of teaching resources and support, poor teaching practices from faculty, and the offload of faculty labor onto GTAs and undergraduate students. Many GTAs, in turn, also wanted to minimize their teaching labor in order to focus on their research; as a result, poor teaching practices were generally accepted as the norm in the department, and undergraduate students were expected to be independent and work hard in order to succeed in mathematics courses. As such, the university level endorsed a meritocratic work ethic, wherein membership into the mathematics community was viewed as being for those who deserved it. Moreover, membership into the mathematics community was reserved for those who had an interest in "real math," or at the very least, who wanted to work hard and deeply understand the "real math" behind "classroom math".

As discussed earlier in this chapter, meritocracy is a logic of color-blind racism (Bonilla-Silva, 2018). The view of mathematics as a meritocratic subject also frames the field as objective and neutral, thus promoting the idea that mathematics is a race-neutral discipline (Lue & Turner, 2020). Viewing membership into the mathematics community as a meritocratic process, then, negates the historical and contemporary racial consolidation of power within the mathematics community, due to its position within an HWCU—and thus, a white institutional space. Indeed, given that both the university (as an HWCU) and the mathematics department (as a subset of an HWCU) are white institutional spaces, it stands to reason that the mathematics community at MAU—being composed of the departmental and community forces—is also a white institutional space.

While historically white colleges and universities—and the mathematics departments within them—were characterized as white institutional spaces in Chapter 1, it may be helpful here to revisit the four elements of white institutional space (Martin, 2008; Moore, 2008), and specifically characterize the mathematics department at MAU as a white institutional space, in light of the findings of this study. The four elements that characterize white institutional spaces are:

1. Racial exclusion of people of color from elite spaces and positions of power
2. Development of a white frame that organizes the logic of the institution
3. Historical construction of a curricular model based upon the thinking of white elites
4. Assertions of neutrality and impartiality with a lack of connection to power relations or politics

The scarcity of racial diversity along the hierarchy that participants described in the mathematics department (including the lack of people of Color amongst research faculty and department chairs, as well as the lack of racial diversity in higher entry-level classes as opposed to the lower-level (and lower-valued) entry-level classes such as Algebra and Trigonometry) are indicative of the racial exclusion of people of Color from elite spaces and positions of power. Moreover, participants' descriptions of racism in department-sponsored social spaces—which were spaces where necessary social ties were formed—are also indicative of the racial exclusion of people of Color from these elite spaces. The white frame organizing the logic of the department was evident in the color-blind and race-neutral logics surrounding the lack of diversity in the mathematics department, descriptions of the culture of individualism, and the racial stress that white participants expressed in trying to address issues of race and racism. Moreover, the traditional teaching practices that were normative in the department, as well as the use of outdated assignments that felt disconnected to learning content were indicative of the historical construction of a curricular model based on the thinking of white elites. Finally, the color-blind and race-neutral logics participants noticed and utilized, as well as their naming of their privilege (but not connecting privilege to power), discussions of the department as decentralized, show clear assertions of neutrality and impartiality with a lack of connection to power relations or politics.

Recall also from Chapter 1 that the purpose of white institutional spaces is to reproduce white privilege and power within these spaces; as such, a key function of the mathematics department—as a white institutional space—was to reproduce the consolidation of power along a racialized hierarchy. Thus, the departmental culture served to maintain racial stratification and uphold whiteness through these four characteristic elements of white institutional space. Given that MAU, as an HWCU, also functioned as a white institutional space, the ways in which both the departmental and university levels of mathematics socialization formed the bounds of the mathematics community, meant that the mathematics community also existed in order to function as a tool of racism and white supremacy, thus preserving and centering whiteness and the racial hierarchy through the rules of membership into the mathematics community.

The Sociohistorical and Sociopolitical Foundations of Mathematics Education

While the department and university levels of socialization form the bounds of the mathematics community, the community is built on the foundation of the sociohistorical and sociopolitical level of mathematics socialization. The foundation, however, extends beyond the mathematics community—unlike the department and community levels of socialization, which are localized to the mathematics community; this is an intentional depiction. Martin's (2000) original multilevel framework of mathematics socialization and identity development was meant to be contextual. As such, my conceptual framework is intended to be highly contextual as well—broadly, to undergraduate students of Color at HWCUs, and in the case of this study, at MAU. While there are some forces of mathematics socialization that are more universal in the

United States—and thus, influences on mathematics communities that permeate nearly all mathematical communities at HWCUs—there are other forces of mathematics socialization that are more contextual, and thus, that may differentiate one mathematics community at an HWCU from another. The most context-specific forces of socialization in my modified version of Martin's (2000) framework (Figure 3) are the university and department levels. Since these levels are the most context-specific, they form the walls of a given mathematics community at an HWCU, and thus, serve as boundaries that construct that specific community.

Elements of the sociohistorical and sociopolitical level of mathematics socialization of undergraduate students at HWCUs primarily include beliefs and narratives about mathematical success—including the qualities necessary for mathematical success, the meaning of mathematical success in broader undergraduate academic contexts, and the differential treatment of undergraduate students of Color in undergraduate mathematics education. As discussed in Chapter 2, stereotypical narratives about mathematical success include mathematical ability and agility as being innate, the association of mathematical success and broader academic success, and the racialized exclusion of undergraduate students of Color from having strong math identities. While these stereotypical narratives are not necessarily prescriptive within a mathematics community—that is to say, while a given mathematics community is not bound to uphold a stereotypical normative mathematics identity—deviating from the stereotypical narratives about mathematics success is difficult for any given mathematical community to do, given the sociohistorical and sociopolitical level of mathematics socialization that these communities are built on.

This difficulty could be seen in the ways in which participants tried to shift the normative narratives around mathematical success in the department. Participants struggled in trying to encourage their students to see mathematical success as something beyond high performance on exams, or having innate skill, speed, and ability. However, because these narratives around mathematical success were so deeply ingrained in society—even outside of the mathematics department—participants found a multitude of barriers in trying to shift the normative mathematics identity within the department. They also found that undergraduate student expectations of classroom practices and how to be mathematically successful were grounded in traditional views of mathematics success, which made it even more difficult for participants to try and shift normative narratives around mathematical success—particularly through changing their teaching practices to more active learning styles that did not center on exam performance.

Defining the Mathematics Community and the Purpose of Membership

By contextualizing the departmental, university, and sociohistorical and sociopolitical forces of mathematics socialization at MAU, the findings of this study also helped to clearly define the mathematics community at MAU. The mathematics community at MAU consisted of members who had autonomy in following their personal values in the department, could be independently successful on traditional markers of academic success (such as exams and course grades), had social ties that helped them navigate the department, had an interest in "real math," and were recognized as stereotypical "math people" by both instructors and peers in the department. Membership into the mathematics community was also meritocratically viewed as being for those who deserved it—whether through innate talent and ability, or through working hard. In integrating Liu's (2017) work on racialized and privileged spaces into my conceptual framework, I had also contended that the creation and protection of the mathematics community and membership into the community was intentional. The mathematics community was created as a racialized, privileged space by a power governor (in this case, the mathematics department), in order to protect and distribute racial privileges and resources (such as recognition, accolades, and other forms of academic capital) to members of the mathematics community.

Scaffolds, Access, and the Role of GTAs

Rather than delving further into a discussion of the racial privileges and resources provided to members of the mathematics community, it is helpful at this point to re-center this section of the discussion with a reminder of the purpose of using this framework. My intention in using this conceptual framework was not to prove the mathematics community is a tool of racism and white supremacy, wherein the consolidation of racial power and the reproduction of whiteness happens within the mathematics community as a privileged space; I come to this work with these assumptions in mind, due to my theoretical perspectives of Critical Race Theory and Critical Whiteness Studies. Rather, my intention in using this framework was to conceptualize the ways in which the mathematics community was constructed, and how agents of mathematics socialization—specifically, GTAs—have the potential to either reinforce or disrupt the boundaries of the mathematics community to allow for more inclusive membership into the community.

Recall that in Liu's (2017) framework, scaffolds allow whites to move freely between privileged spaces. These scaffolds are also present in my conceptual framework, providing permanent structural support to the mathematics community, and racially restricted access to other privileged spaces. However, in my conceptual framework, these scaffolds are also built and maintained by agents of mathematics socialization; thus, agents of mathematics socialization actively work to maintain the boundaries of—and restrict membership into—the mathematics community as a privileged space. Agents of mathematics socialization are members of the mathematics community, however, there are differential levels of membership that are akin to

Liu's (2017) description of proxy privilege. In his discussion of his framework on power governors and privileged spaces, Liu (2017) discusses "spatially and temporally limited" proxy privilege, which "becomes a form of agency that is contingent upon the discretion of the white man" (p. 352). He also hypothesizes that those with proxy privilege may either "support system-justifying beliefs and will not associate their 'privilege' with perpetuating White supremacy," or that "they might also perceive their earned privileges as opportunities to disrupt power and White supremacy or see themselves as change agents within a power-governor" (Liu, 2017, p. 355-356). As agents of mathematics socialization, GTAs have proxy privilege through their conditional membership into the mathematics community; one of the privileges of this conditional membership is to pursue their research and doctoral degrees, but they are only able to maintain those privileges by serving as agents of mathematics socialization for undergraduate students. Thus, this conceptual framework also provides opportunities to understand the power and potential that GTAs—as agents of mathematics socialization—have to transform the boundaries of the mathematics community at MAU, and how much of their privileges they may have to (or be willing to) give up in order to do so.

As the findings from this study illuminate, GTAs had a limit to how much of their privilege they were willing to reject or sacrifice in order to try and disrupt the power concentration in the mathematics community. In other words, GTAs wanted to be good teachers and help undergraduate students of Color, but ultimately, not at the expense of their research, which was a primary reason they had chosen to come to an R1 institution. In fact, several participants mentioned that they would spend less time and energy on their teaching if they were told to by their advisors, and to focus more on research instead. Participants were also reluctant to associate their privilege with the perpetuation of White supremacy, and were reluctant to center race, racism, and the specific needs of undergraduate students of Color.

Additionally, due to the nature of their roles, GTAs faced a multitude of structural limits that restricted their power in deconstructing and reconstructing the scaffolds and boundaries of the mathematics community. The contextual forces at the department and university levels of socialization that compose the walls of the mathematics community only have specific spaces where GTAs have opportunities to create entry points into the mathematics community; GTAs cannot change the walls themselves due to their limited influence and power in changing departmental or university culture as individual agents of mathematics socialization. Moreover, the Furthermore, in trying to make changes to these walls (e.g. in trying to change their own teaching practices and messaging about mathematical success to diverge from the normative departmental culture and help undergraduate students of Color by helping all undergraduate students), GTAs at MAU may only end up taking down certain scaffolds to replace them with others. This creates new access points into the mathematics community, but does not create any systemic change, as the scaffolds are still only able to be used freely by whites (e.g. how these practices and new narratives are still racialized to the detriment of undergraduate students of Color). The process through which new scaffolds are created to replace old ones, while still restricting access into the mathematics community, is an example of how racism and whiteness mutate when attempts towards change are not structurally and systemically focused.

Thus, as agents of mathematics socialization, GTAs are limited in their roles by the type of change they can make to the boundaries of membership into the mathematics community. When they do attempt change by trying to create new entrances into the mathematics community, they risk continuing to perpetuate and uphold the same walls and boundaries into the mathematics community if they focus on scaffolds and areas of access, rather than deconstructing the walls. However, their role is intended to help maintain the scaffolding that protects and reinforces these walls, and GTAs likely feel that in their individual roles, the extent to which they can make change is through the scaffolding; as this study has illuminated, however, the walls of the mathematics community are built in such a way wherein if GTAs try to use their roles to alter the scaffolding, the structural integrity of the community is still able to be maintained. True change to the boundaries of membership into the mathematics community may only be possible by intentionally changing the ways in which the culture of the mathematics department or the university (the walls of the mathematics community community) reproduces white privilege and power, and systematically excludes people of Color. As such, due to the location of GTAs and the power they have over the structure of the mathematics community in their individual roles, collective action—rather than individual action—may be necessary to enact sustainable and impactful change in service undergraduate students of Color and racial justice. Additionally, true change might only be possible if agents of mathematics socialization are willing to give up their privileges in order to deconstruct the privileged space.

Possibilities and Limitations of this Framework

The creation and use of this framework has allowed me to investigate the role of GTAs as agents of mathematics socialization for undergraduate students of Color. More specifically, the use of this framework has allowed me to conceptualize the mathematics community at MAU (and how it is constructed through the forces of mathematics socialization), and analyze the possibilities and limitations in changing the boundaries of membership into this mathematics community. While the role of GTAs as agents of mathematics socialization at MAU may be limited, this framework may be useful to continue to build out and pinpoint ways to enact systemic change to—or dismantle—the boundaries of membership into the mathematics community at MAU. To do so, however, more perspectives may be needed to complete the contextualization of this framework at MAU. For example, it may be useful to understand the differential levels—at the undergraduate, graduate, and faculty levels—of membership into the mathematics community, and how the roles of other agents of mathematics socialization work in concert with each other through their different responsibilities. To do so, the perspectives of undergraduate students, faculty, and administrators may need to be included alongside the perspectives of GTAs, perhaps through a larger institutional ethnographic study of the mathematics department at MAU. Perspectives outside of the mathematics department (e.g., at the university) may also be helpful to include in contextualizing this framework.

Several possibilities for the use of this framework have been illuminated as a result of this study. First, this framework allows for the conceptual bridging of systemic racism, white supremacy, culture, and individuals. This framework also helps to demystify some of the ways in which systemic racism and white supremacy work to reproduce white privilege through cultural norms and practices. As such, through this conceptual bridging, the roles and actions of individual actors can be analyzed within the context of multiple forces of socialization. Moreover, the consequences for individual undergraduate students of Colors' mathematics identity development can also be understood through the lens of these various contextual forces. In making the various forces of mathematics socialization and its ties to the reproduction of white privilege explicit, opportunities to enact meaningful systemic change in terms of membership into mathematics communities might also be illuminated through the use of this framework.

However, despite the possibilities that the utilization of this conceptual framework offers, it is necessary to use this conceptual framework both cautiously and intentionally. Like Martin's (2000) original framework, this conceptual framework is not meant to be generalized without intentional adaptation. In piecing together this conceptual framework, I make no claims that it can be applied to any university mathematics department. This framework is meant to specifically be utilized within a mathematics department at an HWCU, and using it analytically requires deep contextualization—it is possible that if applied to another study in a mathematics department at an HWCU, that different factors at each level of socialization, and different opportunities and constraints for agents of mathematics socialization, may emerge. Finally, as this framework bridges several other theories and frameworks, the use of this framework to conduct research for audiences unfamiliar with the work I bridged through this conceptual framework may require findings to be translated before dissemination, similarly to how the first part of this chapter was written.

Part 3: Summary and Limitations

This third and final section of this chapter is intended to summarize the response to the research questions of this study, as well as address the limitations of this study. As a reminder, the overarching research question that guided this dissertation study is: how do GTAs serve as agents of mathematics socialization for undergraduate students of Color at an HWCU? The subquestions that help to answer this question are:

1. How do GTAs describe the culture (e.g. values and practices) of the mathematics department/community?
    1. Do they align with this culture or want to break from it?
2. What opportunities do they face in breaking from those values and practices?

3. What constraints do they face in breaking from those values and practices?
4. Does the way they discuss their own values, practices, and goals reinforce whiteness & the consolidation of power along a racialized hierarchy in the department, or does it have the potential to make positive changes for undergraduate students of Color?

In Chapters 4 and 5, I have discussed how the culture of the mathematics department is a culture of individualism, with a hidden curriculum of strong social ties. Moreover, there is a deep love of "real math" in the mathematics department, which leads to a divide between "real math" and "classroom math"; this divide results in a deprioritization of, and lack of support for, teaching in the mathematics department. The deprioritization of teaching leads to "poor teaching" practices from faculty, which is harmful to all undergraduate students, as these poor teaching practices reinforce a narrative that some undergraduate students can be successful in mathematics—while others are just "C students". The narratives about mathematical success within the mathematics department at MAU are exacerbated by broader societal narratives about "math people," and the qualities needed to be good at math.

Overall, the GTAs in this study largely wanted to diverge from elements of the culture in the mathematics department that they found harmful to undergraduate students. They also recognized that the culture of the mathematics department might be connected to the lack of diversity along a hierarchy in the department, and largely wanted to support diversity and the success of undergraduate students of Color in the department. However, they struggled with trying to be "fair" to all of their students, and thus, felt that the best way they could support undergraduate students of Color was to support undergraduate students broadly, and adopt more student-centered teaching practices where they could, and try to change narratives about mathematical success. Their role as GTAs made this difficult, however, as there were limitations to their institutional power (e.g. how much change they could make to the curriculum), and as teaching was only a small part of their responsibilities and priorities.

The ways in which the GTAs in this study discussed their own values, practices, and goals illuminated the ways in which they still reinforced and recentered whiteness—despite good intentions. Because participants were reluctant to center race, racism, and the specific needs of undergraduate students of Color, they ultimately reproduced the consolidation of power along a racialized hierarchy in the department. In returning to the conceptual framework that guided this study, it was clear that in order to make true change in how the mathematics community reproduced whiteness and white privilege and power, that GTAs needed to center how race, racism, and whiteness structurally operated in the creation and purpose of the mathematics community. As such, true change from GTAs—given their positioning and role within the mathematics community—-would likely require them to take collective actions and determine privileges they were willing to give up to dismantle the privileged space of the mathematics community.

Thus, as agents of mathematics socialization for undergraduate students of Color at MAU, participants in this study were limited in their own agency to create the kind of change they wanted to be able to. However, by analyzing their roles from a more structural perspective, it is possible that GTAs could be part of creating change in the mathematics department by way of dismantling the mathematics community. Without such structural perspectives, however, GTAs were likely to continue to serve as agents of mathematics socialization in ways that were exclusionary to undergraduate students of Color, thus perpetuating whiteness and the consolidation of power and privilege along a racialized hierarchy in the mathematics department. It is likely that through their good intentions and their divergent teaching practices and narratives about mathematics success, that GTAs in this study had positive impacts on individual undergraduate students of Color. However, as socialization is both structural and interpersonal, without attending to structure, GTAs could not truly change their role as agents of mathematics socialization in recreating the dominant racialized culture in the mathematics community.

When I first came to this study, I believed that GTAs might be a “solution” of sorts to the mathematics socialization of undergraduate students of Color at an HWCU. However, as the findings from this study have highlighted, GTAs are individuals within a broader system and structure (the mathematics community) that they benefit from. Because they benefit from this structure, and because their power is strategically limited within this structure, it is difficult for them as individuals to make any substantial change in the mathematics community. Moreover, I now believe that GTAs should not be relied on to make change in mathematics communities, as this expectation may result in an exploitation of their labor, as well as further obfuscation of the central power source in mathematics communities. Nevertheless, this study did attend to a gap in the existing literature in the racialized mathematics experiences of undergraduate students of Color, and highlighted ways in which GTAs can still try and minimize the negative impacts that they might have on individual undergraduate students of Color.

Limitations of the Study

There are several limitations to this study, some of which have already been named. One major limitation is the deep contextualization of this study; as this study is focused and contextualized at a specific institution, the findings from this study cannot be generalized to other mathematics communities at other universities. Additionally, as this study was conducted during the COVID-19 pandemic, the experiences of participants at MAU varied greatly. Some participants were at MAU for several years prior to the pandemic, and thus, had more in-person experiences than other participants who began their degree virtually. This variation was not attended to during the study, and as such, the specific impact of COVID-19 on departmental and university culture (and thus, the mathematics community) was not analyzed.

Additionally, while participants largely focused on Black people when talking about people of Color and undergraduate students of Color, anti-Black racism was not a central framework in this study. Undergraduate students of Color are not a monolith, and perhaps determining a definition for undergraduate students of Color, or focusing on a specific population, may have elucidated the differential racialization of undergraduate students of Color more clearly than this study did. Somewhat related is the lack of focus on the intersectional identities of undergraduate students of Color (Crenshaw, 1993/2016). Intersectionality is a key tenet of Critical Race Theory (Delgado and Stefancic, 2017). However, due to how late in the focus groups we began to focus specifically on race and undergraduate students of Color, we were unable to focus on intersectionality in the mathematics socialization of undergraduate students of Color.

Finally, this study was limited in that most of the GTAs who signed up to participate in this study were ones who cared about and wanted to learn more about teaching undergraduate students. As participants explained, they felt a bit of a disconnect at times from other GTAs in the department, and so there may have been bias in the ways they described the departmental culture. Additionally, the participants in this study only made up a small proportion of the total GTAs in the mathematics department at MAU, and thus, this study could have been strengthened by the perspectives of more GTAs, as well as others in the department and at the university. However, such a broad endeavor was likely beyond the scope of a single dissertation study.

CHAPTER 6: CONCLUSION

The overarching purpose of this critical qualitative dissertation study was to explore the ways in which mathematics graduate teaching assistants (GTAs) at an HWCU serve as agents of mathematics socialization for undergraduate students of Color. At the heart of this study was my desire to understand the ways in which mathematics GTAs might serve as *gatekeepers* into the mathematics community at an HWCU—and what opportunities and constraints they faced in trying to change the boundaries of membership into the mathematics community at an HWCU. In order to examine the overarching research question empirically, I broke down the research question into the following subquestions:

1. How do GTAs describe the culture (e.g. values and practices) of the mathematics department/community?
    a. Do they align with this culture or want to break from it?
2. What opportunities do they face in breaking from those values and practices?
3. What constraints do they face in breaking from those values and practices?
4. Does the way that GTAs describe their own values, practices, and goals reinforce whiteness and the consolidation of power along a racialized hierarchy in the department, or does it have the potential to make positive changes for undergraduate students of Color and thus, broaden access to membership in the mathematics community?

I explored these subquestions by utilizing critical ethnographic methods to understand the perspectives of ten mathematics GTAs at Mid-Atlantic University, a large, public, research-1 institution in the Mid-Atlantic region of the United States. Findings emerged from three phases of data collection: initial fieldwork, individual interviews with each of the participants, and a series of six focus groups with all of the participants that were held during the second half of the Spring 2022 semester.

My findings chapter (Chapter 4) was organized into two parts: a written portrait of the mathematics department at MAU, using data from the first phase of the study; and four thematic findings that resulted from the second and third phases of the study. The written portrait served to contextualize the four themes that emerged from the interview and focus group data. These four themes were:

- Theme 1: A Culture of Individualism and the Hidden Necessity of Social Ties
- Theme 2: The Valuation of Teaching as a Means of Doing Research
- Theme 3: Attempts to Shift Narratives of Mathematical Success
- Theme 4: Identity Tensions in Supporting Undergraduate Students of Color

As discussed in the second part of the findings chapter, the first two themes addressed GTAs' perceptions of the culture of mathematics department and community, as well as some of the ways in which they sought to break from the normative culture of the mathematics department and community through their teaching practices. Participants recognized the ways in which the culture of the mathematics department was exclusionary and disserved undergraduate students, and they wanted to be good teachers and support their undergraduate students. Themes 2, 3, and 4 explored the opportunities and constraints they faced in breaking from the normative culture of the mathematics department, and how they sought to shift classroom norms and narratives about mathematical success to better support their undergraduate students.

As discussed in the fourth theme, and in the discussion chapter (Chapter 5), participants struggled in identifying ways to specifically support their undergraduate students of Color, due to their own racial identities, racial literacies, and the racial stress they faced when focusing on the specific needs of undergraduate students of Color. While they recognized the ways in which the lack of racial diversity, combined with normative values and practices in the department, might be detrimental to undergraduate students of Color (and people of Color more broadly), they struggled with connecting struggles that undergraduate students of Color faced in the department, to structural racism and whiteness. Indeed, participants were largely reluctant and had difficulty in naming and discussing the connections between racism, whiteness, privilege, and power in the mathematics department, and how these structures systematically affected undergraduate students of Color—and people of Color more broadly—in the mathematics department. As a result of not being able (or willing) to center race, racism, and the specific needs of undergraduate students of Color, they sought to support their undergraduate students of Color by way of supporting their undergraduate students more broadly. However, as I discussed in Chapter 5 (where I also addressed the fourth research subquestion), despite their good intentions in trying to support undergraduate students of Color by way of supporting all of their undergraduate students, participants perpetuated whiteness and the consolidation of power and privilege along a racialized hierarchy in the mathematics department, and maintained the mathematics community as a privileged space.

I shared at the end of Chapter 5 that when I first began this dissertation study, I believed GTAs could be critical change agents in disrupting the mathematics socialization of undergraduate students of Color at an HWCU. In other words, I believed that GTAs might have the power to change the culture of mathematics department to be more inclusive of undergraduate students of Color, and help signal to them that they "belong" in mathematics—and perhaps the STEM fields more broadly. Given the existing research on the influence on STEM and mathematics faculty on the experiences, sense of belonging, and disciplinary identity development of undergraduate students of Color (which I discussed in Chapter 2), I thought that GTAs were a critical demographic to explore, as I believed they might have opportunities to somewhat counteract the socialization from faculty, due to their student-facing positioning in mathematics departments—particularly at larger institutions. What I found in this study was that my participants did indeed recognize the ways in which the normative culture of the mathematics department at MAU was harmful to the experiences of undergraduate students—as well as undergraduate students of Color—and wanted to diverge from this normative culture. And so in some ways, my assumption that GTAs might want to diverge from exclusionary cultural norms was correct. However, the ways in which my participants described the ways in which they sought to support undergraduate students of Color—by way of supporting undergraduate students more broadly—still had the potential to be harmful to undergraduate students of Color. Thus, it was clear that GTAs were not necessarily able to counteract the racialized mathematics socialization of undergraduate students of Color in ways I had hoped they might be able to.

Part of the reason that GTAs were not able to disrupt the exclusionary ways in which undergraduate students of Color were socialized in the mathematics department at MAU was due to their reluctance to center race, racism, and the specific needs of undergraduate students of Color. This reluctance was likely a result of the state of their own racial consciousness development, as well as the ways in which racism and whiteness operated in covert ways in the mathematics department—as well as in U.S. society more broadly. Participants were also limited in making structural change in the department in a myriad of ways, due to their roles as GTAs, and the individual power and capabilities they had in trying to enact institutional reform. As such, while there are certainly possibilities for GTAs to be transformative agents of mathematics socialization for undergraduate students of Color, there are also many structural and contextual forces that constrain their ability to do so.

This study adds to the current literature on the identity development and socialization of undergraduate students of Color in mathematics and STEM more broadly. More specifically, this study attends to the mathematics socialization of undergraduate students of Color at HWCUs through the contextual forces of mathematics socialization (Martin, 2000), by focusing specifically on GTAs as agents of mathematics socialization, which has not yet been done. Moreover, this study adds to the limited body of studies on the role of mathematics GTAs, by centering race, racism, and whiteness to examine their positioning in mathematics departments and communities, as well as their beliefs surrounding mathematics socialization. Prior studies that focus on mathematics GTAs have largely focused on their professional development, training, and their beliefs about mathematics, but not with specific goals of racial equity and justice in mind. Finally, this study also adds to the current literature that utilizes Critical Race Theory and Critical Whiteness in both mathematics education and higher education spaces, by examining how whiteness and the racial consolidation of power is reproduced through mathematics communities as privileged spaces, with mathematics departments as power governors (Liu, 2017). This study also focuses on participants who want to be racially equitable, and have good intentions in doing so, but face structural limitations in doing so due to the ways in which racism and whiteness mutate and operate. As such, this study has several implications for practice and research that may help move university mathematics and STEM spaces closer to racial equity and justice.

Implications for Practice

There are several implications for university mathematics departments that emerge from this study, particularly for departments dedicated to racial diversity and inclusion. As the findings from this study show, white and Asian international GTAs who have good intentions in trying to support undergraduate students of Color may have difficulty in doing so due to their limited understandings of how racism and whiteness operate, as well as their difficulties in connecting their own racial privilege to power. As such, it is imperative for GTAs to have opportunities to develop their critical race consciousnesses—and it may be helpful for them to do so in communities of their peers. Mathematics departments should provide opportunities for GTAs to learn about race, racism, and whiteness in the U.S. as well as in STEM settings, and provide spaces for GTAs to also talk about these issues in community with their peers. It is important to note that mathematics departments do not have to do this work alone; it is imperative that institutions of higher education, particularly HWCUs, provide these types of learning opportunities and ensure that departments are connecting their members to these opportunities and resources. Departments and institutions of higher education should also continue to work not only on diversifying their graduate student population, but creating welcoming environments for graduate students of Color so they are not isolated and expected to take extra labor in supporting undergraduate students of Color on their own. Diversification efforts must happen in tandem with restructuring the climate and culture of departments and providing opportunities for white and Asian international graduate students spaces to learn about race and develop their critical race consciousnesses; this learning and community, however, should be departmentally or institutionally sponsored—rather than something that is expected from graduate students of Color or other people of Color in the department.

The findings from this study also indicate the ways in which GTAs' agency and opportunity to facilitate change in mathematics departments is structurally limited, due to their lack of institutional permanence and power. As such, mathematics departments should also consider the ways in which the findings and implications from this study show the need to engage faculty in diversity and inclusion efforts, particularly when it comes to trying to improve the experiences and identity development of undergraduate students of Color. Mathematics departments cannot rely on the labor of well-meaning GTAs whose labor is already exploited and undercompensated to create sustainable change to their climate and culture. Instead, departments should examine the structure of their departments and the way that socializing power and institutional power is distributed throughout their department, so that transformative changes to departmental climate and culture can be actionable and sustainable.

Along those lines, mathematics departments committed to racial equity, diversity, and inclusion must examine the culture of their departments, the distribution of socializing power, and how the norms, values, and practices within their departments might serve to systematically exclude undergraduate students of Color in covert ways. Mathematics departments who want to improve racial equity, diversity, and inclusion must be intentional and explicit in trying to create more inclusive environments, and achieving racial equity cannot be done without explicitly identifying and naming the ways in which racism and whiteness operate within current normative cultures in departments. As the findings from this study show, racism and whiteness mutate in ways that can lead actors to perpetuate the racial consolidation of power *despite good intentions*. Good intentions are not enough to substantiate the disruption of racial privilege and power; this power must be centered and named explicitly in order for it to be disrupted.

Implications for Research

Implications for future research are somewhat intertwined with the implications for practice that I described in the previous section. For mathematics departments to be able to examine how the culture of their departments might serve to systematically exclude undergraduate students of Color, it may be helpful for departments—or researchers helping departments—to utilize my conceptual framework of membership into mathematics communities. Mathematics departments should be intentional and explicit in naming the ways in which the mathematics community is constructed through the forces of mathematics socialization, and who holds power and permanent membership in the mathematics community, in order for true transformative change to occur. One way of being able to understand the construction and operation of the mathematics community is to use my conceptual framework, contextualized to a specific mathematics department and community.

I discussed other possibilities for the use of this conceptual framework in the conclusion to Chapter 5. Such possibilities include the demystification of how systemic racism and white supremacy work to reproduce white privilege through cultural norms and practices, as well as understanding the contextual forces of mathematics socialization and identity development through a structural lens. This framework bridges structures, culture, and individuals in ways that help to clarify complex processes and concepts. As such, it may be a helpful tool for other scholars seeking to examine and disrupt mathematics socialization processes at HWCUs—particularly for scholar-practitioners seeking to improve racial equity and justice, as well as the access and retention of undergraduate students of Color in mathematics and the STEM fields more broadly.

The final implication for research from this study concerns the methods of this study, and how they contributed to the findings. As I discussed in Chapter 4, my participants were reluctant to discuss race and racism. Despite trying to center race and racism in this study, I made the intentional choice to build up to discussing these topics—as well as participants' reflections on their own roles as socializing agents for undergraduate students of Color. I recognized participants had different comfort levels than I did when it came to engaging in critical reflection and reflexivity. These different comfort levels were perhaps due to their own racial consciousnesses, and the opportunities that they had had in being able to learn about and discuss race and racism—particularly the international Asian participants. Thus, it was an intentional decision to scaffold discussion topics for the focus groups, and begin by discussing participants' shared and divergent values, norms, and practices with the mathematics department, and the aspects of the department they problematized and took issues with, before introducing and connecting race and racism more explicitly. As such, qualitative researchers who are discussing socialization, race, and racism through extended data collection methods such as mine, where they are in large part building professional and personal learning communities, may take a similar methodological approach wherein the primary focus in the early stages of community development does not explicitly center or address topics that require critical reflection. Due to the complexity of covert and colorblind racism, scaffolding critical reflection might also in fact be beneficial in illuminating participants' more complex thoughts and perspectives, and in building trust and community that may help lay the groundwork for transformative change.

In discussing this methodological implication, I by no means intend to imply that Black and Brown researchers of Color need to teach participants about race and racism; there are a large variety of resources that participants can draw on that do not require the further exploitation of the labor of people of Color. However, for white researchers or researchers of Color who have contingently privileged racial identities, such as myself, we may consider being intentional about how we approach the development of critical race consciousness with well-intentioned participants, and the types of labor and risks we are willing to take on in pursuit of racial equity and justice. Those of us researchers with privileged racial identities and proxy privilege must be intentional and thoughtful about how we lead our participants to being able to name race, racism, and their socializing power, as (to allude back to the words of Delgado and Stefancic [2017]), we cannot combat racism and whiteness in mathematics education without naming and centering their influences—particularly when it comes to the formation and sustainment of mathematics communities as privileged spaces at HWCUs.

APPENDICES

Appendix A

Interview Protocol

Section 1: Mathematical Histories

1. When did you first become interested in mathematics? What drew you to the subject? Was there anything, or anyone, that encouraged you to pursue mathematics? Was there anything, or anyone, that discouraged you from mathematics? What about other subjects?
2. How have your perceptions of mathematics changed over time? How have your feelings towards mathematics changed over time? What shaped or influenced these perceptions?
3. When you close your eyes and picture a “math person”, who do you see? Describe that person.
    a. Do you think these qualities are what other people might think of when they picture a “math person”?
4. What do you think are the qualities of a “math person”? How do you know when someone is—or isn’t—a math person?
    a. Why do you describe these specific qualities? What do you think has led you to believe that these are the qualities of a math person?
    b. How and when do you think you came to recognize the qualities of “math people”? From where and from whom did you learn about these qualities? Why do you think they are normalized?
    c. Have the qualities of a “math person” changed for you over time? If so, why?

5. Can you recall a time where you had a student who wasn't a "math person"? How did you support that student? What do you think is the best way to support students who aren't "math people"?
6. Do you think other people view you as a "math person"? How do you know?
   a. Do you think the students you have taught see you as a "math person"?
7. Do you see yourself as a "math person"? Why or why not?

Section 2: The PhD Program at MAU

8. Tell me about your degree program. How did you come to the decision to pursue a PhD in math? Why did you choose MAU?
9. Describe all of the things you have to juggle as a math PhD student. How do you decide what to prioritize?
10. Can you name a fellow graduate student in your program that you would describe as successful? Why would you describe them as successful?
11. How would you describe the departmental culture of the mathematics community at MAU?
    a. What qualities in graduate students do you think are valued in this community?
    b. What qualities in undergraduate students do you think are valued in this community?
    c. How do you know these qualities are valued? Has someone ever outright said so?
12. Which people have the most power in the mathematics community at MAU?
    a. Who are they in relation to MAU and the mathematics department?
    b. What do you think gives them power?
    c. How would you describe the power that you hold in the mathematics community as a doctoral student and a GTA—especially in relation to the people you just named?

Section 3: Teaching Experiences

13. So I know you have taught **[insert courses from a demographic survey].** Can you describe the prep work that has typically gone into teaching these courses?
14. Tell me about your experience in The Math Teaching Seminar 101. In what ways did the Teaching Seminar prepare you to teach students? In what ways did it not prepare you?
    a. What did you learn from this course about what it means to be a good mathematics instructor?
    b. What did you learn from this course about what it means for an undergraduate to be a successful math student?
    c. Were there aspects of the course that felt familiar to you or resonated with your own experiences as an undergraduate math student?
15. What other forms of teaching support (if any) have you received or sought out—either from peers, the mathematics department, (i.e. first-year observations) or from the university (i.e. Teaching Center)?
    a. What did you learn from these things about what it means to be a good mathematics instructor?
    b. Are there things you learned about or wish you could do in your teaching that you haven’t been able to do? Why do you think you haven’t been able to do them?
    c. (if applicable) what support do you wish you had gotten? Or can you name a scenario you wish you had been adequately trained or prepared for?
16. When you think about your past experiences—as a student, as a teacher, and in your training—what do you think has had the most impact on your teaching practices? Specifically, what experiences have taught you about what the most important qualities of a good mathematics instructor are?

17. Do you feel like you are the kind of mathematics instructor that you want to ideally want to be?
    a. If no, why not? What do you think are some of the constraints you face?
18. What does it mean to do well in the classes you've taught? When you think of students who have done well in the classes you have taught, what are some of the things they have in common?
    a. Did you notice any patterns across racial or gendered lines?

<u>Section 4: Race & Diversity</u>

19. Racial and gender diversity in STEM departments is a hot topic across the country. Can you talk to me about racial diversity, or the lack thereof, in the mathematics department at MAU? What about other forms of diversity?
20. Do you ever think explicitly about either your race or your students' races in your teaching practices?
    a. If yes, what sorts of things do you think about? Do these thoughts influence your teaching practices? How so?
    b. If not, can you share more about why not?
21. Undergraduate students of Color—particularly Black, Latinx, and Indigenous students—often face discrimination and exclusion from mathematics spaces and communities at institutions of higher education. Can you describe a time when you knew that a student of Color felt marginalized or uncomfortable in a mathematics course at MAU? How did you know?
22. How do you see race influencing someone's experience in the mathematics department at MAU?

23. What does it mean to you to be [insert race from demographic survey] and a PhD student in math? What does it mean to be [insert race from demographic survey] and a GTA in math?

Appendix B

Focus Group Topics and Questions

Week 1: Introductions

- Brief introductions. Name, what you are teaching this semester (or what you most recently taught), post-graduation goals, and something you enjoyed about spring break
- What brought you to this study? What made you decide to sign up and participate? What are you hoping to learn?
- What's going well for you this semester with your teaching? What is something you are particularly proud of in your teaching practice?
- What is something that you are struggling with this semester with your teaching? (Can be related to being in the classroom, to deadlines, or to working with other people, time management, etc.). What is the biggest thing you worry about (or are aware of, or try to stay aware of) when it comes to your teaching?

Week 2: Teaching Beliefs and Practices

- Any updates from this week? Anything you are particularly proud of, or anything you are particularly struggling with?
- What are some common concerns about teaching undergraduate students that you've noticed (either from faculty, course chairs, or your peers)?
  - What about for undergraduate students of Color in particular?
- What are some concerns about teaching undergraduate students that are **not** common, but that you think should be?
- If you could change one thing about how math is taught at MAU (whether it be common practices you've seen from faculty or peers, a policy or procedure, something about the

structure of TAships or what you receive from your course chair, etc.) what would it be, and why? What do you think the consequences for students would be?

<u>*Week 3: Ownership and Power in the GTA Role*</u>

- (cont.) If you could change one thing about how math is taught at MAU (whether it be common practices you've seen from faculty or peers, a policy or procedure, something about the structure of TAships or what you receive from your course chair, or even something about the students, etc.) what would it be, and why? What do you think the consequences for students would be?
    - What are some of the consequences of having courses like Math 113 be sole contact, high-workload, and difficult to teach—yet mostly assigned to first-year students—and what is the impact for undergraduate students of Color?
- Where do you feel you have ownership over the courses that you TA for? Where do you think you have power as a TA, whether that's in your specific class (and students), or in the department?
    - What power do you have—not just in being able to make decisions about the courses you teach/TA, but in terms of the impact or influence you have over students, and the way that they think about math, or see themselves as capable of doing math?

<u>*Week 4: Values, Success, and Norms*</u>

- What types of undergraduate students are most successful in math courses? What types of undergraduate students are most valued in math courses?
    - How, if at all, do you think you signal these thoughts to your students? Do you think your students know what you value? Do you think they know how you feel

about the definition of success? Are these things that your students have any insights into, or that you show?

- What norms do you think you set around mathematics as an instructor (or TA), whether intentionally or unintentionally? What consequences might this have for undergraduate students of Color?
    - What are some identity-related barriers that a student might face that could discourage or prevent them from engaging in these norms or things necessary for success (like going to OH, raising hands, etc.)., or make them feel uncomfortable doing so in a math space?
- What norms do you think you set around race as an instructor (or TA), whether intentionally or unintentionally? What consequences might this have for undergraduate students of Color?

Week 5: Race, Identity, and Undergraduate Students of Color

- How do you show your students that you see them as people? Do you think you can see someone as a person—a holistic individual—without acknowledging their racial (or other social) identities?
    - What ***is*** essential information to know about your students?
    - Do you start to develop ideas or unconscious biases about a student's work (or mathematical capabilities) when you get to know them more? Or as you see their work more?
- What do you think undergraduate students of Color (particularly Black and Brown students) need from their math instructors?

Week 6: Racism in Mathematics and at MAU

- In what ways does racism show up in mathematics classrooms and spaces, especially at MAU? How do you define racism?
- How might you combat these forms of racism as a TA or instructor? What possibilities do you see because of your position as a graduate student (as compared to faculty)? What barriers do you think you face? (**OR: How do you see your role (as a graduate student) in combating these forms of racism?)**
- Is there anything you are walking away from this space (and participating in this project) with, or having gained?

Appendix C

Dissertation Codebook

Name	Description	Files	References
Being a PhD Student	Participants describe what it is like to be a PhD student in the department (e.g. their role, their responsibilities), and how they navigate the department in their role (e.g. determining priorities, making friends, etc)	18	180
career goals	Participants share their future career goals related to the PhD	3	10
determining priorities	Participants describe how they determine what their priorities are	13	25
getting here	Participants describe experiences or people that were part of their journey to the program	10	31
different undergraduate major	Participants describe an undergraduate major (that they either pursued or considered pursuing) that was not mathematics	8	9
enjoying and succeeding in math	Participants describe past experiences where they enjoyed math and were successful in math, and how that led them to choose math as a field of study	9	15
influential people	Participants describe people who were influential (e.g. teachers, parents, friends) in their decisions to pursue a PhD in mathematics	6	7
here to do research	Participants describe how the PhD and research are connected (i.e. coming to MAU for a PhD in order to do research)	11	18

Name	Description	Files	References
power	Participants describe the power, ownership, and control (or lack thereof) that they have as a GTA	16	52
responsibilities	Participants describe the things they have to do and things they hope to do during the program	12	16
social ties	Participants describe the social ties they have with peers in the department	9	28
Cultural Differences	Participants describe cultural differences between what they are familiar with, and what they see and experience at MAU	9	22
Departmental Climate	Participants describe the climate of the department	17	204
attitudes towards research	Participants describe departmental attitudes towards research	11	24
purpose & role	Participants describe how research is the purpose of specific roles at MAU	6	10
success	Participants describe the ways that research is correlated with success in the department	9	14
attitudes towards teaching	Participants describe departmental attitudes towards teaching	13	53
course policies & practices	Participants describe course policies they have to abide by and common practices in the department	3	12
priorities	Participants describe priorities or concerns about teaching that are most prevalent in the department	2	9

Name	Description	Files	References
success	Participants describe the ways that teaching is correlated with success in the department	6	12
teaching and research as separate	Participants describe the separation between teaching and research in the department	5	5
teaching is a necessity	Participants describe how teaching is seen as a necessity for the department	7	9
workload for certain classes	Participants describe the workload certain classes have	3	6
comparison to other institutions	Participants compare the departmental climate at MAU to other institutions	6	12
important people	Participants describe the importance of specific people in the department	12	16
large, decentralized department	Participants describe the size and decentralization of the department	8	14
race & racism	Participants describe departmental views on race and racism, and how they see race and racism affecting the department	15	85
diversity	Participants describe diversity within different settings and groups in the department	14	22
effects of racial climate	Participants describe the effect of the racial climate in the department on people (e.g. themselves or undergraduate students)	14	38
racism	Participants describe and/or define racism, and the impact of racism on the departmental climate (including undergraduate experience, what is accepted amongst professors, etc).	1	7

Name	Description	Files	References
responsibility	Participants describe where responsibility lies for addressing issues of diversity or racism in the department	8	18
How to Teach	Participants describe how to teach	20	176
being a good teacher	Participants describe how to be a good teacher	20	123
doing better than	Participants describe ways that they want be a better teacher than someone else	5	7
my goals	Participants describe what their goals are when trying to be a good teacher (e.g. things they try to do in their practice, what they want from their students)	19	93
what a good teacher does	Participants describe what they think the qualities of a good teacher are (theoretically, not necessarily within their own practice)	13	23
learning to teach	Participants describe ways they learned to teach	14	53
experience	Participants name the role of experience in helping them learn how to teach	7	8
talking to others	Participants describe how talking to others affects their teaching practice	7	17
teaching support from the department	Participants describe the support they got from the department in regards to teaching	12	28
Undergraduates	Participants describe undergraduate students	20	131

Name	Description	Files	References
how I view them	Participants describe or allude to how they view undergraduate students	14	37
how they see me	Participants describe how they believe undergraduate students view them, and how undergraduate students interact with them	18	35
office hours	Participants refer to office hours	11	16
student feedback	Participant describes soliciting student feedback to improve their teaching	3	6
how they're treated by others in the department	Participants describe how undergraduate students are treated in the broader department	8	13
impact of COVID	Participants describe the impact of COVID on undergraduate students	3	4
struggles they face	Participants describe struggles that undergraduates face in the classroom	14	31
what they want	Participants describe what undergraduates want and expect in the classroom	5	11
Views on Math	Participants describe their views on math	14	123
how I see myself with math	Participants describe how they view themselves with math	10	15
how to be good at math	Participants describe what it takes to be good at math	10	21
math person	Participants describe how the term 'math person' is used and/or what they think of the term "math person"	12	32

Name	Description	Files	References
new views on math	Participants describe how they view math now	12	27
old views on math	Participants describe past misconceptions they had about what math was	10	14
utility of math	Participants describe how math can be useful for people	7	14
Views on Race	Participants describe their views on race and racism	17	77
from my limited perspective	Participants name their identity and experiences as a limitation when it comes to understanding racism and its impacts	7	13
other social identities	Participants bring up other social identities, either in direct comparison to race, or as identities that they also think about, or think should be thought about	6	15
salience of international status	Participants describe how and when they think about the effect of their international status on their lived experiences	5	8
privilege	Participants name or describe privilege they have due to their racial identity	3	5
salience of race	Participants describe how and when they think about the effect of race on peoples' lived experiences (including their own)	13	29
talking to people about race	Participants describe the opportunities they have to talk to others about race	5	9
what we should do about racism	Participants describe what should be done to address racism	6	6

REFERENCES

Adiredja, A. P., & Andrews-Larson, C. (2017). Taking the sociopolitical turn in postsecondary mathematics education research. *International Journal of Research in Undergraduate Mathematics Education*, *3*(3). 444–465.

Agar, M. H. (1996). *The professional stranger: An informal introduction to ethnography.* Academic Press.

Aguirre, J., Herbel-Eisenmann, B., Celedón-Pattichis, S., Civil, M., Wilkerson, T., Stephan, M., Pape, S., & Clements, D. H. (2017). Equity within mathematics education research as a political act: Moving from choice to intentional collective professional responsibility. *Journal for Research in Mathematics Education*, *48*(2), 124–147.

Allen, R. L. (2004). Whiteness and critical pedagogy. *Educational Philosophy and Theory*, *36*(2), 121–136.

Alsubaie, M. A. (2015). Hidden curriculum as one current issue of curriculum. *Journal of Education and Practice, 6*(33), 125-128.

American Council on Education (2017). *American college president study summary profile.* https://www.aceacps.org/summary-profile/

Apple, M. W. (1982). *Education and Power.* Routledge and Kegan Paul.

Ashkenas, J., Park, H., & Pearce, A. (2017, August 24). *Even with affirmative action, Blacks and Hispanics are more underrepresented at top colleges than 35 years ago.* New York Times. https://www.nytimes.com/interactive/2017/08/24/us/affirmative-action.html

Austin, A. E. (2002). Preparing the next generation of faculty: Graduate school as socialization to the academic career. *The Journal of Higher Education*, *73*(1), 94–122.

Basile, V., & Black, R. (2019). They hated me till I was one of the “good ones”: Toward Understanding and Disrupting the Differential Racialization of Undergraduate African American STEM Majors. *The Journal of Negro Education*, *88*(3), 379–390.

Battey, D., & Leyva, L. A. (2016). A framework for understanding whiteness in mathematics education. *Journal of Urban Mathematics Education*, *9*(2). 49–80.

Beasley, M. A., & Fischer, M. J. (2012). Why they leave: the impact of stereotype threat on the attrition of women and minorities from science, math and engineering majors. *Social Psychology of Education: An International Journal*, *15*(4), 427–448.

Bell, D. (1992) *Faces at the bottom of the well: The permanence of racism.* Basic Books.

Bergsten, C. (2007). Investigating quality of undergraduate mathematics lectures. *Mathematics Education Research Journal*, *19*(3), 48–72.

Bishop, J. P. (2012). “She’s always been the smart one. I've always been the dumb one”: Identities in the mathematics classroom. *Journal for Research in Mathematics Education*, *43*(1), 34-74.

Blair, R. Kirkman, E. E., & Maxwell, J.W. (2018). *Statistical abstract of undergraduate programs in the mathematical sciences in the United States*. Conference Board of Mathematical Sciences (CBMS). http://www.ams.org/profession/data/cbms-survey/cbms2015

Blosser, E. (2019). An examination of Black women’s experiences in undergraduate engineering on a primarily white campus: Considering institutional strategies for change. *Journal of Engineering Education*, *109*(1), 52–71.

Bonilla-Silva, E. (2004). From bi-racial to tri-racial: Towards a new system of racial stratification in the USA. *Ethnic and Racial Studies*, *27*(6), 931–950.

Bonilla-Silva, E. (2018). *Racism without racists: Color-blind racism and the persistence of racial inequality in America* (5th edition). Rowman & Littlefield.

Bonilla-Silva, E., & Peoples, C. E. (2022). Historically white colleges and universities: The unbearable whiteness of (most) colleges and universities in America. *American Behavioral Scientist, 0*(0). 1-15.

Borum, V. & Walker, E. (2012). What Makes the Difference? Black Women's Undergraduate and Graduate Experiences in Mathematics. *The Journal of Negro Education*, *81*(4), 366–378.

Bowen, W. G., Chingos, M. M., & McPherson, M. S. (2009). *Crossing the finish line: completing college at America's public universities.* Princeton University Press.

Bowen, W. G., Kurzwell, M. A., & Tobin, E. M. (2005). *Equity and excellence in American higher education*. University of Virginia Press.

Brunsma, D. L., Brown, E. S., & Placier, P. (2012). Teaching race at historically white colleges and universities: Identifying and dismantling the walls of whiteness. *Critical Sociology*, *39*(5), 717–738.

Burdman, P. (2012). *Where to begin? the evolving role of placement exams for students starting college*. Jobs for the Future. https://files.eric.ed.gov/fulltext/ED537265.pdf

Burt, B. A., Williams, K. L., & Smith, W. A. (2018). Into the storm: Ecological and sociological impediments to Black males' persistence in engineering graduate programs. *American Educational Research Journal, 55*(5), 965–1006

Cabrera, N. L. (2014). Exposing whiteness in higher education: White male college students minimizing racism, claiming victimization, and recreating white supremacy. *Race Ethnicity and Education*, *17*(1). 30–55.

Cabrera, N. L. (2020). “Never forget” the history of racial oppression: Whiteness, white immunity, and educational debt in higher education. *Change: The Magazine of Higher Learning*, *52*(2), 37–40.

Cabrera, N. L., Franklin, J. D., & Watson, J. S. (2016). *Whiteness in higher education: The invisible missing link in diversity and racial analyses*. Association for the Study of Higher Education monograph series. San Francisco, CA: Jossey-Bass.

Carlone, H. B., and Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research and Science Teaching*, *44*(8), 1187-1218.

Chang, R. S. (1993). Toward an Asian American legal scholarship: Critical Race theory, post-structuralism, and narrative space. *California Law Review*, *81*(5), 1241–1323.

Chang, M. J., Cerna, O., Han, J., & Sàenz, V. (2008). The contradictory roles of institutional status in retaining underrepresented minorities in biomedical and behavioral science majors. *The Review of Higher Education*, *31*(4), 433–464.

Chang, M. J., Eagan, M. K., Lin, M. H., & Hurtado, S. (2011). Considering the Impact of Racial Stigmas and Science Identity: Persistence Among Biomedical and Behavioral Science Aspirants. *The Journal of Higher Education*, *82*(5), 564–596.

Chang, M. J., Sharkness, J., Hurtado, S., & Newman, C. B. (2014). What matters in college for retaining aspiring scientists and engineers from underrepresented racial groups. *Journal of Research in Science Teaching*, *51*(5), 555–580.

Chemers, M. M., Zurbriggen, E. L., Syed, M., Goza, B. K., & Bearman, S. (2011). The Role of Efficacy and Identity in Science Career Commitment Among Underrepresented Minority Students. *The Journal of Social Issues*, *67*(3), 469–491.

Chen, G. A., & Buell, J. Y. (2018). Of models and myths: Asian(Americans) in STEM and the neoliberal racial project. *Race Ethnicity and Education*, *21*(5), 607–625.

Clark, L. M., Frank, T. J., & Davis, J. (2013). Conceptualizing the African American mathematics teacher as a key figure in the African American education historical narrative. *Teachers College Record*, *115*(2), 1-15.

Cobb, P., Gresalfi, M., & Hodge, L. L. (2009). An Interpretive Scheme for Analyzing the Identities That Students Develop in Mathematics Classrooms. *Journal for Research in Mathematics Education*, *40*(1), 40–68.

Cole, D. & Espinoza, A. (2008). Examining the academic success of Latino students in science, technology, engineering, and mathematics (STEM) majors. *Journal of College Student Development, 49*(4), 285-300.

Crenshaw, K. (2016). Mapping the margins: Intersectionality, identity politics, and violence against women of color. In E. Taylor, D. Gillborn, and G. Ladson-Billings (Eds.) *Foundations of Critical Race Theory in Education* (2nd ed.) (pp. 223-250). Routledge. (Original work published 1993).

Crenshaw, K., Gotanda, N., Peller, G., & Thomas, K. (Eds.) (1995). *Critical race theory: The key writings that formed the movement.* New York: Free Press.

Cresswell, J. W. (2013). *Qualitative Inquiry & Research Design: Choosing Among Five Approaches.* SAGE Publications, Inc.

Cribbs, J. D., Hazari, Z., Sonnert, G., & Sadler, P. M. (2015). Establishing an explanatory model for mathematics identity. *Child Development*, *86*(4), 1048–1062.

Cribbs, J., Piatek-Jimenez, K., & Mantone, J. (2015). The relationship between mathematics identity and personality attributes with students' career goals. In Bartell, T.G., Bieda, J.N., Putnam, R.T., Bradfield, K., & Dominiguez, H. (Eds.), *Proceedings of the 37th annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (p. 502-509). Michigan State University.

Daempfle, P. A. (2003). An analysis of the high attrition rates among first year college science, math, and engineering majors. *Journal of College Student Retention: Research, Theory & Practice*, *5*(1), 37–52.

Dancy, M., Rainey, K., Stearns, E., Mickelson, R., & Moller, S. (2020). Undergraduates' awareness of White and male privilege in STEM. *International Journal of STEM Education*, *7*(1), 1–17.

Davis, J. (2019). Using critical race theory as a pedagogical, theoretical, methodological, and analytical tool in mathematics education for Black students in urban areas. In J. Davis & C. C. Jett (Eds.), *Critical Race Theory in Mathematics Education* (pp.183-205). Routledge.

Davis, L. & Fry, R. (2019, July 31). *College faculty have become more racially and ethnically diverse, but remain far less so than students*. Pew Research Center. https://www.pewresearch.org/fact-tank/2019/07/31/us-college-faculty-student-diversity/

DeFranco, T. C., & McGivney-Burelle, J. (2001). The Beliefs and Instructional Practices of Mathematics Teaching Assistants Participating in a Mathematics Pedagogy Course. *Proceedings of the Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education*, 681–690.

Delgado R. & Stefancic, J. (2017). *Critical Race Theory: An Introduction* (3rd Edition). New York University Press.

Deshler, J.M., Hauk, S., Speer, N. (2015). Professional Development in Teaching for Mathematics Graduate Students. *Notices of the American Mathematical Society*, *62*(6), 638–643.

DiAngelo, R. (2011). White fragility. *International Journal of Critical Pedagogy, 3*(3). 54-70.

Diggs, G. A., Garrison-Wade, D. F., Estrada, D., & Galindo, R. (2009). Smiling faces and colored spaces: The experiences of faculty of color pursing tenure in the academy. *The Urban Review*, *41*(4), 312.

Dortch, D., & Patel, C. (2017). Black Undergraduate Women and Their Sense of Belonging in STEM at Predominantly White Institutions. *NASPA Journal About Women in Higher Education*, *10*(2), 202–215.

Dwyer, S. C., & Buckle, J. L. (2009). The space between: On being an insider-outsider in qualitative research. *The International Journal of Qualitative Methods, 8*(1). 54-63.

Eagan, M. K., Hurtado, S., & Chang, M. J. (2010). *What Matters in STEM: Institutional Contexts that Influence STEM Bachelor's Degree Completion Rates*. 2010 Annual Meeting of the Association for the Study of Higher Education, Indianapolis, Indiana.

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

Ellis, J. (2014). Preparing Future Professors: Highlighting the Importance of Graduate Student Professional Development Programs in Calculus Instruction. In S. Oesterle, P. Liljedahl, C. Nocil, & D. & Allan (Eds.), *Proceedings of the Joint Meeting of PME 38 and PME-NA 36* (pp. 3–9). PME.

Ellis, J., Kelton, M., & Rasmussen, C. (2014). Student perceptions of pedagogy and persistence in calculus. *ZDM—The International Journal on Mathematics Education, 46*(4), 661-673.

Feagin, J. R. (2006). *Systemic racism*. Routledge.

Feagin, J. R. (2020). *The white racial frame: Centuries of racial framing and counter-framing* (3rd ed.). Routledge.

Ferguson, R. (1990). Introduction: Invisible center. In M. Fever, R. Ferguson, T. Minh Ha, and C. West (Eds.), *Out there: Marginalization and contemporary cultures* (pp. 9-14). New Museum of Contemporary Art and M.I.T. Press.

Ferrare, J. J., & Miller, J. M. (2020). Making Sense of Persistence in Scientific Purgatory: A Multi-Institutional Analysis of Instructors in Introductory Science, Technology, Engineering, and Mathematics (STEM) Courses. *The Journal of Higher Education*, *91*(1), 113–138.

Fries-Britt, S.(1998). Moving beyond Black achiever isolation: Experiences of gifted Black collegians. *The Journal of Higher Education, 69,* 556-576.

Garibay, J. C. (2018). Beyond traditional measures of STEM success: Long-term predictors of social agency and conducting research for social change. *Research in Higher Education*, *59*(3), 349–381.

Gasiewski, J. A., Eagan, M. K., Garcia, G. A., Hurtado, S., & Chang, M. J. (2012). From Gatekeeping to Engagement: A Multicontextual, Mixed Method Study of Student Academic Engagement in Introductory STEM Courses. *Research in Higher Education*, *53*(2), 229–261.

Geertz, C. (1973). *The interpretation of cultures*. Basic Books.

Gholson, M., & Martin, D. B. (2014). Smart Girls, Black Girls, Mean Girls, and Bullies: At the Intersection of Identities and the Mediating Role of Young Girls' Social Network in Mathematical Communities of Practice. *Journal of Education*, *194*(1), 19–33.

Ghosh-Dastidar, U., & Liou-Mark, J. (2014). Bridging pathways through research and leadership for underrepresented students in STEM. *Mathematics and Computer Education*, *48*(3), 214–226.

Glesne, C. (2016). *Becoming Qualitative Researchers: An Introduction* (5th edition). Pearson Education, Inc.

Grant, M. R., Crompton, H., & Ford, D. J. (2015). Black Male Students and The Algebra Project: Mathematics Identity as Participation. *Journal of Urban Mathematics Education*, *8*(2), 87–118.

Gusa, D. L. (2010). White Institutional Presence: The Impact of Whiteness on Campus Climate. *Harvard Educational Review*, *80*(4), 464–490.

Gutiérrez, R. (2007). (Re)Defining equity: The importance of a critical perspective. In Cobbs, p. & Nasir, N.S. (Eds.), *Improving Access to Mathematics: Diversity and Equity in the Classroom* (pp. 37–50). Teachers College, Columbia University.

Gutiérrez, R. (2013). The sociopolitical turn in mathematics education. *Journal for Research in Mathematics Education*, *44*(1), 37–68.

Harris, C. (1993). Whiteness as property. *Harvard Law Review, 106*(8), 1707-1791.

Harris, G., Froman, J., & Surles, J. (2009). The professional development of graduate mathematics teaching assistants. *International Journal of Mathematical Education in Science and Technology*, *40*(1), 157–172.

Haynes, C., & Patton, L. D. (2019). From Racial Resistance to Racial Consciousness: Engaging White STEM Faculty in Pedagogical Transformation. *Journal of Cases in Educational Leadership*, *22*(2), 85–98.

Hazari, Z., Sonnert, G., Sadler, P. M., Shanahan, M. (2009). Connecting high school physics experiences, outcome expectations, physics identity, and physics career choice: A gender study. *Journal of Research in Science Teaching, 47*(8), 978-1003.

Hernández-Truyol, B. E. (1997). Borders (en)gendered: Normativities, Latinas, and a LatCrit paradigm. *New York University Law review, 72*(4). 882-927.

Hillel, J. (2001). Trends in curriculum: A working group report. In D. Holton (Ed.), *The Teaching and Learning of Mathematics at University Level: An IMCI Study* (pp. 59-70). Kluwer Academic Publishers.

Hilts, A., Part, R., & Bernacki, M. L. (2018). The roles of social influences on student competence, relatedness, achievement, and retention in STEM. *Science Education*, *102*(4), 744–770.

Hurtado, S., Han, J. C., Sáenz, V. B., Espinosa, L. L., Cabrera, N. L., & Cerna, O. S. (2007). Predicting transition and adjustment to college: biomedical and behavioral science aspirants' and minority students' first year of college. *Research in Higher Education*, *48*(7), 841–887.

Imlay, S. & Schaap, B. M. (2017). *Presidents of minority serving institutions*. American Council on Education. https://www.acenet.edu/Documents/infographic-ACPS-msi-presidents.pdf

Jackson, P. (1968). *Life in Classrooms*. Rinehart and Winston.

Jiminez, L., Sargrad, S., Morales, J., and Thompson, M. (2016). *Remedial education: The cost of catching up*. Center for American Progress. http://cdn.americanprogress.org

Johnson, A. C. (2007). Unintended consequences: How science professors discourage women of color. *Science Education*, *91*(5), 805–821.

Johnson, D. R. (2012). Campus racial climate perceptions and overall sense of belonging among racially diverse women in STEM majors. *Journal of College Student Development, 53*(2), 336–346.

Jones, S. R., Torres, V., & Arminio, J. (2014). *Negotiating the Complexities of Qualitative Research in Higher Education: Fundamental Elements and Issues* (2nd edition). Routledge.

Justin-Johnson, C. (2004). *Good fit or chilly climate: An exploration of the persistence experiences of African American women at predominantly white college science programs (Unpublished doctoral dissertation).* University of New Orleans.

Kim, J. Y. (1999). Are Asians Black?: The Asian-American civil rights agenda and the contemporary significance of the Black/White paradigm. *The Yale Law Journal*, *108*(8), 2385–2412.

Ladson-Billings, G. (2016). Just what is Critical Race Theory doing in a *nice* field like education? In E. Taylor, D. Gillborn, and G. Ladson-Billings (Eds.) *Foundations of Critical Race Theory in Education* (2nd ed.) (pp. 15-30). Routledge. (Original work published 1998).

Langer-Osuna, J. M., & Nasir, N. S. (2016). Rehumanizing the "Other": Race, Culture, and Identity in Education Research. *Review of Research in Education*, *40*(1), 723–743.

Larnell G. V. (2016). More than just skill: Examining mathematics identities, racialized narratives, and remediation among Black undergraduates. *Journal for Research in Mathematics Education*, *47*(3), 233-269.

Lee, M. J., Collins, J. D., Harwood, S. A., Mendenhall, R., & Huntt, M. B. (2020). "If you aren't White, Asian or Indian, you aren't an engineer": racial microaggressions in STEM education. *International Journal of STEM Education*, *7*(1), 1–16.

Leonardo, Z. (2004). The color of supremacy: Beyond the discourse of "white privilege." *Educational Philosophy and Theory*, *36*(2), 137–152.

Leyva, L. A. (2016). An Intersectional Analysis of Latin@ College Women's Counter-stories in Mathematics. *Journal of Urban Mathematics Education*, *9*(2), 81–121.

Leyva, L. A., McNeill, R. T., & Marshall, B. L., & Guzmán, O. A. (2021). "It Seems like They Purposefully Try to Make as Many Kids Drop": An Analysis of Logics and Mechanisms of Racial-Gendered Inequality in Introductory Mathematics. *The Journal of Higher Education*, 92(5), 784-814.

Leyva, L. A., Quea, R., Weber, K., Battey, D., & López, D. (2021). Detailing Racialized and Gendered Mechanisms of Undergraduate Precalculus and Calculus Classroom Instruction. *Cognition and Instruction*, *39*(1), 1–34.

Lin, A. M. Y. (2015). Researcher Positionality. In F. M. Hult & D. C. Johnson (Eds.), *Research Methods in Language Policy and Planning: A Practical Guide* (pp. 21–32). John Wiley & Sons, Inc.

Liu, W. M. (2017). White male power and privilege: The relationship between White supremacy and social class. *Journal of Counseling Psychology*, *64*(4), 349–358.

Liu, W. M. (2020, November 12). *Racial Capitalism* [PowerPoint Presentation]. University of Maryland, College Park, Race, Whiteness, and Identity. ELMS: myelms.umd.edu

Liu, W.M., & Liu, R.Z. (forthcoming). *Systems of White Supremacy and White Privilege: A Racial-Spatial Framework for Psychology.* Oxford University Press.

Lue, K. (2022). Navigating The Multiple Roles of Mathematics Graduate Teaching Assistants in Pursuit of Racial Equity, Access, and Justice. In S. Clem (Ed.) *Exploring how we teach: Lived experience, lessons, and research for graduate students by graduate students*. Utah State University.

Lue, K. & Turner, B.O. (2020). The stories we tell: Disrupting the myth of neutrality in math through counternarratives. *Journal of Folklore in Education, 7*, 136-146.

Lue, K., Zheng, J., Park, J. J. (2022, November 16-19). *Diversity through our EYES: Asian International Mathematics Graduate Teaching Assistants' Perceptions of Race and Diversity.* Paper Presentation at the 2022 ASHE Conference. Las Vegas, Nevada.

Madison, D. S. (2020). *Critical ethnography: Methods, ethics, and performance* (3rd edition). SAGE Publications, Inc.

Malone, K. R., & Barabino, G. (2008). Narrations of race in STEM research settings: Identity formation and its discontents. *Science Education*, *93*(3), 485–510.

Margolis, E., Soldatenko, M., Acker, S., & Gair, M. (2001). Peekaboo: Hiding and outing the curriculum. In E. Margolis (Ed.), *The Hidden Curriculum in Higher Education* (pp.1-19). Routledge.

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

Martin, D. B. (2007). Mathematics learning and participation in the African American context: The co-construction of identity in two intersecting realms of experience. In Cobbs, P. & Nasir, N.S. (Eds.), *Improving Access to Mathematics: Diversity and Equity in the Classroom* (pp. 146–158). Teachers College, Columbia University.

Martin, D. B. (2008). E(race)ing race from a national conversation on mathematics teaching and learning. *The Montana Mathematics Enthusiast*, *5*(2 & 3), 387–398.

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

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

Martin, D. B. (2019, November) *All identity work ain't good identity work: A brief commentary on mathematics identity research.* Colloquium Presentation at the University of Maryland Center for Mathematics Education, College Park, MD.

Matias, C. E., Viesca, K. M., Garrison-Wade, D. F., Tandon, M., & Galindo, R. (2014). "What is critical whiteness doing in OUR nice field like critical race theory?" Applying CRT and CWS to understand the white imaginations of white teacher candidates. *Equity & Excellence in Education: University of Massachusetts School of Education Journal*, *47*(3), 289–304.

McGee, E. O. (2015). Robust and fragile mathematical identities: A framework for exploring racialized experiences and high achievement among Black college students. *Journal for Research in Mathematics Education*, *46*(5). 599–625.

McGee, E. O. (2016). Devalued Black and Latino racial identities: A by-product of STEM college culture? *American Educational Research Journal*, *53*(6), 1626–1662.

McGee, E. O., & Bentley, L. (2017). The Troubled Success of Black Women in STEM. *Cognition and Instruction*, *35*(4), 265–289.

McGee, E. O., & Martin, D. B. (2011). "You would not believe what I have to go through to prove my intellectual value!" Stereotype management among academically successful

Black mathematics and engineering students. *American Educational Research Journal*, 48(6). 1347–1389.

McGee, E. O., & Pearman, F. A. (2014). Risk and Protective Factors in Mathematically Talented Black Male Students: Snapshots From Kindergarten Through Eighth Grade. *Urban Education*, *49*(4), 363–393.

McIntosh, P. (1989, July/August). White privilege: Unpacking the invisible knapsack. *Peace and Freedom Magazine*, 10-12.

Merriam, S. B., Johnson-Bailey, J., Lee, M.-Y., Kee, Y., Ntseane, G., & Muhamad, M. (2001). Power and positionality: negotiating insider/outsider status within and across cultures. *International Journal of Lifelong Education*, *20*(5), 405–416.

Merriam, S. B. (2002). *Qualitative research in practice: Examples for discussion and analysis.* Jossey-Bass.

Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation.* Jossey-Bass.

Miller, J. P. & Seller, W. (1990). *Curriculum: Perspectives and practice.* Copp Clark Pitman.

Mills, C. (2007). White Ignorance. In S. Sullivan & N. Tuana (Eds.), *Race and Epistemologies of Ignorance* (pp. 13-38). State University of New York Press.

Moore, W. L. (2008). *Reproducing racism: White space, elite law schools, and racial inequality*. Rowman & Littlefield.

Moses, R. P. & Cobb, C. E. (2001). *Radical equations: Math literacy and civil rights.* Boston: Beacon Press.

Nasir, N. S., & McKinney de Royston, M. (2013). Power, identity, and mathematical practices outside and inside school. *Journal for Research in Mathematics Education*, *44*(1), 264–287.

Nasir, N. S., & Shah, N. (2011). On defense: African American males making sense of racialized narratives in mathematics education. *Journal of African American Males in Education*, *2*(1), 24–45.

National Science Board. (2016). *Science and Engineering Indicators 2016* (NSB-2016-1). National Science Foundation. https://www.nsf.gov/statistics/2016/nsb20161/uploads/1/nsb20161.pdf

Ngo, F., and Kosiewicz, H. (2017). How extending time in developmental math impacts student persistence and success: Evidence from a regression discontinuity in community colleges. *The Review of Higher Education*, *40*(2). 267-306.

O'Meara, K. (2007). Striving for what? Exploring the pursuit of prestige. In J. Smart (Ed.), *Higher education: Handbook of theory and research,* 22 (pp. 121-179). New York, NY: Springer.

Omi, M. & Winant, H. (1994). *Racial formation in the United States from the 1960s to the 1990s*. (2nd edition). Taylor & Francis, Inc.

Ong, M., Wright, C., Espinosa, L., & Orfield, G. (2011). Inside the double bind: A synthesis of empirical research on undergraduate and graduate women of color in science, technology, engineering, and mathematics. *Harvard Educational Review*, *81*(2), 172–209.

Oppland-Cordell, S. B. (2014). Urban Latina/o Undergraduate Students' Negotiations of Identities and Participation in an Emerging Scholars Calculus I Workshop. *Journal of Urban Mathematics Education*, *7*(1), 19–54.

Oppland-Cordell, S., & Martin, D. B. (2015). Identity, power, and shifting participation in a mathematics workshop: Latin@ students' negotiation of self and success. *Mathematics Education Research Journal*, *27*(1). 21–49.

Ortagus, J. C. (2016). Pursuing prestige in higher education. *College & University*, *91*(2), 10–19.

Palmer, R. T., Maramba, D. C., & Dancy, T. E. (2011). A qualitative investigation of factors promoting the retention and persistence of students of color in STEM. *The Journal of Negro Education*, *80*(4), 491–504.

Palmer, D., & Caldas, B. (2017). Critical Ethnography. In K. A. King, Y.-J. Lai, & S. May (Eds.), *Research Methods in Language and Education* (pp. 381–392). Springer International Publishing.

Park, J. J. (2020). Do we really know what we see? The role of cognitive bias in how we view race in higher education. *Change: The Magazine of Higher Learning*, *52*(2), 46–49.

Park, J. J., Kim, Y. K., Salazar, C., & Hayes, S. (2019). Student–faculty interaction and discrimination from faculty in STEM: The link with retention. *Research in Higher Education*, *61*(3), 330–356.

Park, J. J., Kim, Y. K., Salazar, C., & Eagan, M. K. (2020). Racial discrimination and student–faculty interaction in STEM: Probing the mechanisms influencing inequality. *Journal of Diversity in Higher Education, 15*(2), 218-229.

Park, J. J., Kim, Y. K., Lue, K., Zheng, J., Parikh, R., Salazar, C., & Liwanag, A. (2021). Who Are You Studying With? The Role of Diverse Friendships in STEM and Corresponding Inequality. *Research in Higher Education*, *62,* 1146-1167.

Patton, L. D., & Haynes, C. (2020). Dear white people: Reimagining whiteness in the struggle for racial equity. *Change: The Magazine of Higher Learning*, *52*(2), 41–45.

Perez, T., Cromley, G., & Kaplan, A. (2014). The role of identity development, values, and cost in college STEM retention. *Journal of Educational Psychology, 106*(1), 315-329.

Phillips, C. J. (2014). The new math and midcentury American politics. *Journal of American History, 101*(2), 454–479.

Pierrakos, O., Beam. T., Constantz, J., Johri, A., & Anderson, R. (2009*).* On the development of a professional identity: Engineering persisters versus engineering switchers. Paper presented at the 39th ASEE/IEEE Frontiers in Education Conference, San Antonio, TX.

Raychaudhhuri, D., & Hsu, E. (2012). A Longitudinal Study of Mathematics Graduate Teaching Assistants' Beliefs About the Nature of Mathematics and their Pedagogical Approaches Towards Teaching Mathematics. In Brown, S., Larsen, S., Marrongelle, K., & Oehrtman, M. (Ed.), *Proceedings of the 15th Conference on Research in Undergraduate Mathematics Education* (pp. 522–525).

Saldaña, H. (2021). *The coding manual for qualitative researchers* (4th ed.). Sage Publications, Inc.

Santelices, M. V., & Wilson, M. (2010). Unfair treatment? The case of Freedle, the SAT, and the standardization approach to differential item functioning. *Harvard Educational Review*, *80*(1), 106–134.

Seltzer, R. (2017, June 20). *The slowly diversifying presidency*. Inside Higher Ed. https://www.insidehighered.com/news/2017/06/20/college-presidents-diversifying-slowly-and-growing-older-study-finds

Seymour, E. & Hewitt, N. (1997). *Talking about leaving.* Westview Press.

Seymour, E., Hunter, A-B., & Weston, T. J. (2019). Why we are still talking about leaving. In E. Seymour, & A-B. Hunter (Eds.), *Talking about leaving revisited: Persistence, relocation, and loss in undergraduate STEM education* (pp. 1-53). Springer.

Sonnert, G., Sadler, P., Sadler, S., & Bressoud, D. (2015). The impact of instructor pedagogy on college calculus students' attitudes towards mathematics. *International Journal of Mathematics Education for Science and Technology, 46*(3), 370-387.

Speer, N., Gutmann, T., & Murphy, T. J. (2005). Mathematics Teaching Assistant Preparation and Development. *College Teaching*, *53*(2), 75–80.

Speer, N. M., Smith, J. P., & Horvath, A. (2010). Collegiate mathematics teaching: An unexamined practice. *The Journal of Mathematical Behavior*, *29*(2), 99–114.

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.

Strauss, A. & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed.). Sage Publications, Inc.

Tate, W. F. (1997). Critical race theory and education: History, theory and implications. *Review of Research in Education, 22*(1), 195-247.

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

Trapani, J., & Hale, K. (2019). *Higher Education in Science and Engineering. Science and Engineering Indicators 2020.* (NSB-2019-7). National Science Foundation: National Science Board. https://ncses.nsf.gov/pubs/nsb20197/

Treisman, U. (1992). Studying Students Studying Calculus: A Look at the Lives of Minority Mathematics Students in College. *The College Mathematics Journal*, *23*(5), 362–372.

Triandis, H. C. (1995). *Individualism & collectivism.* Routledge.

Trow, M. (1999). American higher education—Past, present and future. In J. L. Bess & D. S. Webster (Eds.), *Foundations of American Higher Education, Second Edition.* (pp. 7-22). Simon & Schuster Custom Publishing.

Turner, B. (2020). Products of white institutional spaces: A curricular analysis of whiteness in an online mathematics curriculum. In In Sacristán, A.I., Cortés-Zavala, J.C. & Ruiz-Arias, P.M. (Eds.). *Mathematics Education Across Cultures: Proceedings of the 42nd Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education, Mexico* (pp. 578-581). Cinvestav / AMIUTEM / PME-NA.

Turner, E., Dominguez, H., Maldonado, L., & Empson, S. (2013). English Learners' Participation in Mathematical Discussion: Shifting Positionings and Dynamic Identities. *Journal for Research in Mathematics Education*, *44*(1). 199-234.

U.S. Department of Education. (n.d.) *United States Department of Education lists of postsecondary institutions enrolling populations with significant percentages of undergraduate minority students.* https://www2.ed.gov/about/offices/list/ocr/edlite-minorityinst.html

U.S. Department of the Interior. (n.d.) *Minority serving institutions program.* https://www.doi.gov/pmb/eeo/doi-minority-serving-institutions-program

U.S. News. (2022a). *2022-23 best national university rankings*. https://www.usnews.com/best-colleges/rankings/national-universities

U.S. News (2022b). *Top public schools: National universities.* https://www.usnews.com/best-colleges/rankings/national-universities/top-public

Van Maanen, J. (2011). Ethnography as work: Some rules of engagement: *The Journal of Management Studies*, *48*(1), 218–234.

Weidman, J. C., Twale, D. J., & Stein, E. L. (2001). Socialization of graduate and professional students in higher education: a perilous passage? *ASHE-ERIC Higher Education Report*, *28*(3), 1–112.

Whittaker, J. A., & Montgomery, B. L. (2013). Cultivating Institutional Transformation and Sustainable STEM Diversity in Higher Education through Integrative Faculty Development. *Innovative Higher Education*, *39*(4), 263–275.

Woodall, D. (2013). Challenging whiteness in higher education classrooms: Context, content, and classroom dynamics. *The Journal of Public and Professional Sociology*, *2*(8). 1-17.